Application of the Biosphere Reserve Concept to Coastal Marine Areas

A Marine Conservation and Development Report

IUCN
The World Conservation Union

Application of the Biosphere Reserve Concept to Coastal Marine Areas

Papers presented at the UNESCO/IUCN San Francisco Workshop of 14-20 August 1989

UNESCO'S MAN AND THE BIOSPHERE PROGRAMME

Launched in 1971, the MAB Programme seeks answers for improving linkages between people and the biosphere. MAB concentrates on the conservation and monitoring of biological diversity and ecosystem processes, the sustainable management of natural resources at the ecosystem and landscape levels, and the integration of the socio-cultural and ethical dimensions in land development. The biosphere reserve concept was initiated by MAB to reconcile the conservation of natural and semi-natural solutions to local land use problems so that local people fully and directly benefit from the biopshere reserves.

UNESCO AND THE MARINE SCIENCES

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UNESCO's Coastal Marine (COMAR) Programme has been working officially since 1981 to increase the scientific understanding of coastal waters and to transfer this knowledge to participating countries for the benefit of better management and sustainable development through extensive training and research projects. Operating through regional and inter-regional projects, COMAR studies land-sea interactions and marine ecosystems such as lagoons, estuaries and bays, mangroves, coral reefs and seagass beds.

THE MARINE AND COASTAL AREAS PROGRAMME

IUCN's Marine and Coastal Areas Programme was established in 1985 to promote activities which demonstrate how conservation and development can reinforce each other in marine and coastal environments; conserve marine and coastal species and ecosystems; enhance awareness of marine and coastal conservation issues and management; and mobilise the global conservation community to work for marine and coastal conservation. The Marine Conservation and Development Reports are designed to provide access to a broad range of policy statements, guidelines, and activity reports relating to marine issues of interest to the conservation and development community.

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Contents

Part II: Case Studies

Introduction

The biosphere reserves concept was first initiated under UNESCO's Man and the Biosphere (MAB) Programme in 1974 to meet the increasing need to reconcile long term protection of natural and semi-natural ecosystems with human uses, backed up by interdisiplinary research. Almost all biosphere reserves set up since that date were in terrestrial systems and it was not until the late 1980s that attention turned towards the land-sea interface with its specific suite of ecological, socioeconomic and legislative conditions. Coastal biosphere reserves cover a number of interests in addition to those of the MAB Programme since they are of direct concern to coastal zone management planning and long term research and monitoring. It was thus in the interests of the MAB Programme, the COMAR Programme and the Intergovernmental Commission of UNESCO and the Marine and Coastal Areas Programme of IUCN to jointly explore the appropriateness of the biosphere reserve concept to coastal areas. The workshop on the *Application of the Biosphere Reserve Concept to Coastal Marine Areas* was accordingly convened by UNESCO and IUCN, and hosted by NOAA, at the Fort Mason Centre, San Francisco, on 14-20 August 1989.

The objectives of the workshop were as follows:

- to review the scientific, management and administrative characteristics that are specific to coastal and marine areas;

- to synthesise from this review those factors that most affect the establishment of coastal marine biosphere reserves; and

- to prepare guidelines for the application of the biosphere reserve concept to coastal marine areas.

Towards these ends, a number of keynote papers were solicited to address the scientific, social, political, managerial and administrative aspects of coastal and marine planning. In addition, a number of speakers were invited to present case studies to illustrate some of the actual issues that have arisen around the world in coastal marine area management and planning, and to provide practical examples of situations against which the guidelines could be tested and refined.

This publication is a straightforward presentation of the keynote papers and case studies which were prepared for the workshop. The debate on planning for coastal marine areas has continued to develop since 1989, but the issues addressed in these papers remain central to this discussion. The keynote papers together provide an excellent digest of the different factors which need to be considered in biosphere reserve planning, examining constraints across the full range of physical to socioeconomic spheres.

The case studies presented at the workshop illustrate some of the issues that have had to be addressed in a tremendous variety of environments around the world - political and socioeconomic as well as biophysical. We have not attempted to revise these case studies in the light of developments since 1989 - for those interested in the progress of a particular area, this is a historical document. A case study can only ever aim to capture a moment in time, but its real value is in pinning down a conceptual debate to address actual situations which may be expected to recur elsewhere. In this context, the summarised case studies presented in this document provide examples which are reflected in many present day situations and therefore are as relevant today as they were in 1989.

The San Francisco workshop has also given rise to the MAB Digest entitled *Towards Coastal Biosphere Reserves* by A.T. Agardy and J. Robertson Vernhes (1993) which is a companion to this document.

Part I

1. Development and Implementation of the Biosphere Reserve Concept and its Applicability to Coastal Regions

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Origin and Development of a Concept

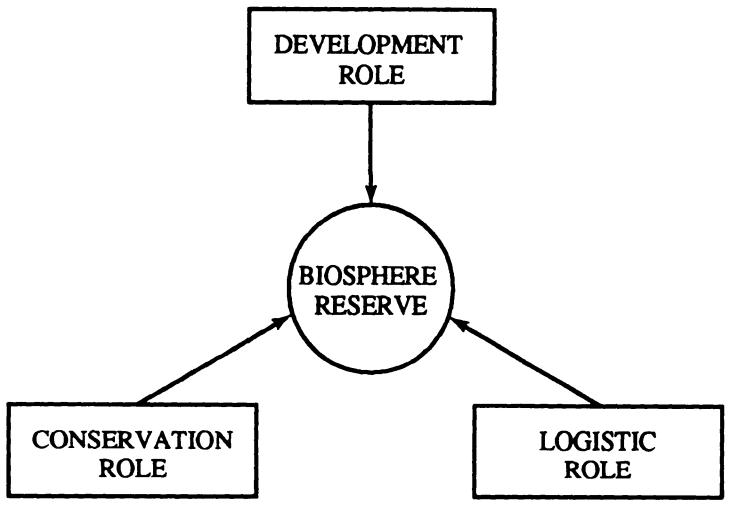
The Biosphere Reserve concept originated some fifteen years ago within the Man and Biosphere Programme (MAB), which itself can be considered as an offshoot, at the intergovernmental and interdisciplinary level, of the earlier International Biological Programme (IBP). The origin and development of these two programmes have been reported in a number of publications: see for instance, Worthington (1983), and Batisse (1980). Under IBP, the need for conservation of ecosystems was particularly stressed. When MAB was formulated, the concept of the biosphere Reserve responded simply, at the beginning, to this need to preserve more systematically genetic resources within representative ecosystems. For those more directly involved in the organization of the MAB Programme, it was also meant to provide a network of identified areas for basic operations as well as research facilities, which were required for such an international scientific effort. And, while this was not emphasised in the first place, the inclusion of Biosphere Reserves in a programme whose main objective was the rational utilisation of natural resources by Mankind, necessarily implied that the imperatives of resource management and development would not be ignored in their design. Thus, although in a somewhat "fuzzy" or hidden way, the three fundamental concerns of Biosphere Reserves were present from the beginning, and were bound to emerge more forcefully as the implementation of the project moved on.

The three roles responding to these concerns can be briefly presented as follows (Batisse, 1986): (i) a "conservation role" (providing protection of genetic resources, species and ecosystems on a worldwide basis), (ii) a "logistic role" (providing interconnected facilities for research and monitoring in the framework of an internationally coordinated scientific programme) and (iii) a "development role" (searching for rational and sustainable use of ecosystem resources and hence for close cooperation with the human populations concerned). Many areas in the world have been performing one or two of these functions for a long time, but few can claim to perform them all.

The very idea and distinctive feature of the Biosphere Reserves is that each one of them must - at least to some extent - address itself to all three basic concerns and to their synergistic combination, as illustrated very simply in Figure 1. Naturally the relative importance of the three roles will vary considerably from case to case, depending on the great diversity of

situations the world over; but it is the combined presence of these three roles which characterizes the Biosphere Reserve concept. In other words, a "Biosphere Reserve" that does not have a protected core area is not a true Biosphere Reserve. A National Park that does not care for the sustainable development of the surrounding regions and for the basic needs of their populations, is not a true "Biosphere Reserve" either. While conservation has been, and should remain, the first concern of Biosphere Reserves, in no way should any of them simply be considered as a "nature reserve" or other conventional form of "protected area".

Figure 1. The Three Concerns and the Three Roles of a Biosphere Reserve



- Association of Environment with Development
- Conservation of Genetic Material and Ecosystems
- International Network for Research and Monitoring

Clearly the concept of Biosphere Reserves was developed by terrestrial ecologists, so that the functional zonation patterns which were drawn for its practical implementation apply best to terrestrial environments. The well-known simplest pattern (Figure 2) consists in a core area, devoted to strict protection, surrounded by a delineated buffer zone where only activities compatible with the conservation objectives can take place, itself surrounded by a more or less defined transition area where cooperation with the population and sustainable resource management practices can be developed. In reality the zonation of a Biosphere Reserve is bound to be more complex, as illustrated in Figure 3; but basically the three main types of areas should remain: namely core areas, buffer zones and transition area.

It is interesting to note that, in the very early stages of the programme, the particular importance of coastal areas was underlined, and that sketches of possible configurations of coastal Biosphere Reserves were given in the first MAB report on "Criteria and Guidelines for the Choice and Establishment of Biosphere Reserves" (UNESCO, 1974). Those sketches, drawn by Professor G. Carleton Ray, related to a river estuary with a reef complex, to a continental lagoon with a barrier beach, and to a partly inhabited tropical atoll.

Figure 2. Schematic zonation of a biosphere reserve

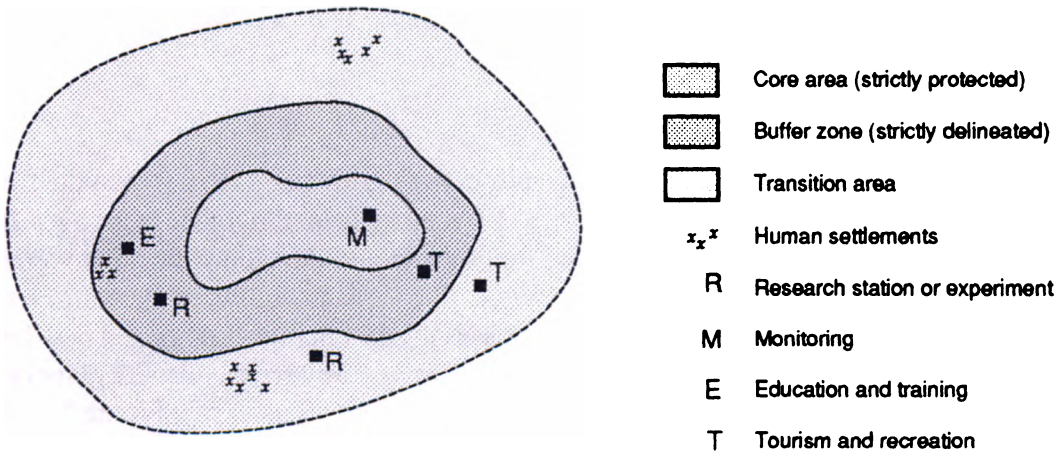
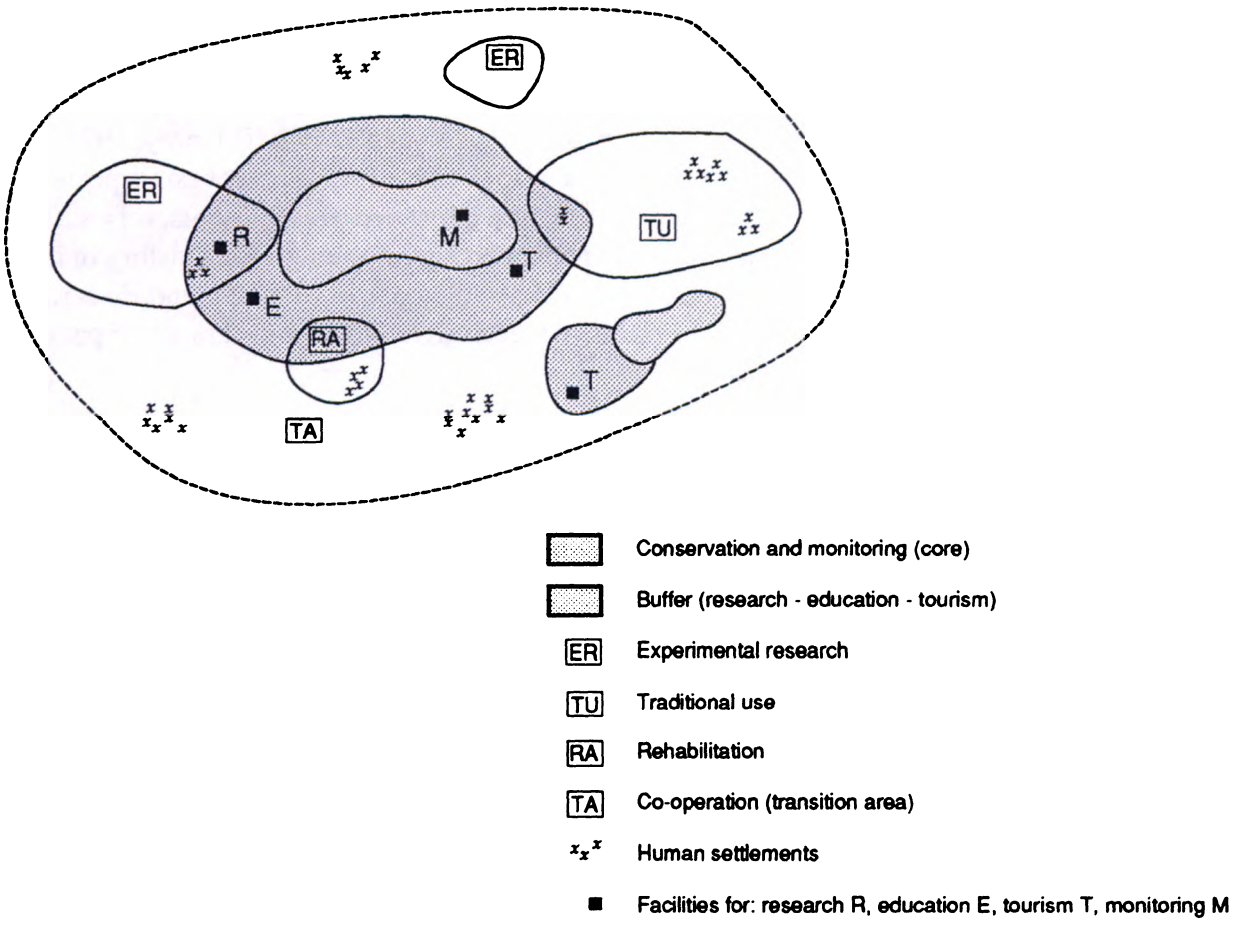


Figure 3. Schematic Distribution of Biosphere Reserve Functions



It should be admitted, however, that - even in the case of terrestrial areas - the concept of Biosphere Reserves was somewhat loosely described in the first years of its implementation (including in the above-mentioned report), and that it has been understood in rather different ways by various people in various parts of the world.

Implementation of the Project

In the initial phase of implementation of the project - roughly from 1976 (when the first batch of biosphere reserves were designated) to 1981 (when their total number went over 200), the conservation role was kept prominent and the logistic and development roles were largely forgotten. In fact almost all Biosphere Reserves then designated were areas already under protection, such as national parks, and in most cases the designation did not add new land, new regulations, or even new functions. The designation was mainly seen as a quality label for some existing protected areas, and the basic combination of concerns shown in Figure 1 was hardly achieved anywhere. This evolution indeed is not surprising - not only because of the initial lack of clarity in the formulation of the new concept, but also because of its very novelty and of the practical difficulties in implementing it adequately and on a world-wide basis.

World-wide Heterogeneity

The world-wide approach was seen as a major yardstick for implementation in the MAB framework, and the land surface of the globe was classified in terms of "biomes" and biogeographic provinces with the idea that a representative network of Biosphere Reserves would include at least one of them in each terrestrial biogeographic unit (Udvardy, 1975). This approach is naturally commendable but it may lead to neglect of some other basis aspects of the real situation. For instance, the establishment of a protected area presents very different problems when one is dealing with a densely populated region having a long history of human occupation - such as in many parts of Europe, the Middle East, or Southern and Eastern Asia - as opposed to a sparsely populated region having received relatively little human impact, such as much of Africa and the Americas.

The presence or quasi-absence of local population around the buffer zone, makes a considerable difference in terms of management and in the very significance of the development role. The cultural and social characteristics of such populations, and their relationships with the national authorities, are also important, and so are some other aspects. Accordingly, it should come as no surprise to find considerable heterogeneity in the current list of designated Biosphere Reserves - altogether 285 in 72 countries, and ranging from previously established national parks in Africa, the USA, and the USSR, to small biological reserves in Europe. They also include field research stations with some land around, or rural landscapes with traditional human settlements but little "Nature" to conserve. This heterogeneity is inevitable and should in no way be harmful to the programme. It reflects the complexity of land systems in relation to human presence and the reality of the world, which some Nature conservationists would like sometimes to ignore.

Uneven Fulfillment of Roles

What is much less satisfactory - and what should progressively be corrected - is that many "Biosphere Reserves" on the official list do not perform in a true manner the three roles indicated in Figure 1, and are not therefore proper Biosphere Reserves. For a better assessment of this problem we should reflect briefly upon the actual significance of these three roles in the light of present experience in implementing the programme.

1. As regards the conservation role, which was initially taken for granted, the question may be asked: conservation of what and for what? Some Biosphere Reserves encompass, for instance, a large piece of tropical forest, and one tends to consider that this is a good thing per se as long as nobody questions it. When traditional or new human pressures develop in the area, the justification for conserving land without any development disturbance has, however, to be made convincingly. When the area has been already the subject of past or continuing anthropic impacts, the exact purpose of conservation has to be clarified. It is not sufficient to say that in a Biosphere Reserve the core area, or core areas, should be "strictly" protected - an objective which in many cases is in fact impossible to achieve when one thinks of possible interferences as diverse as long-range air or water pollution, poaching, or fire. What is necessary is to define precise conservation objectives - which can be more or less ambitious - and to ensure that management of the Biosphere Reserve (including, of course, its core areas) is fully compatible with these conservation objectives. Some people, for instance, find it hard to understand that maintenance of sheep-grazing may be compatible with conservation of important grassland ecosystems in Europe. Generally speaking, conservation in Biosphere Reserves should stress maintenance of ecological processes rather than protection of individual species of biota.

2. The logistic role of Biosphere Reserves is also a multifaceted one. Its primary purpose is supposed to be to provide research and monitoring facilities for participation in an international network. However, such a network is still in its infancy from an operational viewpoint, and much has to be done to give it life and value. Most Biosphere Reserves do have some research or observation facilities - some highly sophisticated, some very limited - but there is hardly any correlation between them. There is also little common understanding on what type of research or monitoring has to be conducted. As time goes on, Biosphere Reserves will have to participate in some cooperative programmes either of global character, such as the International Geosphere-Biosphere Programme, or of a regional or interregional character, to study specific problems such as tropical forest-soil fertility. But at any rate, Biosphere Reserves have their own individual research requirements for which some facilities are required. This type of local research naturally relates to the improvement of knowledge regarding the Biosphere Reserve itself - inventories, and functioning of ecosystems, etc.; but, as the case may be, basic and applied local research must also be oriented towards the development needs of the surrounding population, and look for sustainable use of resources and appropriate technologies that are compatible with the conservation objectives of the core areas. Incidentally, the presence of permanent research facilities and personnel is an additional guarantee for protection of these core areas.

3. The development role of a Biosphere Reserve obviously depends very much on the socio-cultural context within a more or less extended transition area. It is certainly the most difficult and the most innovative role for Biosphere Reserves to fulfil, and it is only natural that it was blurred through the first stages of the programme. Yet, two points should be stressed. The first is that in many developing countries, and probably in some developed ones, protection of ecosystems and species has little future unless the human populations in the area, who often have legitimate claims on the land and the waters, see some direct benefit for themselves deriving from the conservation measures involved. The second - and related - point is that, in many areas of the world which are of great interest for conservation but of marginal agricultural value, there are people living for whom some satisfactory form of rural development should be sought. Wherever this applies, conservation of a given ecosystem could proceed hand-in-hand with compatible forms of development of the same ecosystem under the Biosphere Reserve approach, where such conservation and such development are engineered through participation of, and cooperation with, the people concerned. In this respect, the Biosphere Reserve should be seen asa tool for environmental management (Batisse, 1982).

Flexibility Required

It will appear obvious from the preceding remarks that the Biosphere Reserve concept requires considerable flexibility in its implementation to accommodate the great ecological, economic, and social complexity of our world, but that it provides a consistent backbone and unifying link for a new unconventional approach to conservation. The major obstacles in the proper establishment and functioning of Biosphere Reserves are not conceptual or technical - we know fairly well, in each particular situation, what would be desirable - but managerial and institutional. Here we do not know exactly how to act, and in particular how to organize cooperation between the different partners involved.

The flexibility in implementing the Biosphere Reserve concept is naturally reflected in the zonation patterns which are adopted for each one of them, and through which its multiple functions can be distributed and carried out. In sparsely-inhabited regions, for instance, the core areas will tend to be large, with less-extended buffer zones where most human activities would be prohibited, and the transition area may have low significance. Conversely, in areas with high human pressure, the reverse situation would tend to occur and certain human activities would be permissible in the buffer zone and even in core areas, depending on local conditions and objectives.

The schematic zonation patterns which have been considered so far apply easily when the Biosphere Reserve is located within a region with some ecological and geographical unity - a forest and forest climax ecosystem, for instance. The zonation is more intricate when such unity does not exist, for instance in the case of an oasis in a desert or an isolated mountain. In fact, in all cases where the area of interest includes an ecotone - an interface or zone of tension between very different ecosystems - zonation presents a real problem, and in particular the distribution of the three roles of the Biosphere Reserve illustrated in Figure 1 is easier to apply to each side of the interface than to the interface itself.

We probably encounter here one of the main reasons why so few coastal Biosphere Reserves have been created. Not more than ten on the current list can claim this qualification, and only three or four really deserve it. At the opening of the 1983 International Biosphere Reserve Congress in Minsk (UNESCO-UNEP, 1984), we had to note that "the conspicuous absence of coastal biosphere reserves in almost all areas of the world is a matter of concern". Yet, the ensuing "Action Plan for Biosphere Reserves" adopted later on (UNESCO, 1984) was almost silent about what should be done on the matter, apart from calling for a "classification of representative ecological areas covering intertidal and marine habitats in coastal areas". Such a classification was worked out (Hayden et al., 1984) and provides as useful supplement to the former terrestrial classification, but naturally it constitutes only a supporting measure for encouraging the establishment of coastal Biosphere Reserves.

Applicability to Coastal Regions

It would seem today that there should be no semantic ambiguity about the meaning of the word "coastal". "The coastal zone is the band of dry land and adjacent ocean space (water and submerged land) in which land ecology and use directly affect ocean-space ecology, and vice versa. The coastal zone is a band of variable width which borders the continent.. Geographically, the landward boundary of the coastal zone is necessarily vague... The seaward boundary has been defined as the extent to which man's land-based activities have a measurable influence on the chemistry of the water or on the ecology of marine life" (Ketchum, 1972).

In other words it should be well established in all languages that the "coastal zone" is both land and sea and that its boundary extends rather widely on each side of the coastline interface. However, mostterrestrial ecologists tend to forget the marine part of the coastal zone, and most oceanographers seem to consider that it stops at the high-tide mark. This forceful split between scientific disciplines and scientific institutions is aggravated in practically all countries of the world by an equal split between responsible administrations, the jurisdiction of land authorities stopping somewhere in between high- and low-tide marks, and the maritime authorities denying any competence to anyone else over the sea realm.

The above, outdated and narrow-minded conflict between disciplines is scarcely conducive to building up a solid scientific front for protection of coastal environments! Similarly, the multiplicity of centres of decision that attempt to preserve, often very jealously, their sectoral authority, is not conducive to the rational management of coastal areas. Yet everyone knows that these areas contain very special, very important, very fragile, and very threatened ecosystems on both sides of the coastline which interplay in a highly complex fashion. When considering the concentration of human population, and of economic activities in coastal regions defined in a broad way, they constitute in fact about the most important subdivision of the planet (Ray & McCormick-Ray, 1987), and should receive priority attention for adequate planning and rational development, including through the Biosphere Reserve programme. The results of the future studies of the Blue Plan, concerning the Mediterranean Basin, are particularly revealing as regards the crucial importance of coastal regions and of their proper management for both developed and developing countries (Grenon & Batisse, 1989).

The Coastal Conservation Concern

Assuming that the political will exists for their establishment, Coastal Biosphere Reserves should respond in the first place to the widespread and increasing conservation concern for coastal ecosystems.

Considering, first, conservation on the land side, the application of the concept to conservation in a coastal area has of course to embody the general principles recalled earlier, including delineation of a buffer zone and protection of a core area. A major obstacle to conservation in terrestrial coastal areas arising all over the world, and particularly in those with dense human populations and long histories, is the high economic value of coastal land, where a large variety of very profitable human activities tend to concentrate, including urbanisation, industry, energy, tourism, and all forms of transport. It is well known for instance that protection of inland lagoons and other coastal wetlands, which are all-too-often considered as areas for discharging waste or for covering with concrete, is a formidable challenge.

The problem is aggravated by the need to protect the marine side of a Coastal Biosphere Reserve from what takes place on land, as river discharge and effluents come from there and as human activities which disturb marine ecosystems are largely land-based. Proper delineation of a coastal conservation area demands protection of the marine part from what comes from the land. This imperative has been too-often forgotten in the establishment of marine parks and of some Biosphere Reserves (such as Miramare in Italy or Malindi-Watamu in Kenya, the latter of which is shown in Figure 4). This implies, in particular, adequate consideration of what takes place in whole watersheds, though admittedly it is difficult to control sediment and pollution reaching the sea from large-scale watersheds.

When we come to conservation on the marine side of the coastline as such, we are confronted with a dynamic system having two major interacting components, the water column and the sea-bottom. With the exception of traditional rights of fishermen and similar groups, jurisdiction over the sea-bottom and definition of authority or "ownership" is not fully clear. It would appear, however, that delineation of core areas or buffer zones on the sea bottom could be made by the national authority concerned in order to ensure some degree of conservation of benthic life. One approach could consist of deciding on a certain depth for delineation of a buffer zone. The definition of core areas within the buffer zone could in theory follow, although these core areas may have to be modified with time because of geomorphological changes and as actual enforcement of protection may raise serious difficulties. (Inthe case of the Iroise Biosphere Reserve in France, marine core areas exist in fact only because of the extremely rough sea, the chaotic rocky bottom, and the strong currents, prevent any human approach in a fairly large part of the Biosphere Reserve).

Delineation of the sea-bottom has, however, no effect on the water column, which is not a fixed element and is subject to external influences from currents, tides, and other movements. This would make it hard to define meaningful core areas and buffer zones protecting pelagic life. The situation is comparable to some extent to what happens in a terrestrial area where atmospheric or river-borne pollutants cannot be prevented from entering a reserve. Nevertheless, from the point of view of properly controlled fishing activities, the idea of a transition area on the sea-

ward side, which would be somewhat analogous in purpose to a terrestrial transition area, may have real value.

It appears in conclusion that the conservation concern of Biosphere Reserves can be translated in zonation patterns for coastal areas provided zonation is extended both on land and on the sea-bottom, the water column being subject to minimal disturbing influences of human origin. At the same time, however, the protection of the interface demands spatial continuity at some point between terrestrial and marine core areas - a criterion which in our view should be given very high importance for establishment and evaluation of coastal Biosphere Reserves.

The Coastal Development Concern

There is no need for long discussion on the logistic role of a coastal Biosphere Reserve, as it corresponds closely to the terrestrial situation with the obvious addition of facilities for marine studies. Research and monitoring activities will be essential, both as regards land and sea, and moreover as regards local studies and participation in cooperative programmes and networking.

Conversely, the development concern in coastal Biosphere Reserves will be marked by the specific features of coastal regions. These relate broadly to three major types of human occupation and use, which can be characterised as follows:

a) The continuing presence in many parts of the world - particularly, but not exclusively, in developing countries - of traditional coastal cultures making use of marine resources for their daily life (fish, molluscs, corals, mangroves, seaweeds, local navigation, etc.);

b) The rapid development of international and/or domestic coastal tourism (beaches, hotels, marinas, second homes, scuba diving, sport fishing, high demand for freshwater and imported products. etc.); and

c) The increasing concentration of population in many coastal areas of developed and developing countries alike, accompanied by rapid urbanization (often unplanned) and development of agriculture, industry, trade and transport - all competing for land-use on limited linear-shaped coastal space.

Obviously, Biosphere Reserves cannot be established very close to areas characterised by the latter type of dense human occupation - which unfortunately tends to spread along practically all the coastlines of the world - and would contribute little to the economic life of these areas. But they can provide much needed educational and recreational facilities for such urban populations.

Coastal biosphere reserves will, naturally, have to be established where there is still something to protect or where restoration can take place, and they will have to play their development role as well as their conservation role for this purpose. Their main development role will thus be directed towards meeting the traditional needs of the coastal populations which have been mentioned under the first type of human occupation. This implies protection and sustainable management of both their terrestrial and their marine resource-base - particularly traditional

fishing. It also relates to the role and impact of tourism, the second type of human occupation which was referred to above. The Coastal Biosphereresserve has to promote forms of tourism which benefit concretely the local population, and which are compatible with the maintenance of their cultural identity as well of course as with the conservation objectives which have been established and that in particular do not disturb the dynamics of the coastline.

Conclusion

Generally speaking, the fragile and highly-coveted coastal regions of the world badly need integrated land and water use planning to reconcile their multiple functions, including that of terrestrial and marine conservation. Properly designed and managed, Coastal Biosphere reserves could constitute a most useful tool for this purpose. Ideally, they would pay equal attention to conservation requirements on the land side and on the marine side, keeping particularly in mind the impact of land-based activities on the marine side. On the land side, consideration should be given not only to the type of ecosystems to be included, but also to land-use in coastal plains and to coastal landscapes. On the marine side the precise place of traditional activities, such as various forms of fishing, will have to be appreciated. Figure 5 suggests a very idealised zonation pattern for a hypothetical Biosphere Reserve where the above considerations have been kept in mind.

A number of existing Biosphere Reserves, which have a coastline or consist of islands, could easily be extended so as to cover the marine part to a given depth. Some existing Biosphere Reserves, centred on the marine side, should be extended on the land side through purchase of land, and arrangements should be made with authorities or the owners concerned to help make them effective from the viewpoint of marine conservation.

As far as the deeper ocean is concerned, where the water column plays the major role, it would seem that the concept of Biosphere Reserves could only be used where it could be clearly linked in realistic operational terms with the adjacent terrestrial area. The seaward extension of a Biosphere Reserve to reach the Exclusive Economic Zone or the continental shelf, could be conceivable as buffer zone or transition area as long as it could be handled and remained meaningful in relation to the basic concept.

When considering the international list of Biosphere Reserves, we feel that the first priority is not so much to add new ones on the terrestrial realm, but rather to improve the structure and functioning of existing ones and to establish operational research, monitoring, and information exchange, networks between them. But an equal priority is, definitely, to set up, all over the world, a substantial number of fully functional coastal (i.e. both terrestrial and marine) Biosphere Reserves as a major contribution to the rational use and conservation of these most threatened and most precious areas of Planet Earth. Even more than for strictly terrestrial ones, the key to successful coastal Biosphere Reserves will be the proper design and operation of their management, and therefore the continued will and cooperation of all specialists, authorities, and people, concerned. When there is a will there is a way. Biosphere Reserves could, and should, contribute significantly to the objective, stated by IUCN, of protecting effectively at least one-third of the coastlines and coastal landscapes and seascapes of the world.

Acknowledgements

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2. Challenges for Biosphere Reserves in Coastal Marine Realms: Representing Ecological Scales

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Editors' Note: The authors have reviewed and referenced this paper in the light of developments in the field of protected areas and related scientific issues since the 1989 San Francisco Workshop. The reference list is designed to provide a lead into the now extensive literature on this subject.

1. The Challenge

a. Coastal marine ecosystems may be characterized at scales that differ by orders of magnitude; e.g. in space from meters to thousands of kilometers and in time from seconds to millenia (Mann & Lazier, 1991; Ray & Hayden, 1992; Ray & McCormick-Ray, 1992a).

b. The major challenges are: (1) to establish an international coastal marine Biosphere Reserve (BR) network inclusive of these ecological scales; (2) to achieve sustainable resource use within the BR network and to assess the effects of human activities at comparable scales; and (3) to establish research and monitoring programs within BRs directed to management problems at local, regional, and global levels.

2. The Biosphere Reserve Concept

a. MAB's "Practical Guide" (UNESCO, 1984a) defines a generalised, all-inclusive BR "model" with three general components (functions) :

Conservation
Development
Logistics

Definitions of these components are given by Batisse (this volume), but the activities carried out under each will vary from place to place. Therefore, "model", coastal marine BRs should be identified and implemented regionally, in accordance with biogeographic, environmental classifications (Hayden *et al.*, 1984).

b. The MAB Action Plan (UNESCO, 1984b) is a "guidelines" in that it contains most of the objectives to be carried out within BRs, lacking only the MAB research themes (see MAB Practical Guide, UNESCO, 1984a).

c. The present task for this Conference is to *modify and improve* these existing documents within the context of coastal marine systems as was attempted by Ray *et al.* (1981) as well as more recently (Ray & Gregg, 1991; Risser & McCormick-Ray, 1991). This mainly requires:

- Clarification of how coastal marine systems may be delineated, how they function ecologically, and how their biodiversity may be defined and described (Ray & Grassle, 1991);
- Specification of what an appropriate research-monitoring programme would be;
- Simplification of the MAB Action Plan with guidelines on priorities; and
- Enhancement of administrative support and logistics so that the "guidelines" may be applied to real situations, most especially to "model" biosphere reserves.

3. Properties of Coastal Marine Systems

a. *Ecosystem hierarchy.* "Ecosystem" is a conceptual paradigm for which boundaries are scaled according to parameters of interest (Levin, 1987; Kelly & Harwell, 1989; Ray & Hayden, 1992). Hierarchy theory (O'Neill *et al.*, 1986) has direct application to the choice of sites and the functioning of BRs. For example, how many BRs should there be? What time-space scales need they represent? Which processes and attributes need be the focus of research and monitoring? These questions are scale-dependent, as is the MAB/BR criterion of "representativeness" for selection of BR sites.

i. Ecosystems range in scale from local habitat-community to global. Coastal marine ecosystems are defined horizontally, vertically, and temporally; ecological gradients define boundaries as ecotones (Ray & Hayden, 1992).

ii. Coupling of processes. One of the major terrestrial-marine differences is that ecological processes of land, sea, and air operate at very different time-space scales; e.g., for marine systems, land-air-sea coupling is relatively strong and the life histories of marine organisms are strongly coupled to physical processes, possibly explaining marine functional diversity (Steele, 1991). For terrestrial systems, ecological research has centered about biotic processes and physical-biotic processes are often not seen as strongly coupled. Benthic ecosystems are perceived as intermediate. This leads to difficulties in comparing these systems, most particularly in evaluating perturbations and in concepts of succession and biogeography that have been evolved mainly for terrestrial systems.

iii. Biodiversity and stability. Biodiversity may be measured differently for marine and terrestrial systems; species vs. higher taxa (May, 1988; Ray, 1988). The temptation is to give high-diversity areas priority, but serious errors may result; e.g., the "source-sink hypothesis" reminds us that sources (often critical habitats) for some species may be areas of low diversity. In addition, interpretations of ecological

stability must also be mindful of scale (Jackson, 1991). An example concerns the oft-repeated, but erroneous, interpretation of marine systems as "open" vs terrestrial systems as relatively "closed". These are scale-dependent attributes.

4. Comparative Ecosystem Classification

a. *Coastal-zone concept.* The coastal zone incorporates land-sea-air interactions within the extent of the continental plains and continental shelves (Ray & Hayden, 1992). This zone contains a disproportionate amount of total biodiversity, productivity, and human resources (Holligan & de Boois, 1993). Hierarchy and ecotone concepts are fundamental to comprehending it. Ecological gradients and species assemblages may be used to depict the coastal zone as a *nested hierarchy of ecosystems* (Ray & McCormick-Ray, 1992a).

b. The lack of an appropriate taxonomy-classification of coastal marine environments, most particularly for the coastal zone, which can give a pragmatic interpretation of scale, is a major impediment to the development of a representative network of coastal marine BRs. *This objective is number 1 in the MAB Action Plan and it is imperative that resources be found for the task.*

c. The exisiting coastal marine environmental classification adopted by IUCN (Hayden *et al.*, 1984) provides a general, coastal marine classification and environmental taxonomy on a global basis. Further development of a *regional coastal marine classification is urgently needed* for the development of a coastal marine BR Network. The history of terrestrial biogeography is an illustration of the intensive, long-term nature of this task. Shortcuts are to identify a region where a sample "case" study could be accomplished, using a "transect" approach to ecological characterization. *Present "action-oriented", tactical imperatives should not be used as an excuse that this strategic "scientific" task is not paramount.*

d. The terrestrial classification adopted by MAB (Udvardy, 1975) defined eight terrestrial realms and 193 provinces. The Hayden *et al.* (1984) classification estimated about 20 realms and 45 coastal provinces; however, total coastal marine provinces might number in excess of 250 for the entirety of the coasts and seas. The two schemes differ fundamentally in that the terrestrial is classified by means that define each province as unique, whereas the existing coastal marine scheme is a taxonomy that facilitates comparisons, essential for information transfer.

5. Selection of Representative Biosphere Reserves

a. Within the context of ecosystem hierarchy, "representativeness" seems to be an appropriate guide for selection (Ray *et al.*, 1981). Nevertheless, there have been conceptual problems, leading to the adoption of the word "coverage" (UNESCO, 1984a). We hold that the differences are semantic; that is, both terms denote that BRs must be *inclusive* of the variety of habitats/ecosystems.

b. Representativeness may be illustrated by a comparative approach, for example:

- Compare and contrast *similar* systems : e.g. U.S. east coast and Australia east coast;

- Compare and contrast *dissimilar* systems : e.g. U.S. east coast and Australia east coast against the Bahamas and islands of the Bering Sea.

c. The major problem for the selection of representative "core" areas in marine segments of BRs lies in the expectation that coresare established in protected areas that remain pristine. However, no marine core is totally unused; it is the *nature* of the use that appears to present a problem, mostly whether extraction of resources occurs. For marine areas, a "core", could simply comprise a resource area that is carefully managed in order that ecological processes are preserved as nearly as possible in their original state, or in a state susceptible to restoration (Ray & McCormick-Ray, 1992b). The "buffer" differs from the core in that it is an area that is managed according to some principal of resource extraction and can be delineated by human use patterns, more than by ecogeographic considerations. Figures 1 and 2 illustrate two ways in which a given area may be considered: firstly as a collection of habitats, and secondly from the point of view of uses to which it may be or is put.

d. *BR selection requires a parallel effort in the social sciences.* Previously, sites have been selected by virtue of their "natural" attributes, which appears to be an anachronism in terms of man *in* the biosphere. Ecosystems and social systems may be congruent to some extent. This topic is a major research arena in itself, and is a current feature of interest in the human dimensions of environmental change (Dasmann *et al.*, 1983; Jacobson & Price, 1991).

6. Conclusions

a. Biosphere reserves - indeed most protected areas - should serve three fundamental purposes (Ray & McCormick-Ray, 1992):

- conservation of biodiversity from species to ecosystems;
- sustainability of resource use; and
- assessment of the effects of local to global environmental change.

b. Research and monitoring are the *sine qua non* of coastal marine BRs (Hayden *et al.*, 1991). The development of research programs for BRs, centered about MAB research themes, will require innovative perspectives about biodiversity, scaling, biogeography, integration of the natural and social sciences, and most especially, the translation of research findings into sustainable management practice. *BR nominations should not be accepted unless at least the potential of a research and monitoring programme is clearly identified.* Research generally falls into four categories :

- biodiversity and conservation biology
- ecological process
- bio-ecogeography
- geocultural patterns and processes

The choice of appropriate scale is critical in all four aspects so that a practical number of BRs can be selected.

c. Conservation biology *per se* is a high priority, in the sense of research on individual species, but land-seascapes and ecosystems are seen as the principal conservation, management, and research targets. Research on "indicator" or "keystone" species is especially important. Research on single species represents but one, small ecosystem component and results may automatically bias management.

Figure 1. Composite map of habitat types of the coastal tone. After Dasmann *et al*, 1983.

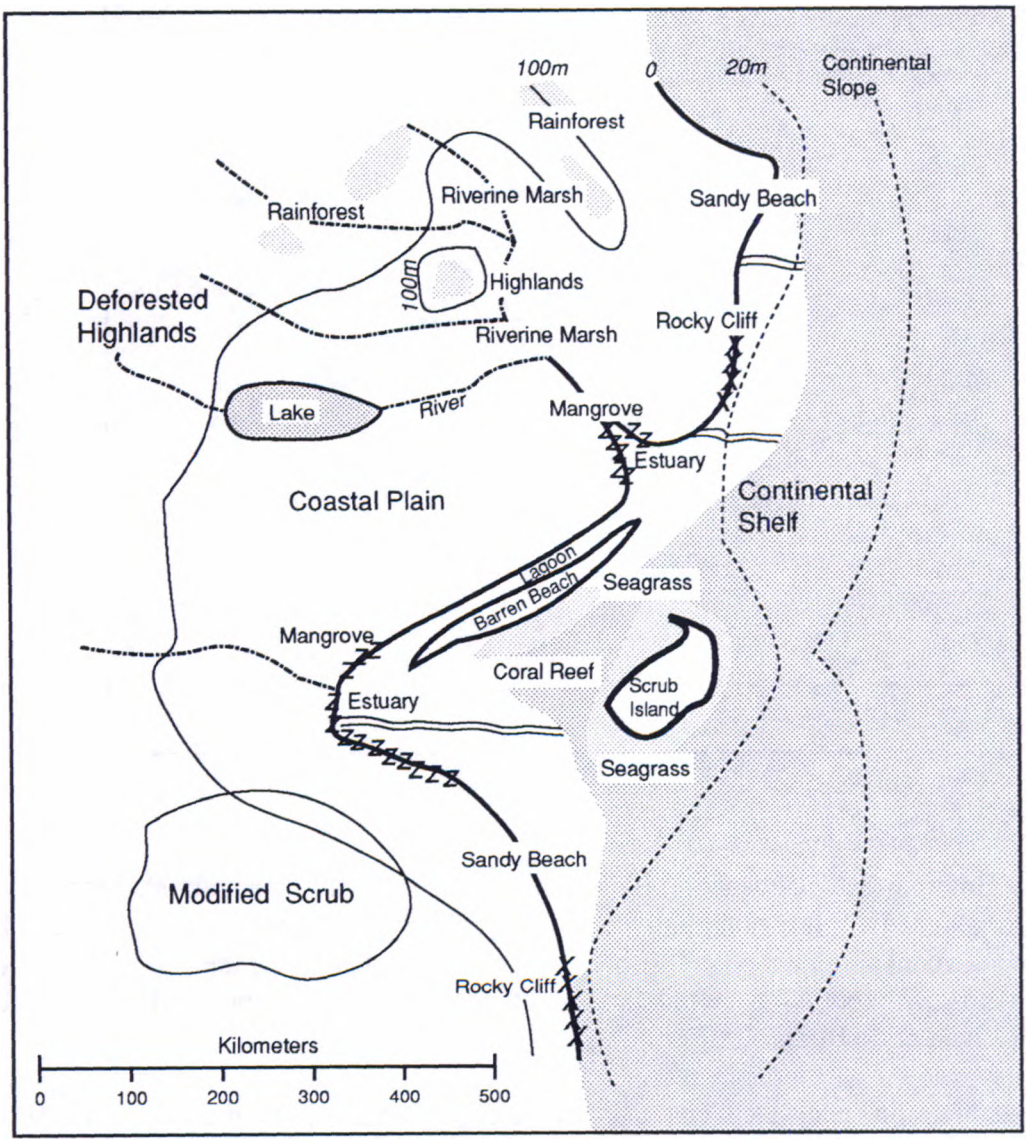
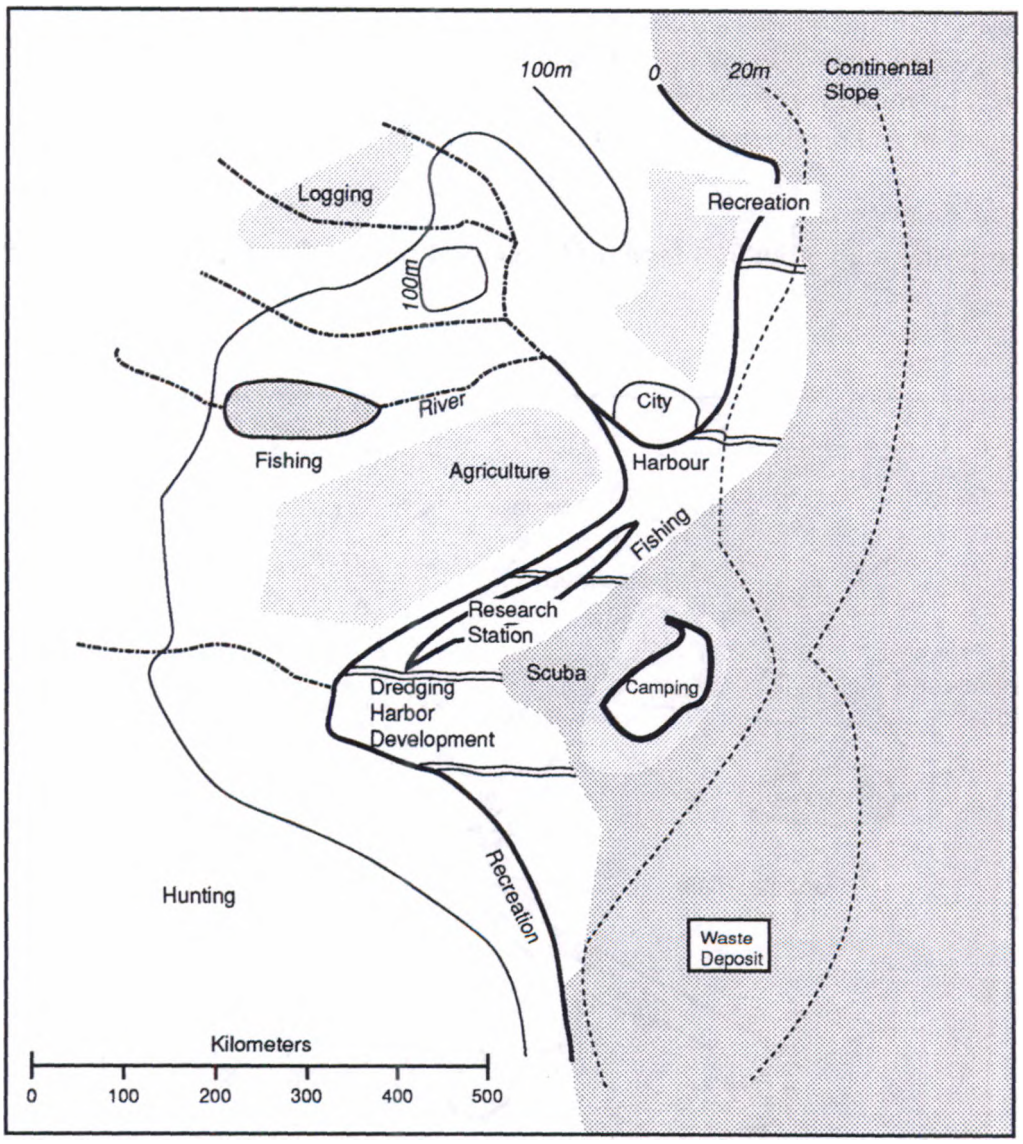


Figure 2. Composite map of human uses of the coastal zone. After Dasmann *et al*, 1983.



d. The International Geosphere Biosphere Programme (IGBP) and other programs of "global change" are potentially excellent collaborators for ecosystem research and management applications in BRs at the higher levels of ecological processes. For coastal systems, collaboration should be sought with programmes on land-sea interactions (Holligan & de Boois, 1993).

e. Coastal marine ecosystem characterization requires a complex of ecological description and analysis, driven by theory. It should result in both a *mapped classification and a taxonomy of environments*. This requires development and application of geographic information systems, which will allow comparisons to be made among systems.

f. GIS technology is essential for the development of a coastal marine BR network, most particularly for the logistics function (research and information transfer) (Ray & McCormick-Ray, 1992b). However, GIS is often misunderstood and abused. The recognition that the *GIS is a scientific tool, better adapted for evolution of hypotheses* than to direct management, leads to the conclusion that a *science-manager team is essential for proper application of concepts*. Coastal zone "planning" has often been deficient in this respect

g. In order fully to develop a global network of functional coastal marine BRs, the capabilities of MAB, at national and international levels alike, should be carefully considered. Therefore, it is critical that this Workshop eventually lead to:

- improved guidelines that will simplify existing procedures and documentation and that will unify terrestrial and coastal marine concepts and applications

- strategies for a regional classification-taxonomy, incorporating the social and natural sciences, and emphasizing the coastal zone

- methods for networking, based on ecological and cultural geography, rather than on administrative, agency-dominated imperatives.

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3. Human Interactions in Tropical Coastal and Marine Areas: Lessons from Traditional Resource Use

R.E. Johannes and K. Ruddle

Introduction

The Bali Action Plan which came out of the 1982 World National Parks Congress contains a recommendation to "*investigate and utilise the traditional wisdom of communities affected by conservation measures, including implementation of joint management arrangements between protected area authorities and societies which have traditionally managed the resources*". This marks a substantial if belated shift in the perception of traditional users of protected areas by natural resource managers. No longer regarded as intruders in their own territories, traditional users are becoming recognised as integral parts of the ecosystem.

Creating a biosphere reserve entails making tradeoffs that enable both traditional users and the world at large to benefit through sounder resource management. Here we outline what some fishermen and other traditional users of coastal marine resources in the tropics can offer marine biosphere reserve planners in this respect and, very briefly, what planners can offer in return.

According to the Final Report of the Task Force on Criteria and Guidelines for the Choice and Establishment of Biosphere Reserves (UNESCO, 1974) "*the MAB programme should give high priority to biotic regions in which there are no or few reserves. Particular attention should be given to tropical forests and grasslands, island ecosystems, tropical coasts and coral reefs*". Here we focus on the traditional users of (i) the reef and lagoon habitats of the islands of Oceania, and (ii) the wetlands found along many tropical coasts. Both of these ecological systems are often intimately linked with, and dramatically affected by, changes in adjacent terrestrial ecosystems, especially those of forest and grassland. No marine biosphere reserve should be designated in such areas without some control being exercised over these adjacent ecosystems. Our focus is thus on people who live in those types of biotic communities identified by biosphere reserve planners as needing particular attention, or who traditionally use, or are otherwise directly influenced by these communities.

Oceania

On the majority of islands of Oceania, people have for centuries depended on a typically narrow fringe of coastal waters for a very large portion of their animal protein. The finite nature of marine resources became apparent to these islanders long before it did to continental peoples

with access to wide continental shelves and large terrestrial sources of animal protein. Consequently, different Pacific island peoples devised all the basic means of fisheries conservation in use today - size restrictions, gear restrictions, closed seasons, closed areas and, most importantly, limited entry - centuries before the need for marine fisheries conservation was even recognized in the west.

Traditional practices that function to conserve marine resources remain widespread among the traditional fishermen of Oceania, and merit serious study by marine biosphere reserve planners in the region. As we will discuss below, the traditional knowledge of island fishermen concerning marine resources can make an important contribution to marine reserve planning.

Some traditional marine resource management practices in the region have eroded or been forcibly abandoned as a consequence of the myriad pressures associated with the uneven conflict between western-style, resource-extractive development strategies and adaptive traditional resource-use strategies. In other areas, marine conservation may never have existed because it was not needed. In some lightly populated coastal areas, for example parts of Melanesia, marine resources have always existed in quantities surplus to human needs. Overexploitation is now occurring for the first time in some of these areas and there are no cultural precedents to underpin an effective local response. Reserve development in such areas may require a major education programme to help create a local conservation ethic, which can be defined as an awareness of man's ability to deplete or otherwise damage natural resources, coupled with a commitment to reduce or eliminate the problem.

Coastal Wetlands

Some of the world's highest population densities are found in the long-reclaimed former wetland areas which form the deltas and coastal plains of South and Southeast Asia. Some vast, relatively unutilized areas do remain and elsewhere ecologically similar regions, like the Orinoco Delta in South America or the Niger Delta of West Africa, rank among the world's more sparsely populated regions.

As regions containing large tracts of young alluvia, and hence tropical soils of above average fertility, many former wetlands in South and Southeast Asia have been converted into highly productive "breadbaskets". In South America, in contrast, apart from a few isolated areas of human settlement, wetlands have largely been regarded as marginal areas if not outright wastelands.

Wetlands provide diverse, renewable natural resources which support mixed traditional economies based on capture fisheries, aquaculture, agriculture, animal husbandry, the use of forest products, and hunting and gathering. Among the more specialized uses of wetlands is one that is ubiquitous throughout Southeast Asia - the millenia-old conversions to irrigated ricefields, often in association with fish culture or capture.

Despite the seasonal dominance of the aquatic environment in wetlands, terrestrial habitats are also important biosphere components in these areas. Grasslands, and mangrove and other forests support game and useful plants. Levée soils provide fertile, non-flooded cultivable

areas. Many of the resource systems employed by traditional communities to exploit tropical wetlands are basically agro-aquatic systems that transform the natural communities into more specialised and managed ones. A few species of primary importance to the human community are cultured but the fundamental structure and functions of the natural ecosystems are maintained.

One of the simplest resource systems is the widespread cultivation of irrigated rice and associated ricefield fisheries. Other systems are more mimetic of the wetland environment in that they maintain a wider diversity of biotic elements, while changing selected elements within it. This is exemplified by shifting cultivation and the transition to perennial crops in wetlands, as among the Banjarese and Buginese pioneer settlers in some Indonesian coastal zones, and especially by those systems that closely integrate agriculture and aquaculture as in southern China.

Other adaptive strategies, such as cattle herding, subsistence or small-scale commercial hunting, fishing and gathering, merely crop or cull natural resources. If not overly intensive they result in little modification of wetland ecosystems.

Customary Marine Tenure

Customary marine tenure (CMT) is a practice which involves the observation of exclusive fishing rights. These rights generally apply to specific areas, and may include rights to particular species, or to use of a particular gear type. CMT has been documented for coastal and estuarine waters on all continents, but it is particularly widespread in the tropics, especially in Oceania.

The importance of this custom for marine biosphere reserve planners, or indeed any marine resource managers in such areas, is that fishermen with marine property rights are less likely to overfish than those without. This is because it is generally in the best interests of those who control access to a renewable resource to exploit it in moderation since they will reap the benefits in future years. It is not assumed here that all CMT systems are or were necessarily effective in conserving marine resources any more than it is assumed that contemporary fisheries management by means of limited entry always succeeds. But it is widely accepted by fisheries scientists that fisheries conservation is all but impossible without some form of exclusive fishing rights.

A second reason marine resource managers must be aware of these customs is that CMT owners are just as attached to their rights as land owners. Thus they do not look kindly upon those who would try to include their fishing grounds in reserves simply by negotiating with their governments.

Many Oceanian societies do not conceptually divide natural resources and the space they occupy into aquatic and terrestrial components. Thus local principles of sea tenure often differ little from those that govern land tenure and the use of terrestrial resources. Among these peoples, in addition, individuals and society are often looked upon as integral parts of nature. One consequence is that the entire physical, economic and spiritual life of such communities

is centred on their natural resource assemblage and the space containing it. For such people this focus is so central to their conception of themselves that alienation of their natural resources and tenured marine (and terrestrial areas) is unthinkable. The fundamental importance of this view is sometimes not appreciated by westerners.

In some regions CMT was destroyed by colonial powers who considered the practice of restricting entry to fishing grounds to be primitive. Despite this disruption (sometimes motivated by foreign businessmen wanting access to island fishing grounds) CMT remains strong in many areas today, most notably in Oceania. In some countries its legitimacy is recognised in law. In others the practice persists firmly despite lack of such recognition. Its significance began to be realised by researchers only in the late 1970s.

Much of the earlier research on CMT is characterized by a lack of appreciation of its basis within larger socioeconomic systems. In the Pacific Basin, for example, such tenure arrangements vary from the sole quasi-ownership of specific localized sites by individuals, families, clans or other small social groups, to the complex state legal system of Japan.

Local CMT needs to be well understood and documented before any efforts are made to introduce new management arrangements associated with marine reserves. Proposed new arrangements may heighten the perceived value of local resources and trigger the invention of fictional ownership, or stimulate conflicting traditional claims to resources and thus generate local conflict.

During the Third South Pacific National Parks and Reserves Conference, held in Apia, Western Samoa, in 1985, it was noted that although CMT serves as a marine conservation measure, this custom has not been used to advantage in establishing protected areas in waters under traditional ownership. Coastal biosphere reserves in Oceania would help address this opportunity.

Traditional Ecological Knowledge of Marine Resources

The knowledge possessed by local users of natural resources can play a vital role in siting and managing protected areas, especially in areas where recorded knowledge of local environments and biota is inadequate. In clear, warm tropical waters which facilitate dive fishing and underwater observation, knowledge among traditional fishermen may be remarkably sophisticated.

Traditional ecological knowledge (TEK) offers a shortcut to the acquisition of some of the basic natural history data needed to understand better the natural environments of traditional peoples. It is often superior in important respects to information gained by means of conventional resource surveys performed by imported consultants whose work is constrained by insufficient time and money. Local fishermen know, for example, the timing and location of a host of significant biological events. Certain otherwise unremarkable beaches may serve as rookeries for nesting sea turtles, or come alive with spawning land crabs during certain lunar periods and seasons. What may look like an insignificant and relatively barren islet to a reserve planner during a site inventory made in one season, may be thronged with breeding seabirds or sea snakes, in others. Researchers doing biotic inventories are also liable to overlook unfamiliar

species whose value as food, medicine, and tools, for example, is known only to local people.

Tropical fishermen in some regions also know of the wide range of reef food fishes which aggregate at specific and invariable locations, at particular seasons and, often, at particular moon phases year after year, in order to spawn. The widespread existence and importance of this phenomenon was recognized by biologists almost entirely as a consequence of information obtained from fishermen in the Caribbean and tropical Pacific. Because these aggregations occur at predictable times and places, they provide biologists with an excellent opportunity to monitor stocks. In addition, because of the often exceptionally large catches, they provide a useful focus for management. (Salmon fisheries are a well developed temperate zone model for this form of stock monitoring and management). Such spawning areas do not always coincide with areas judged to be important on the basis of aesthetic qualities, species diversity or other common criteria for choosing protected areas. But they often deserve protection for the purpose of fisheries conservation. The fishermen sometimes protect these areas with traditional taboos or village-based fishing regulations.

TEK is sometimes embedded in a matrix of myth and ritual and is thus difficult to discern. Ideally, therefore, this knowledge should be recorded and evaluated by researchers who possess not only an appropriate background in biology and resource management, but also anthropological skill in interpreting information from one culture and language to another. Because TEK is dwindling around the world at an alarming rate, recording it is an urgent matter. Biosphere reserves can help with this task. Allowing TEK to vanish would amount to throwing away centuries of priceless practical environmental knowledge.

Conclusions

Where protected status is being sought for areas over which villagers traditionally exert control, they cannot be expected to cooperate with reserve planners without some consequent benefits. Local people who reveal their natural resource management strategies or TEK are relinquishing a certain amount of status or power. Naturally they may be reluctant to do so if they see no benefits from its disclosure or if they fear that competitors might learn of it and profit at their expense, or that a biosphere reserve would restrict their activities.

Planners should therefore have some incentives in mind, for example, lease payments, greater legal recognition of local village authority over local resources, better protection from outside encroachment, enhanced income from tourism, and representation in dealings with the outside world. One recognized function of terrestrial reserves is the protection of sacred sites, notably of Aboriginal peoples in Australia. Much less well known, let alone well protected, are the sacred marine sites found here, as well as in Oceania and elsewhere.

In areas where marine tenure is secure its holders may choose to reject the establishment of protected areas. What can be done in such circumstances? An option rarely feasible on land which is sometimes available for coastal waters is the establishment of protected areas in untenured areas adjacent to major population centres. Fishing rights in waters in the vicinity of major population centres have rarely persisted because the large numbers of migrants

overwhelm the rights of the original inhabitants. Here, protected areas may be established without fear of violating existing tenure arrangements. Enforcement of management regulations is eased by the proximity of such reserves to population centres where they are more readily subject to surveillance.

Overfishing is usually a problem near district centres. But degraded marine ecosystems typically regenerate faster than terrestrial ecosystems and once a marine area is protected, populations of fish and invertebrates may recover within a few years. The replacement rates of marine communities are comparatively fast because marine animals and plants are more mobile than terrestrial biota; they reproduce at early ages compared with dominant terrestrial species; and, with the noteworthy exception of some corals, they have relatively short lifespans.

Protected marine areas provide opportunities to help preserve valuable traditional fishing practices in developing countries. Traditional skills are being lost as fishermen substitute fibre glass launches with outboard motors for sail-powered native craft, nylon for locally-produced fibre nets and lines, and so forth. Few may wish to go back to the humbler technology, but retention by a few individuals of the skills needed to make and use such traditional technology should nevertheless be encouraged in case of eventual need. Such a need may arise through economic difficulties, perhaps following the withdrawal of foreign aid support. Tourists are often interested in such activities, and income from tourism in marine reserves can provide the incentive needed to maintain or reactivate some of this technology.

Most traditional resource use systems in tropical coastal regions involve the integrated use of a primary resource as a subsistence base, together with its nutritional and economic complements and other local raw materials. Policy makers generally foresee more specialised and "modern" uses for reclaimed tropical coastal regions. They often tend to think of utilisation in terms of non-integrated agriculture, aquaculture, animal husbandry or forestry; the abstraction of water for irrigation, industrial and domestic uses; or industrial development and human settlement. Biosphere functions are sometimes not even perceived, let alone regarded as useful. In such areas biosphere reserves could provide a framework for more integrated resource management that prevents such piecemeal thinking and disconnected development.

Conflicts arise and waste occurs when resource-use strategies are not properly coordinated, potential alternative and complementary strategies are not evaluated and tradeoffs are not made. More research is needed on the ecological consequences of both traditional and more modern uses of tropical ecosystems in order to provide sound scientifically based guides for the formulation of alternative strategies.

Interaction among resource systems is an especially complex subject for which the theoretical base and the data needed to frame hypotheses are poorly developed throughout the tropics. Relationships among among linked resource systems comprise a particularly important focus of regional management for sustainable coastal zone development. The majority of incompatibilities or conflicts in coastal resource use occur in such intensively used and circumscribed areas as estuaries, straits and lagoons. While problems often arise directly from local interventions, an additional and more insidious process is the destructive impact of inappropriate uses of "upstream" resources on "downstream" parts of the system.

In the more densely populated parts of Southeast Asia, for example, almost any river basin, from its watershed to the inshore coastal marine waters into which it flows, provides examples of environmental, resource and socioeconomic problems that have arisen from intervention in closely linked upstream systems. Similarly, coral reef communities are extremely vulnerable to certain human activities affecting adjacent terrestrial ecosystems. Bad land management, for example, has almost certainly degraded or destroyed more coral reef communities through smothering by eroded soil than all other forms of human activities combined. Biosphere reserves could serve to diminish these problems through the promotion of more integrated resource use patterns.

Integrating traditional and modern law will also often be necessary in the process of creating biosphere reserves. This presents unusual and challenging difficulties. A passage from the publication, "*Integrated Renewable Resource Management for Insular Areas*", published in 1987 by the U.S Congress Office of Technology Assessment neatly addresses an important issue:

"*To the western-trained lawyer, such a judicial system (i.e. a blend of traditional and western law) seems to invite imprecision into a (western) system of law that values precision. The western insistence on precision, however, tends to denigrate custom, which by definition, is unrecorded, internalized and integrated with culture. If precision is valued, the written statute or case will always defeat custom. If preservation of custom is the goal, judges must reach beyond the demand for precision, and experience the cultural milieu of the custom*".

In addition, the fixing of traditional custom through explicit, detailed legal definitions framed in terms of state law may weaken the adaptive flexibility of traditional systems.

Modern management programmes that are patterned as much as is practicable after traditional practices are more likely to be understood and respected by traditional resource users. Public acceptance of management schemes is especially critical in the tropics because government enforcement is very expensive and thus almost always inadequate. Enforcement is often largely through informal social pressure and the authority of local village leaders, and is more likely to succeed if management measures are familiar and their purposes understood.

4. Human Interactions in Coastal and Marine Areas: Present Day Conflicts in Coastal Resource Use

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Introduction

The past thirty years have seen major alterations of coastal areas all over the world as a result of intensifying, unregulated human pressure. Mankind everywhere is threatening the coastal environment through overexploitation of coastal natural resources. The more powerful the technologies and the more intensive the activities, the deeper the troubles.

Pollution and coastal zone reclamation are casting a dark shadow over the future of many temperate shorelines. In tropical areas mangroves and coral reefs communities are being cleared in both the Indo-Pacific and the Atlantic. And shores at high latitudes are being disturbed by new economic activities and by the implementation of geostrategical networks. Only a conservation policy with global and comprehensive approach will be able to stop such a trend.

The following is a review of some of the key issues and problems to be addressed in the management of the coastal zone. These should be considered in the context of the current global instability of shorelines. Subcontinental seas have been greatly enlarged in the last 18,000 years owing to a sea level rise of about 140 m. Postglacial valleys were invaded by the rising sea to produce rias, fjords, and the intricate inlet systems of many archipelagos. Active sedimentation from deltas is feeding many lido-lagoon complexes. Such recently created coastal systems are particularly sensitive to perturbations.

Changes in Coastal Area Structure and Function

Large areas of some coastal biomes have been lost through deliberate conversion to various production systems. Freshwater and brackish coastal floodlands have been increasingly drained for conversion into agricultural lands. These coastal wetlands often support highly intensive agriculture leading to the elimination of wildlife (mammals, birds, reptiles, amphibians, fishes) and to environmental pollution through the release of artificial fertilizers, pesticides, and industrial and sewage effluents.

Upper tidal mudflats have been lost in many areas through conversion to evaporation ponds for sea salt production, an ancient industry found on tropical and temperate shores where the

climate is dry and hot for at least three months of the year. Industrial processes now outcompete traditional salt production, and by 1988 only half of the 500,000 ha of ponds existant in 1960 were producing salt, the other half being used for aquaculture, reclaimed, or waiting unused until some profitable reconversion.

Large tidal flats (waddens and schorres) have been reclaimed all around the shores of western Europe and the Far East where continental land is too limited to provide the food necessary to support dense populations. Polder systems, requiring strong and high dykes to prevent submersion during the highest tides, were constructed where the climate is wet enough to wash the salt from the ground and to prevent salt water intrusion. The most elaborate polder system was developed in Holland, spread around the North Sea and then to Indonesia and South America. In China, polder systems have been developed for traditional intensive rice culture. This system is sometimes associated with the culture of milkfish, for example in the Indo-Malayan countries.

A second form of coastal disturbance stems from physical developments associated with maritime activities, and urban or industrial developments. Modern economies are closely related to marine transport capacity. A commercial harbour requires at the very least a riverside embankment or piers. Where small scale dockyard facilities are connected with a continental transportation network designed for freight distribution, the commercial port activity may not cause much disturbance to the coastal environment. But the situation changes completely when harbour facilities are used for heavy industrial activities such as the metallurgy, chemicals, oil, and pulp and paper. Heavy industries require large areas for plant development and storage, and they contribute to the development of transport networks and to urbanization.

Large platforms have been built along some shores by dredging and filling with waste, garbage and sediments. Building activities are taking place in deeper and deeper waters, with man-made islands connected to the complex and, later on, to offshore islands. The reclamation of shallow seas can be correlated to industrialisation along the shores of North America, Western Europe and Japan. In the last 30 years Japan has reclaimed 56,000 ha of lands over shallow seas with a growing part for urbanisation, and the shoreline has been dramatically changed as a consequence (Table 1).

Table 1: Japan's shoreline length by type (1984)

	Total Length (km)	Proportion (%)
Natural coast	18,402.08	56.7
Semi-natural coast	4,511.44	13.9
Artificial coast	9,294.54	28.6
Estuary	263.79	0.8
Total	32,471.85	100.0

Associated with the urbanisation and economic concentration on coastal areas is the need for raw materials for building, and these may be obtained from local, coastal sources. Problems have arison around the world from such resource use as extraction of sand from beaches and dredging for limestone or of coral reefs, which not only change the morphology and the landscape but can also disturb the hydrology, enhance erosion and disturb the whole ecosystem. Such extraction may also be directed at metallic substances or semi-precious materials. The collection of shells and corals for curios or the handicraft industry may permanently disrupt large areas of reef and dredging for red or black corals disturbs large benthic areas.

Mineral extraction in coastal zones escalated with the onset of offshore oil extraction during the 1960s and its booming, linked to the petroleum crisis, during the 1970s. This activity excludes large productive grounds from fisheries, perturbs the environment by pollution and transportation, and causes seabed and coastal disturbances such as localised subsidence. Mineral deposits are not renewable in the short term and when the extraction is finished, only destruction is left.

Another area of intensifying coastal use is tourism. Until the 1960s, the impact of coastal tourism was largely restricted to few fashionable places connected with rich capital cities, and to attractive rivieras where the mild climate and attractive landscape provide a leisurely atmosphere. Parts of the Mediterranean coast, Florida and California are typical. The development of cheap mass transportation changed the scale and the nature of recreational impact on coastal areas. Millions of tourists now launch seasonal invasions of the coasts in search of sandy beaches, playgrounds and sailing facilities. In addition, an increasing number of wealthy retired people or younger active professionals now invest in a second house or a condominium for longer holidays or permanent settlement. This trend, which began during the 1960s, opened the way to widespread speculative investment in coastal resort development.

The more attractive and fashionable rocky shores were the first to be settled, but shortage of space and increasing building costs raised prices to levels beyond the common customer. Investors and public developers turned to alternative sites on lido and sandy coasts which were considered unsuitable for permanent settlement, being too remote and dangerous. Coastal resort development is now widespread throughout the world, and the associated infrastructure is intensifying in already developed areas.

Many developing tropical countries are anxious to have a piece of the "touristic cake". The immediate economic gain of developing leisure settlements in remote coastal areas is evident, and desirable. Not so immediately evident is the disturbance to the traditional way of life in fishing villages and the commencement of problems in the fragile lagoon and beach environments.

Coastal environments worldwide are under severe pressure from human activities leading to pollution. Continental drainage carries effluents to the sea from intensive agriculture, industries and urban sewage. Heavy metals, toxic chemical products, faecal bacteria and noxious viruses primarily affect estuaries and deltas. Some of the richest coastal marine areas have been excluded from any use by chemical pollution, and oppurtunities have already been lost for conserving coastal diversity.

Red tides, which are associated with coastal pollution, are becoming more frequent. Such dinoglagellate blooms occur naturally when an excess of nutrients in conjunction with an elevated temperature and calm weather provide conditions for growth of high concentrations of these toxic unicellular organisms. Spectacular red tides, which occur increasingly in Japanese, North American and western European coastal waters, cause many disturbances and losses. These are evidence of the destabilisation of marine communities and increasingly attract the attention of the media.

Another increasing form of pollution is oil spills, with more and more accidents linked to oil extraction or transportation. Severe accidents have included loss of control of wells linked to offshore platforms (Gulf of Mexico, North Sea, Persian Gulf) and wreckage of oil tankers carrying a heavy cargo (Amoco Cadiz in Britanny, Exon Valdez in Alaska). Environmental damage is initially massive, attracting instant media attention and the support of governments. After a few years the natural biodegradation of hydrocarbons allows some restoration to take place.

Much more dangerous, and less understood, is the transfer of pollutants both along the food chain from algae, seaweeds and plankton to top predators, and from coastal waters to the continental slope and even the margin of the bathyal basin.

Unless there is a strong policy concerning coastal pollution, incidents will remain numerous. In 1985 in Japan, there were 871 cases of pollution, more than half affecting the Seto Inland Sea and the Bays of Tokyo, Ise and Osaka.

Since coastal morphology is the fragile expression of the balance of forces between the continent and the ocean, any perturbation may cause problems through alterations to erosion and sedimentation. Extraction of materials from the shore leads quickly to increased erosion, causing regression of the beaches and breaking the sand dune strings and lidos. The same effect results from coastal subsidence following oil and gas extraction. The reduction in sedimentation caused by construction of dams is a threat to many deltas (Nile, Mississippi). Conversely, the excessive sedimentation which follows deforestation or stripmining causes siltation and mortalities in shallow seas.

Owing to coastal current systems and the transfer of sediments, a small change in shoreline structure may have knock on effects at quite a distance. Locally the changes are more immediate. For example, clearance of the mangrove belt has led to typhoon and cyclonic waves washing away coastal marsh and deltaic formations and to submergence of land by saline waters.

Shallow sea bottoms, coastal lagoons, coral reefs and mangroves are the nursery grounds for many species, both benthic and pelagic. Disturbance of such areas through environmental destruction or pollution leads to stock depletion and reproductive loss. Estuaries and deltas are areas where the fingerlings of anadromous and catadromous migrating species concentrate. Shorelines reclamation and other coastal developments may cause drastic reductions in the stock of many useful species.

Natural Resource Disturbance and Depletion

Alongside these physical impacts on the marine environment have been impacts arising from the direct exploitation of marine life. Overfishing has become the norm for inshore waters. The main culprit here is motorisation which provides rapid access to wider and deeper fishing grounds. Until the 1930s, engines were too heavy and too expensive a tool, and small-scale family fisheries were usually managed with sailing boats. Medium-scale offshore fisheries made some use of motorboats in the 1930s and 1940s. But the true revolution was the worldwide use of outboard motors, first in North America and western Europe during the 1960s, then in the Far East and tropical areas. As they enlarged their radius of action, fishermen came to compete in previously inaccessible grounds such as remote islands, coral reefs, sandy beaches, mangroves and lagoon complexes. At the same time the use of new synthetic fibre nets drastically increased fishing productivity. Catch capacity also rose with more efficient equipment such as ring-nets with power-blocks, small otter trawls, automatic jigs or longlines with small winches, and haulers for tangle-nets.

As a consequence, many traditional fishing societies are in dispute with their neighbours and sometimes among themselves. Future prospects for family fisheries appear quite dim since rising costs of investment require a higher return which cannot be supported by the natural productivity of coastal systems.

Environmental Protection Measures

To stop this worldwide assault on the coastal environment, strong protection and conservation policies must be developed. But enforcing prohibitions and restrictions on human activities carries a negative image, even when obviously necessary. To be effective such an approach requires a mutual cooperation between local, regional, national and international administrations and agencies.

There have traditionally been a number of approaches to marine conservation and protection of the marine environment including protection or regulation of the exploitation of identified species; fisheries management; control of pollution; and creation of marine protected areas.

Species specific management efforts have primarily been directed at the large marine mammals which have been the subject of targetted exploitation efforts. Commercial hunting of marine mammals raised an international wave of emotions and pressures which changed the protective management approach from one based on economics and profit to one based on conservation.

The first international agreement protecting a marine species was the North Pacific Fur Seals Convention (1911) signed between USA, Great Britain, USSR, and Japan, which forbade pelagic sealing over a wide area. As a consequence, and with the help of scientific management, the seal population of Pribilof Islands increased from 124,000 in 1911 to 1,500,000 in 1940. Now under the"Convention on the Conservation of the North Pacific Fur Seals" signed by USSR, Canada, USA, and Japan in 1957 and renewed every six years, the stock is maintained at the Maximum Sustainable Yield (MSY). The fact that there have been no new entrants, no sealing outside the Commission's jurisdiction, and that the exploiters (USA and USSR

government agencies) are managed under a strictly controlled scientific programme explains this success story. Norway has signed agreements along similar lines on sealing and the conservation of seal stocks in the North West Atlantic with USSR (1957) and Canada (1971). A Convention for the Conservation of Antarctic Seals, which covers six species, was signed in February 1972.

The history of the protection of whales is long and complex starting in 1910 with the 8th International Zoological Congress. During the League of Nations Conference to promote the rational exploitation of the sea (1930), regulation prohibiting the hunting of endangered species of whales was recommended, leading to the earliest international regulation concerning whaling on 7 June 1937. But it was the founding in 1948 of the International Whaling Commission which first opened the way to strict international regulations for hunting and then to more protective rules, culminating in a general moratorium for any whaling operations beyond the small catches allowed to maintain the aboriginal way of life, which entered into force in 1986.

The increasing pressure of NGOs lobbying for wildlife protection and environment conservation has made clear the necessity for a worldwide strategy. The entry into force in 1975 of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) opened the way to the protection of many endangered marine species.

Another area of direct species management aimed at conservation of exploited stocks is fisheries management. Once identified, overfishing can be controlled by different means, including:

a) Limitation of fishing effort by licensing or technical means

b) Quotas for landings fixed below the MSY, perhaps supported by seasonal closures

c) Permanent or seasonal reserves prohibiting fisheries on more sensitive grounds.

International agreements should cover large areas and cover commercial species. For example, it became evident at the end of the last century that steam-trawling affected the productive North Sea coastal fisheries. A North Sea fishing convention was agreed in 1882 to protect the coast within three miles against the destructive effects of trawling. It introduced several measures to harmonise the registration of fishing boats and the use of certain kinds of fishing gear.

1902 saw the establishment of a body that was to have a profound effect on fisheries conservation: The International Council for the Exploration of the Sea. The following years saw a proliferation of international agreements concerning fishery regulation, including the International Pacific Halibut Convention (1923), International Pacific Salmon Fisheries Convention (1930), North East Atlantic Permanent Commission (1949), International Convention for North West Atlantic Fisheries (1949), Convention for the Establishment of an Inter-American Tropical Tuna Commission 1949, International Convention for the High Seas Fisheries of the North Pacific 1952, and North East Atlantic Fisheries Convention 1959.

It was gradually recognized that marine natural resources are limited, and cannot support the higher levels of catch facilitated by modern industrial fishing fleets. As a consequence of the International Law of the Sea (1982), every state is responsible for the management of coastal resources within the 200 mile EEZ, with due respect to the general conservation of the marine life system.

An equally important approach to marine conservation has been the protection of specific areas by their designation as protected areas. Historically coastal environments were included in terrestrial protected areas. While protecting wetlands and lagoons, such parks had little impact near the shoreline or on continental shelf and coastal waters.

At first the motivation behind protected areas designation was much more to protect the landscape than to preserve natural resources, but results were valuable. In the USA the National Parks, National Monuments and National Seas Shores Act of 1916 enabled the designation of numerous sites with a coastal and marine component, including the half million hectare Everglades National Park, of which 25% is marine; and the Fort Jefferson Marine Park founded in1935, which covers 18,000 ha. In the US Virgin Islands, a national park was established in 1956 and expanded in 1962 consisting of 2,816 ha of federally owned land on St. John Island and 2,287 ha of adjacent marine waters. In addition national sea shores cover large areas, including Assateague Island (Maryland, Virginia) 15,832 ha; Cape Cod (Massachusetts) 17,840 ha; Cape Hatteras (North Carolina) 11,400 ha; Cape Lookout (North Carolina) 9,800 ha; Fire Island (New York) 7,732 ha; Padre Island (Texas) 53,567 ha; Point Reyes (California) 25,818 ha.

A similar approach was used in France where the 1930 legislation protecting the scenic landscapes and historical sites served to establish in April 1975 the "Parc de la Camargue" covering 14,000 ha of the Rhone delta.

The 1970s saw a worldwide trend in the development of regulations for the protection of coastal areas as a whole. In the USA, the 1972 Marine Protection, Research and Sanctuaries Act was implemented through the NOAA Estuarine Sanctuary Guidelines (1974) covering such large areas as: Sapelo Island (Georgia) 2,460 ha; Rookery Bay (Florida) 34,000 ha; Apalachicula Bay (Florida) 72,000 ha; South Slough (Oregon) 1,600 ha; Elkhorn Slough (California) 800 ha; and Waiman (Hawaii) 2,360 ha. The Key Largo Coral Reef Sanctuary, founded on 18 December 1976, covers 25,900 ha.

Other important landmarks in this evolution were the Australian Great Barrier Reef Marine Park Act (1975), the Japanese Nature Conservation Law (1972) and many appropriate Acts within the western European countries, including Establishment of the Sea Shore Conservatory Office (1975); Preservation of Nature Act for France (1976); Bundesnaturschutzgesetz (Conservation of Nature and Landscape Act) for Federal Republic ofGermany (1976); Conservation of Nature Act for the UK (1973), and so on.

During the 1970s marine parks and reserves spread in the industrialised crowded coastal areas of Japan, USA and western Europe as well as in the remote islands and archipelagos of the South Pacific and Indian Ocean. Many mangrove and coral reefs shores were put under more or less

efficient protective regulation in various South American, African and East Asian countries. The most spectacular achievement is Japan where 64.25% of the natural coast is designated as natural park or nature conservation area.

Considering the unity of the coastal complex, new approaches include the coastal land, the shoreline and the shallow seas in the same legislation. A good example of such an development is the French coastal management, protection and development law (1986).

The pollution problem in ocean and coastal areas has received enormous attention from the media in the last decades and many national legislations have been enacted as a result. The US National Environment Protection Act (1969) provided a basis for further legislation on pollution control. International aspects were considered in the USA-USSR agreement on cooperation in the field of environmental protection, 1972, and provision for a world wide policy was achieved by the United Nations Conference on the Human Environment (Stockholm, 1972) which set up the United Nations Environment Programme (UNEP).

The MARPOL Conventions (1973-1978) provided the impetus for many national and regional regulations. A good example is the Mediterranean Action Plan (1975). Other action plans for the Persian Gulf (1978), West Africa (1981), South East Asia (1981) South East Pacific (1981), Red Sea (1982), Caribbean seas and islands (1981), South Pacific (1982), East Africa (1985), were to follow.

Unfortunately coastal pollution control is an expensive policy requiring strict and operative planning for prevention, management of crises and recovery actions. This accounts for the ongoing degradation of many tropical coastal areas where the existing infrastructure and logistical arrangements for pollution control are completely inadequate.

Some coastal developments may be of value in terms of enhancing productivity or even restoration of ecosystems. Productivity can be raised through modern technologies without any damage to the biota through restocking or aquaculture activities. Economic returns follow on from the recovery of the environment where the effects of stock depletion or substrate damage is mitigated by positive human interventions such as the building of artificial reefs. Such interventions should be applied with caution - for example, restocking should only proceed after reassuring answers are obtained for questions of whether the artificially bred populations can change the wild genetic stock, or about the impact of the introduced species on the ecological balance.

Policy Options

Present day conflicts in coastal resource use cannot be solved without taking the social context into account. Sparcely populated shorelines present an entirely different set of management problems to densely populated and built up coastlines

Pressures from rough climatic conditions, scarcity of land, instability of the environment, political troubles, wars, and so on all limit human settlement on the coastal area. Only adaptable societies can survive the stresses of polar frost, permanent gales and strong seas, lack of

freshwater, endemic diseases and epidemics, permanent wars and destructive raids.

Few communities have developed an adaptive structure for their social and technical organisation which can match the pressure of the coastal environment. Such organisation is typically linear in space: the range of coastal societies is strictly limited to the shores (coastal seas, lagoons, marshes and wetlands on the continental fringes), extending over thousands of kilometres of the coast but restricted to a very thin layer never exceeding a few kilometres inland.

These people of the sea, living "on the outer skin" of continents are very vulnerable since their adaptation is such that any kind of change may break their social structure. Thus any change in wildlife migrations, natural or human perturbation of the environment, new technologies, or new cultural contact, can bring disaster. Although such areas are sparsely populated, any reduction of space can be lethal for the whole coastal society. Such "empty shores" are found all around the Arctic on the fringe of the Asian and American continent and around the intertropical mangrove and coral reef belts of South East Asia, Northern Australia, Micronesia, Polynesia and Melanesia.

Low population densities are also typical around large lagoon and lido complexes built by active deltaic sedimentation. In such coastal areas one finds two areas of settlement, on continental lagoon shores where villages practise both fishery and agriculture, and on the sandy sea shores, used exclusively by migrating fishing communities, at times distantly based.

In contrast, where living resources are particularly abundant and where natural facilities exist for transit and contact, certain civilizations have used the coastal area to develop a way of life linked to fisheries and marine trade. While sea-oriented, the focus of coastal civilizations remains strongly integrated with those continental structures that support their development.

Integrated development policies must take a regional and global as well as a local perspective. A global approach is needed to halt the present conflicts between traditional systems and the increasing concentration of economies and populations in coastal areas. Effective protection of large areas depends on the capacity to take into account the need for economic and social progress of the country.

In all parts of the world where coastal areas are not completely covered by human colonisation, the optimum approach is to save nature for the common heritage, by integrating human settlements in a comprehensive and progressive policy based on sustainable yield of the resources. The marine biosphere reserve concept is compatible with this end, and provides a valuable accessory for its attainment.

5. Oceanographic Features of Importance for Coastal Marine Biosphere Reserves

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Oceans cover 70% of the surface of the globe. About 75% of the worlds population live in the coastal areas of the continents, and the population increase here is, on average, greater than inland. Human dependence on coastal fisheries for the provision of protein is high, particularly in underdeveloped tropical and sub-tropical regions. It is estimated that in developing countries between 40 and 100% of protein intake is derived from fish. Most of this harvest is dependent on productivity in shallow, inshore environments such as estuaries and lagoons, coral reefs, seagrass beds, and mangrove swamps, but an ever-increasing threat to these environments is posed by human activities on land and in the coastal zone. This threat comes from a variety of sources, such as overfishing, pollution from sewage and industrial wastes, increased turbidity caused by deforestation or poor agricultural practice, and direct destruction of coastal habitats including reclamation of lagoons and mangroves, extraction of corals, and conversion of estuaries and mangroves to agricultural land. Such practices will not only reduce fish and seafood production but are destroying some of the worlds least known and most diverse ecosystems.

The need to protect coastal habitats from pollution, overexploitation and destruction is evident. One way to protect coastal marine environments is through the establishment of "marine parks" or "biosphere reserves".

Although more "parks" or "reserves" have been designated on land than in coastal areas, marine parks and reserves are now relatively common in many countries throughout the world. In most cases the motive for the establishment of these protected areas has been to protect a biological resource, either in the form of a specific organism, group of organisms, or ecosystem, or in the form of an area of particularly high productivity, perhaps with a harvest value or a development potential. Accordingly, areas such as coral reefs, fjords or sounds with spawning or migrating fish stocks, sea lion or seal crawlouts and whelping areas, and bird nesting islands have been protected from exploitation or direct destruction. Areas of particular value to recreation or tourism, and areas which are of value from a purely scientific value, perhaps as marine reference areas, have also been designated. In principle it should be possible to demonstrate the benefits of conservation to society, and hence to involve people in conservation, to avoid conflicts of industry and conservation, and to integrate conservation and development.

To date, the success rate of marine and coastal areas around the world has not been particularly

encouraging. Too often, human populations along the coast have expanded rapidly to exceed the carrying capacity of the coastal environment. Planned and unplanned developments (urban, industrial and agricultural) are allowed to take place too close to the borders of protected areas. Rapid development of tourism often occurs in the immediate vicinity of a protected area which is itself an attraction for tourists. Associated activities such as boating, diving and walking in sensitive areas contribute to the destruction of the very resource which provides the attraction for visitors. In many parts of the world, fishing and other traditional resource exploitation has grown to exceed the level of sustainable yield, and harvesting methods have changed to more destructive techniques.

In many cases, such problems could have been averted at the planning stage of protected area development, or by more rigourous management of the established area. There are a numberof specific issues which frequently result in failure to attain the desired level of protection. These are faced by all countries, but are a particular problem in developing countries.

1. There is rarely a national policy specifically for the protection of marine and coastal species, habitats or ecosystems. Few countries have legislation of any kind for marine environmental protection.

2. There is usually a lack of institutional structures dealing with marine and coastal resource management. Few developing countries have institutions such as universities which address marine environmental issues.

3. There is generally a lack of trained personnel capable of planning and implementing marine and coastal conservation programmes.

4. Financial resources for the development and implementation of marine conservation programmes are often limiting. In many regions even conservation efforts specifically designed to safeguard subsistence and commercial fisheries have not been considered.

5. Mechanisms for joint management and protection of marine resources shared between neighbouring states are usually poor.

As well as the above institutional problems, there is another set of problems, frequently overlooked, which relate to oceanography. In the marine environment the relationship between an area and its surroundings is much more significant and more complex than on land. The interrelationship of biological phenomona and physical/chemical factors is much more acute in the marine environment. Oceanographic features such as currents which transport and disperse sediments and pollutants also contribute to the distribution of organisms.

Oceanographic factors of a biological, physical and chemical nature need to be considered in the management of marine protected areas. Some of the specific problems related to oceanographic factors are described below.

1. There is usually not even basic data on ocean currents and local wind patterns which have a direct or indirect influence on the coastal zone. Major events which have effects over

large areas, such as the monsoon, are better known, but their influence at the scale of a habitat or area of concern may not be known.

2. Little is usually known of the chemical or physical composition of runoff from land to coastal waters. There is often a particular need for information on the extent of sediment transport to the coastal zone, and on its subsequent deposition in the marine environment. Information of a basic nature is also lacking on the transport of pollutants from land to sea.

3. Little data is available on the distribution and ecology of important, sensitive or vulnerable marine organisms. The migration pattern of the different animals in an area to be protected needs to be known in some detail in order that those areas essential to the species receive protection. Similarly, information is needed on reproduction ecology and dispersion of propagules.

4. Little is usually known on the interactions between different marine sub-systems. There is strong evidence for important links between habitats such as coral reefs, coastal lagoons, seagrass beds and mangroves. Where an area is to be protected it is important to understand its relationship to other ecosystems.

The role of oceanographic factors in distributing materials means that an area directly protected by environmental legislation may be threatened by exposure to pollutants originating from elsewhere. International agreements to prevent marine pollution have been made in some areas, with the aim to protect marine resources, and it is important that such agreements are implemented and enforced. Where such protective measures are not in force careful and rigourous planning will be required to protect particularly sensitive, vulnerable or threatened areas.

The central issue to be considered is the interaction of the complex processes which take place in the marine environment and activities on land which subsequently impinge on the marine environment. Rivers provide the principle link between activities taking place far inland and the marine environment, while direct runoff is an important link with coastal waters. Winds act to transport air pollution and dust from inland to both the oceans and coastal zone. Ocean currents and wind drift link oceanic areas which are widely separated in space, and pollutants, nutrients and organic matter are thus transported across biogeographical and national boundaries, as well as across marine park boundaries. The migration and spread of organisms and their propagules (eggs, larvae, seeds and young) is another means by which distant oceanic and coastal areas are linked.

The implication for management of these linkages is that effective conservation of marine and coastal areas requires integration with land use management, the consideration of extended areas, and multinational conventions or agreements for the protection and conservation of shared resources. In summary, a regional approach is required for management of marine resources.

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6. Political and Social Dynamics for Establishing Marine Protected Areas

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"How complex and unexpected are the checks and relations between organic beings which have to struggle together in the same country". Charles Darwin, 1882.

Introduction

Anyone who is experienced in attempting to establish marine protected areas, or to manage them, will recognize that Charles Darwin's statement is as applicable to the political and social context as it is to ecology. Success in establishing marine protected areas depends absolutely on understanding the political and social contexts of the countries or societies in which the areas are located.

The purpose of this paper is to identify the political and social factors that are critical in the establishment and management of marine protected areas and to highlight some general approaches which have been shown to be successful in application in various countries and situations.

Generally speaking, most countries have approached the management of marine natural resources through the regulation and management of individual marine activities such as commercial fishing by specialist agencies, with varying degrees of coordination of regulation between different agencies. Most countries have a department of fisheries or primary industry which is responsible for managing the extraction of living resources from the marine environment. The establishment of marine protected areas has a significant impact on the responsibilities of such agencies. Because they are usually powerful and influential and are represented in government by powerful and influential Ministers, their support or, at least, absence of strong opposition, is a vital element in the successful establishment of marine protected areas.

The traditional approach to the creation of marine protected areas has been the establishment of small protected areas designed to provide special protection within their borders for particularly valuable features. The surrounding sea may be subject to regulation by specialist resource agencies, such as departments of fisheries, or subject to no regulation. This is still the most common application of the concept of marine protected areas. A comparatively recent

development in the marine context is the establishment of a large, multiple-use protected area, preferably including a complete marine ecosystem, with an integrated management system providing varying levels of protection throughout the area. The application of the biosphere reserve concept to marine or coastal environments is an example of this approach.

It is conceptually possible for the same management results to be achieved with either of these approaches. However, the integrated, multiple-use protected area has the advantage that coordination of regulation of different human activities can be automatically achieved since the overriding responsibility for management rests with a single agency. Coordination of management in the marine environment is in many ways even more important than it is in the terrestrial sphere. This is because the high degree of connectivity in the seas facilitates the transmission of substances and effects throughout the water column. As well, the tradition of the seas being common property leads to actual or potential conflict between different users and uses and to the absence of incentives for users to limit voluntarily their use of resources to sustainable levels.

This paper considers both approaches to marine protected area management. While the factors that must be considered in these approaches are the same, their application is different. Whichever approach is adopted, it is recognized that effective conservation of the marine environment can only be achieved by the creation of integrated management regimes. These will consist either of general regulation of human activities affecting the marine environment, supplemented by the provision of special protection for comparatively small areas, or of creation of a much larger marine protected area with levels of protection varying within it according to a zoning plan.

This paper does not explore the development of integrated coastal management systems, covering both land and water, but the principles described in this paper do apply to this more general and desirable approach. The biosphere reserve system is particularly suited for application to coastal management regimes including land and sea areas.

Policy Statement

The need to integrate the management of marine protected areas and of the surrounding marine environment has been recognized in policy statements adopted by the 4th World Wilderness Congress in Colorado, USA, September 1987 and by the 17th General Assembly of IUCN, Costa Rica, February 1988. While differing slightly in phraseology, these statements were essentially the same.

The IUCN Resolution recognized that the primary goal towards which marine conservation and management are directed is: "*To provide for the protection, restoration, wise use, understanding and enjoyment of the marine heritage of the world in perpetuity through the creation of a global, representative system of marine protected areas and through the management in accordance with the principles of the World Conservation Strategy of human activities that use or affect the marine environment*" (IUCN, 1988).

IUCN recognized that, as an integral component of a global system of marine conservation and management, each national government should seek cooperative action between the public and all levels of government for development of a national system of marine protected areas. The term "marine protected area" is defined as: "*Any area of intertidal or subtidal terrain, together with its overlying waters and associated flora, fauna, historical and cultural features, which has been reserved by legislation to protect part or all of the enclosed environment*".

The Importance of Socio-Political Considerations in the Selection of Marine Protected Areas

On land, the concept of habitat critical to the survival of rare or endangered species often plays a decisive role in identifying the areas worthy of protected status. In the sea, habitats are rarely precisely or critically restricted and survival of species cannot usually be linked to specific sites. The concept of critical habitat of endangered species is usually restricted in application to areas critical to certain marine mammals, sea turtles and sea birds and to the habitats of the occasional endemic species. Therefore, in the sea the case for protection of an area is not often based on concepts of critical habitat of endangered species or threat of extinction, but it may be based on protection of important habitat for commercially or recreationally important species.

On land, whilst some human use, particularly low impact recreation, is accepted in most protected areas, human use is often a secondary consideration in site selection and management planning. While the validity of this comment varies between societies, it appears to be generally true. In contrast, in the sea provision for reasonable use is usually a primary consideration. Where a habitat occurs throughout a wide geographic range and is degraded in areas accessible to human use or influence, understanding of the dynamics and impact of human activity may be critical to habitat protection. Technology has greatly increased the accessibility of marine environments.

In most countries, there is a long history of public or sectoral use of marine areas close to the coast, often for subsistence. Attempts to exclude these uses from traditional areas may jeopardise the physical or economic survival of local people. In such cases, community opposition to the establishment of marine protected areas will be very strong and may jeopardise their successful management.

It follows from these humanitarian, economic and pragmatic considerations that where there is a choice of suitable areas, as there often is in the sea, the dominant criteria for selection of marine protected area locations, boundaries and management systems should be socioeconomic, with ecological criteria being applied to marginal decisions.

Allies and Opponents

There are three general types of environmental threat which may be addressed in conservation planning and management. The first concerns the degradation or loss of ecosystems through direct removal, modification or destruction. The second concerns direct, incidental and sometimes unintended effects on ecosystems through alteration of physical, chemical or biological processes. The third concerns amenity and involves the threat of endangering future

options for use of natural areas and resources for a wide range of direct or indirect purposes including those not currently anticipated.

Decisions about protecting or conserving natural areas and resources ultimately depend upon amenity options. Discussion of amenity value often identifies profound differences in opinion over the desirable use of natural resources and of the relationship between humans and the other elements of the natural environment. At one extreme is the utilitarian approach in which the dominant consideration is the economic value in terms of materials collected or harvested or of areas suitable for reclamation or alienation. At the other extreme are cultural, spiritual or philosophical views concerning the "right" of natural areas and biological communities to exist as wilderness, undisturbed by humans.

The position taken by a person in debate over the management of natural areas often reflect the degree and nature of that person's direct economic dependence upon the resources of natural areas. The more amenity relates to philosophical values or psychological perceptions the further it departs from objectively assessible factors. It becomes increasingly an issue of cultural and political choice in which sustainability and the potential philosophical and economic benefits of various options become key factors. In debate over protection and management of a natural area it is often of critical importance to identify allies who appreciate the long term socioeconomic benefits which can flow from maintaining it in a natural state.

Fishing and fisheries interests were traditionally the most important factors in the management of marine areas. Until relatively recently the technical capacity of many fisheries was so limited that over-fishing was a rare and questionable phenomenon. For a long time, coastal waters and deep oceans were the realm of fishermen and mariners who had little or no ground for competition or conflict over conservation of the resource. For these reasons fishermen may have been slow to recognize the need for management other than allocation of rights to fish. Now, the problems of fisheries include demonstrable over-fishing and competition from expanded uses of the sea that have developed in the age of leisure. The impacts of terrestrial activities which result in pollution of the sea and the degradation of marine habitats have added the need for protection to those fisheries resources and the environment on which they depend.

Perhaps with some reluctance, fishermen and fisheries managers are accepting the need and the potential benefits of a broader approach to marine environment and resource management. With increasing knowledge of the life cycles and habitat requirements of target species, fishery interests can provide powerful allies for the preservation of core areas which are critical habitats of those species. Equally, fishermen can be powerful opponents if they sustain the argument that proposed management measures unreasonably restrict their amenity.

In developed countries it is increasingly accepted that recreation plays important economic, as well as social, roles in achieving quality of human life. As the coastal plains of the world have become crowded, coastal seas have become prime recreation areas. They can offer naturalness and physical challenge which contrast with an increasingly controlled and modified terrestrial environment. These values can be more widely shared through the medium of environmental tourism and consequently provide economic benefits to local communities and economic arguments for the maintenance of natural areas.

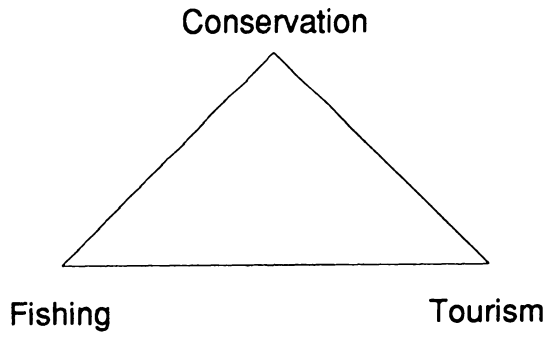
Recognition of the importance of recreation has been accompanied by the application of new technologies to recreation. New recreational users, such as SCUBA divers, dinghy and ocean sailors, sailboard riders and tourist operators have emerged to demand access to the resources previously shared by relatively few mariners and fishermen. These developments have led to crowded waterways and to competition for marine resources, for attractive day and overnight anchorages, for diving and fishing spots, for permanent mooring sites, for waterfront properties and for the associated business and employment opportunities.

Budowski (1976) summarised the uneasy relationship between tourism and environmental conservation identifying three different relationships: conflict; coexistence; and symbiosis. He noted that unplanned or poorly planned tourism in areas of conservation significance can often lead to conflict. He also pointed out that there were examples which prove that a change of attitude leading to a symbiotic relationship between tourism and conservation can bring physical, cultural, ethical and economic benefits to a country.

Recreation and tourism interests can provide increasingly powerful allies or opponents in the conservation and management of natural and near-natural areas. Alienated, they may provide nearly irresistible pressure for rapid and ill-serviced development which can turn a natural area with a small, long-established human community into an urban sprawl with large transient population and major social problems. As informed and creative allies, they can provide a counter to economic forces which consider such areas solely for the value of resources which can be extracted from them, or as alternative sites for alienation, reclamation or waste disposal. In the terminology of the Biosphere Reserve Programme they can provide solid political and economic support for the protection of core areas, for creation and compatible use of substantial buffer areas, and for the sustainable provision of resources.

Kenchington (1984) described the dynamics of marine resource and environmental management of the Great Barrier Reef in terms of the interaction of three groups: fisheries, recreation/tourism and conservation/science (Figure 1). Management of large marine areas will generally involve a multiple use solution which can meet the reasonable and compatible requirements of the three groups. If this can be achieved, it may provide an alliance or community of social, economic and political purpose to address the external threats of pollution and alienation.

Figure 1. Management of the reef: the three major interests



This figure represents the considerable overlap between the interest groups: much fishing is recreational; most reef visitors (other than commercial fishermen) reach the reef aboard chartered vessels or aircraft which are part of the tourist industry; many conservationists fish recreationally; and to the extent that it is selling the "unspoiled wilderness" aspect of the marine environment, the tourist industry has a vested interest in conserving or preserving its assets.

Introduction of multiple use management is no easy panacea. Whilst it offers a means to take into account the dynamics of new developments in use and management, it involves power sharing and loss of apparent influence for established interests. Multiple use management is thus most immediately attractive to the new interest groups, recreational users, conservationists, divers and tourist operators who see an opportunity to acquire a voice in areas otherwise managed mainly for the immediate but long established interests of commercial fishermen and coastal, economic development.

Effective amenity conservation planning requires a "bottom-up" approach, building alliances from the basis of the expectations and socio-economic needs of those who use or value a marine area and the resource it contains. It often involves economic research and community education to demonstrate causes and effects of human impacts and provide evidence that effective management has the potential to mitigate or prevent a decline in amenity.

The indirect, widespread nature of many threats (such as pollution of marine areas from non-point land sources) makes socio-economic factors important and unavoidable elements of management decisions. They are as important as ecological factors in determining the success or failure of marine conservation programmes. Given predictions concerning human population growth and trends in coastal development and probable consequential impacts on marine ecosystems it is clear that a sense of urgency should prevail regarding marine management. They only realistic response is to develop an approach to conservation which is aimed at long term sustainable use in accordance with the principles of the World Conservation Strategy.

Political and social systems

Variations in political and social systems throughout the world are almost infinite. It follows that the most efficient way of establishing marine protected areas within the framework of an integrated conservation regime also varies almost infinitely. The best approach in a country with a single central government and no federal system is unlikely to be the same as that in a country with three tiers of government, with the functions and powers of each level of government defined either in a Constitution or by tradition. Equally, the methods to be used in a highly developed country, with sophisticated communication technologies, will differ greatly from those appropriate to developing nations, perhaps with a low level of literacy or without access to modern communication technologies.

Opportunities will be different for countries with single party governments or government by a non-elected ruler, than for countries with multiple party parliaments and a strong tradition of community involvement in governmental decision making. Nevertheless, for most countries, the adoption of a broad, integrated approach to conservation, management and protection of marine resources is necessary now and is becoming increasingly urgent.

There are several prospective routes to the declaration and management of marine protected areas and the conservation of marine protected resources. Legislatively, these may range from new specific purpose legislation to continued use of existing legislation with relatively minor modifications. In any country, the appropriate approach can only be determined by those with a detailed understanding of its culture, tradition and legal processes (Kelleher and Lausche, 1982). However, the general principles touched on in this paper have been shown to be productive when applied to various political and social systems.

General Principles for the Establishment of Marine Protected Areas

Community interests

As a general principle, if a marine protected area is to be successfully established, it must contribute to the interests of a combination of political and public sectors whose influence exceeds that of those sectors that may be disadvantaged.

The world is littered with paper parks. These are generally the result of careful planning on ecological grounds, with inadequate attention to political and social factors.

Overall policy

An overall policy on the management, use and conservation of marine and estuarine areas should be developed for the country as a whole, for regions of the country, where appropriate, and for any identified sites of particular significance at the national level. The process of creating a policy, as well as its existence in provisions, will contribute to a national recognition of the importance of conservation of marine protected areas, to the selection and establishment of an appropriate system of marine protected areas and to the attainment of the primary goal of management, that is, sustainable use. The policy may be established within national or regional conservation strategies.

The general policy statement by IUCN quoted earlier in this paper can be used as a basis from which to develop a country's specific policy statement.

Statement of objectives

The objectives for establishing marine protected areas should be clearly defined. If this is not done and if conservation is not given precedence over exploitation, the setting aside of areas may be an empty political gesture. A primary conservation objective in resource management and in the creation of marine protected areas must be recognized as essential to sustained use and enjoyment of the marine resource.

Sustainable use

Generally speaking, the support of the community for the creation of marine protected areas will be greatly enhanced if emphasis is given to the linkage between protection and maintenance of ecological processes and the sustainable use of living resources. Explicit reference to the

objectives and concept of the World Conservation Strategy is desirable in all communications with people affected by proposals for marine protected areas. Most people, especially traditional users of the marine resource, react much more positively to the concept of sustainable use than to exclusive protection. Most societies with a long tradition of marine resource utilisation have established rules to prevent overexploitation. Sometimes, these have been eroded by introduction of a cash economy and by other economic and political changes but the ethic of sustainable use remains strongly embedded in most traditional societies.

Again generally speaking, governmental agencies and ministers responsible for exploitation of the marine environment are senior to and more powerful than those agencies and ministers responsible for environmental protection. It follows that the cooperation of these agencies and ministers will be much more easily obtained if the emphasis is on sustainable use rather than on exclusive protection.

Multiple use protected areas

Because of the strong linkages between different areas in the sea and the absence of boundaries between them, small protected areas in the sea are of limited effectiveness in protecting living resources. It follows that the application of the multiple use managed area, such as the biosphere reserve, is likely to be more effective in the marine environment than the creation of isolated, highly protected patches in an area that is otherwise unmanaged or is subject to regulations with an industrial bias. There has been experience throughout the world of the failure of the conventional piecemeal protection of small marine areas alongside conventional fisheries management. Overexploitation and collapse, sometimes irreversible, of stocks of exploited species and progressive deterioration of the protected area has been commonly experienced.

The socio-political advantage of the multiple use protected area approach is that it can be shown to provide for conservational management of a large area while allowing for different levels of access and of fishing and collecting in different zones within the area, and for continued sustainable harvest of food and materials in most of the area.

Management arrangements

If management is to succeed, interagency disputes, concerns, obstruction or delay must be minimised. Legislation and management arrangements for marine protected areas should grow from existing institutions unless there is overwhelming public and political support for completely new administrative agencies. Such public and political support is rare - the Great Barrier Reef in Australia is one of the few large marine areas that have been shown to be valued so highly by the community and the political system that the establishment of a completely new administrative agency was supported unequivocally by the people and all political parties. With the exception of the first, the following rules are likely to increase public and political acceptability of proposals for marine protected areas:

- creation of new agencies should be minimised;

- existing agencies and legislation should be involved using interagency agreements,

- existing sustainable uses should be interfered with as little as possible;
- existing staff and technical resources should be used wherever practicable;
- unnecessary conflict with existing legislation and administration should be avoided;
- where conflict with other legislation and administration is inevitable, precedence should be defined unambiguously.

Coordination

To minimise interagency disputes, a formal mechanism is required for the coordination of planning for marine protected areas involving all intragovernment, intergovernment and international agencies with responsibilities within the marine protected area. The relative precedence of the various pieces of legislation which apply to the area, the functions of each agency and specific mechanisms for achieving coordination and resolving disputes should be established.

Activities external to marine protected areas

Because of the linkages between marine environments and between marine and terrestrial environments it is important that specific coordination mechanisms are established for the control of activities which occur outside a marine protected area which may adversely affect features, natural resources or activities within the area. Often, low or high water mark constitutes a jurisdictional boundary. Coordination across such boundaries is notoriously difficult, complicated by interagency competition, a history of lack of coordination and an absence of technical knowledge in land management agencies of marine processes and vice versa. Boundaries also exist between marine protected areas and adjacent marine areas. In all cases, a collaborative and interactive approach between the governments or agencies with adjacent jurisdictions and responsibilities is essential.

Legal powers

Experience has shown that if a marine protected area is to be treated seriously by the people, the power to establish any marine protection or conservation management system should be provided by law, with approval and any subsequent amendments requiring endorsement by the highest body responsible for such legislative matters in the country concerned.

The legislation for establishment should contain enough detail for:

- proper implementation and compliance
- delineation of boundaries
- provision of an adequate statement of authority and precedence
- provision of sufficient infrastructure support and resources to back up necessary tasks

Consistency with tradition

The form and content of legislation, management plans and management practices should be consistent with the legal, institutional and social practices and values of a nation and people involved in a marine protected area:

- Where traditional law and management practices are consistent with the goals and objectives of the marine protected area, these traditional elements should be drawn upon to the greatest practicable extent. This applies to both the traditional, perhaps unwritten, law of indigenous communities and to the more recent traditions of a country or people.

- The customary or accepted ownership and usage rights of a marine area which is to be managed is a critical consideration. There may be public or communal rights as well as private ownership and customary fishing rights need careful consideration. They should be interfered with as little as practicable and, if the exercise of those rights is compatible with conservation of the marine environment, advantage of this should be taken, perhaps by involving those with the customary rights as managers.

Definitions

The definitions and terminology in legislation and management plans should use words which reflect, in language clearly understood by those affected, the intentions, goals, objectives and purposes of the legislation and management plan. Terminology is likely to differ from country to country but where practicable there is some advantage in adhering to that which has been internationally standardised.

Responsibility

It is vital in establishing a marine protected area to identify and establish institutional mechanisms and specific responsibility for management and administration. Responsibility, accountability and capacity should be specified and adequate to ensure that the basic goals, objectives and purposes of the marine protected area can be realised. As well as government agencies, local government and administration, traditional village community bodies, individual citizens, clubs and associations with compatible goals, objectives and responsibilities should be involved in management whenever practicable.

Management and zoning plans

A management plan should be prepared for each marine protected area. Wherever the multiple use protected area concept is to be applied, whether as a biosphere reserve or otherwise, the concept of zoning should be used as a management tool. The provisions of zoning plans should override all conflicting legislative provisions within the constraints of international law.

Public participation

Public involvement and active participation in the establishment, maintenance, monitoring and

implementation of management of a marine protected area is of key importance to its acceptability and success. It is highly desirable that the concept of public participation is established in legislation and that the procedures are sufficiently detailed to ensure that it is effective.

Accordingly, opportunities should be provided for the public to participate with the planning or management agency in preparing management and zoning plans for marine protected areas, including the preparation of a statement of the purpose and objectives of the protected area, the preparation of alternative planned concepts, the preparation of the final plan and in the preparation of any proposed major changes to the plan.

Preliminary research and survey

International experience has shown that it is often a mistake to postpone, by legislation or otherwise, the establishment and management of marine protected areas until massive research and survey programmes have been completed. Often, sufficient information to make strategically sound decisions regarding the boundaries of marine protected areas and the degree of protection to be provided to zones or areas within them already exists. Postponement of decisions may lead to increasing pressure on the areas under consideration and to greater difficulty in making the eventual decision. Provision in legislation for periodic review of management or zoning plans allows their continual refinement as user demands change and the results of research and other information become available.

Monitoring and review

If a marine protected area is to achieve its objectives, the following activities are required:

- surveillance of use in order to determine the extent to which users are adhering to the provisions of management plans;
- monitoring to determine the condition of a managed ecosystem and its resources;
- research to assist in development, implementation and assessment of management;
- periodic review of management and zoning plans in order to incorporate desirable modifications indicated from the results of surveillance, monitoring and research;
- involvement of the public in the review process to the same extent and preferably using the same mechanism as for the initial planning phase.

Compensation

Consideration should be given, where local rights and practices are firmly established, to arrangements for specific benefit to local inhabitants in terms of employment in management or of compensation for lost right. Experience has shown that the success of conservation management programmes depends critically on the support of local people.

Financial arrangements

While financial arrangements vary from country to country and locality to locality, consideration should also be given to establishing special funds whereby revenue arising from marine management can be applied directly to the programme or to affected local people.

Regulations

While education and the voluntary cooperation of users of marine protected areas are often seen as the most important elements in successfully managing a marine protected area, these mechanisms will not be successful without regulations to enforce the provisions of a management or zoning plan. Such regulations should provide protection to the area for which a plan is being developed and control activities occurring outside the marine protected area which may adversely affect features, resources or activities within the area. The regulations must provide adequate enforcement powers and duties, including:

- effective penalties for breach of regulations;
- incentives for self-enforcement of rules and regulations by users;
- adequate powers for professional field staff to take effective enforcement action including pursuit, apprehension, identification, gathering of evidence, confiscation of equipment and evidence and laying charges in courts of law; and
- provisions, where feasible, for local people to provide enforcement. This is especially practicable when the local people can continue their traditional uses of a marine protected area, even if limitations on that use have to be applied.

Education

To be effective, management should be supported by educational measures to ensure that those affected are aware of their rights and responsibilities under the management or zoning plan and that the community supports the goal of the plans. Few countries could afford the cost of effective enforcement in the presence of a generally hostile public. Conversely, costs of enforcement can be very low where public support exists.

A well designed education and public involvement programme will generate political and public enthusiasm for the marine protected area and its goals and objectives. The idea that it is the people's protected area will generate pride and commitment.

Conclusion

Rapid increases in the world's population and in the use of natural resources have brought home to the people of the world the recognition that environmental resources are not infinite and that the environment's capacity to absorb the products of human civilization is already being exceeded in many parts of the world.

This widespread realisation has led to new concepts of management which recognise the interdependence of development and conservation. Sustainable use of living resources has become a goal to which many nations of the world now formally subscribe. The preservation of species diversity and ecosystems is now seen to be vital to the future well being of the human race.

The increasing awareness of governments and the governed of the principles contained in the World Conservation Strategy provides an opportunity for the application of management techniques in the marine environment which have previously been reserved for the terrestrial environment. The establishment of marine protected areas can contribute greatly to the achievement of sustainable development. However, a global, representative system of marine protected areas will only be achieved if the task is approached with a recognition of the political and social dynamics which govern human societies around the world. Sustainable development of the marine environment will only be achieved if the marine protected area system is embedded within a general management approach to the marine environment that ensures that the seas' resources are not overexploited.

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7. Planning, Management, and Administrative Processes for Marine Protected Areas

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Introduction

There are many different approaches to marine protected area planning, management, and administration. The choice of approach should be influenced by the prevailing resources as well as environmental, social, political, and economic parameters. The climate of the area and the species living within it must also be considered. These parameters help to identify the boundary of the "target marine protected area" and its interactions with:

- linked environments and component species (the ecological component);
- the pressures on these by human needs and activities (the socioeconomic component); and
- the political, administrative, and institutional influences and constraints (the political component).

An understanding of the interaction among these three components will ultimately lead to the appropriate management strategy (Salm, 1988). The process for determining the final management and administrative strategy is called the planning process. In other words, planning is the deliberate action between knowledge (scientific and objective understanding of an environmental problem) and implementation (putting solutions to the problem into effect) (Dobbin, 1981).

In developing administrative and management approaches to marine protected areas the following definition is helpful for planning:

"*Planning is deciding in advance what to do, how to do it, and who is to do it. Planning bridges the gap from where we are to where we want to go. It makes it possible for things to occur which would not otherwise happen. Although the exact future can seldom be predicted and factors beyond our control may interfere with the best laid plans, without planning, events are left to chance. Planning is an intellectual process, the conscious determination of courses of action, the basing of decisions on purpose, facts, and considered estimates.*" (Koontz and O'Donnell, 1972).

It would be wrong to assume that a universal blueprint or design can be applied to every marine protected area. Because each site has different characteristics, dynamics, resources, uses, issues, and management objectives, there can be no one definitive model. For example, compare the planning for a small offshore island (having important turtle or seabird nesting sites, no inhabitants, no special management issues, no conflicting uses) with a vast mainland estuarine complex (having settlements, expanding fisheries, recreation, agriculture, and port development potential). The two sites would necessarily have vastly different types and levels of management and administrative systems.

However, it is possible to follow the planning and design process which has been applied over many years to real projects by landscape architects, architects, and regional environmental planners. Their experience has resulted in a planning process that provides basic elements which can be adapted as needed to individual cases. This planning process includes the flow of relevant information through problem identification, data collection, data analysis, and data synthesis as the major phases (Figure 1, IUCN 1988). The emphasis is on the "process" - or the path one follows to achieve results. That path should include interdisciplinary teamwork, cross-sectoral planning, and participation by the end users and/or the manager throughout the planning process.

The small offshore island mentioned above could be afforded strict protection without conflict with any existing uses, and may not require a management presence. In cases of a low level of conflict, there could be the need for minimal surveillance or perhaps seasonal presence of rangers. A strict nature reserve of this sort would require minimal administrative support - possibly restricted to a cooperative agreement with the Coast Guard or Navy for periodic surveillance and enforcement.

This type of protected area takes us all the way back to Ray's original "critical marine habitats" (CMH) concept (Ray, 1976). Ray's CMH approach requires identification and strict protection of areas of intense biological diversity or sensitivity. What is missing - how to fit the CMH concept into the larger environmental, socioeconomic, and administrative context - is something that can be achieved through coastal and ocean planning.

Advance planning (prospective planning) is the key to resolving current issues and setting up the process to deal with future issues. It is more effective than reactive planning which responds to one issue at a time. Therefore, even the smallest and most strictly controlled areas cannot be protected in isolation.

In the vast mainland wetland area example, we might also use the CMH concept to identify "hot spots" on which to focus intensive management action. However, these sites cannot stand alone, and we would need to fit them into a cohesive framework. The definition of this framework, and the fitting of the critical marine habitats into it, requires an appropriate level of environmental planning. There is the need for thorough identification of the issues, review of development options, and careful assessment of their social and environmental consequences. Generally, the resulting planning process will need to:

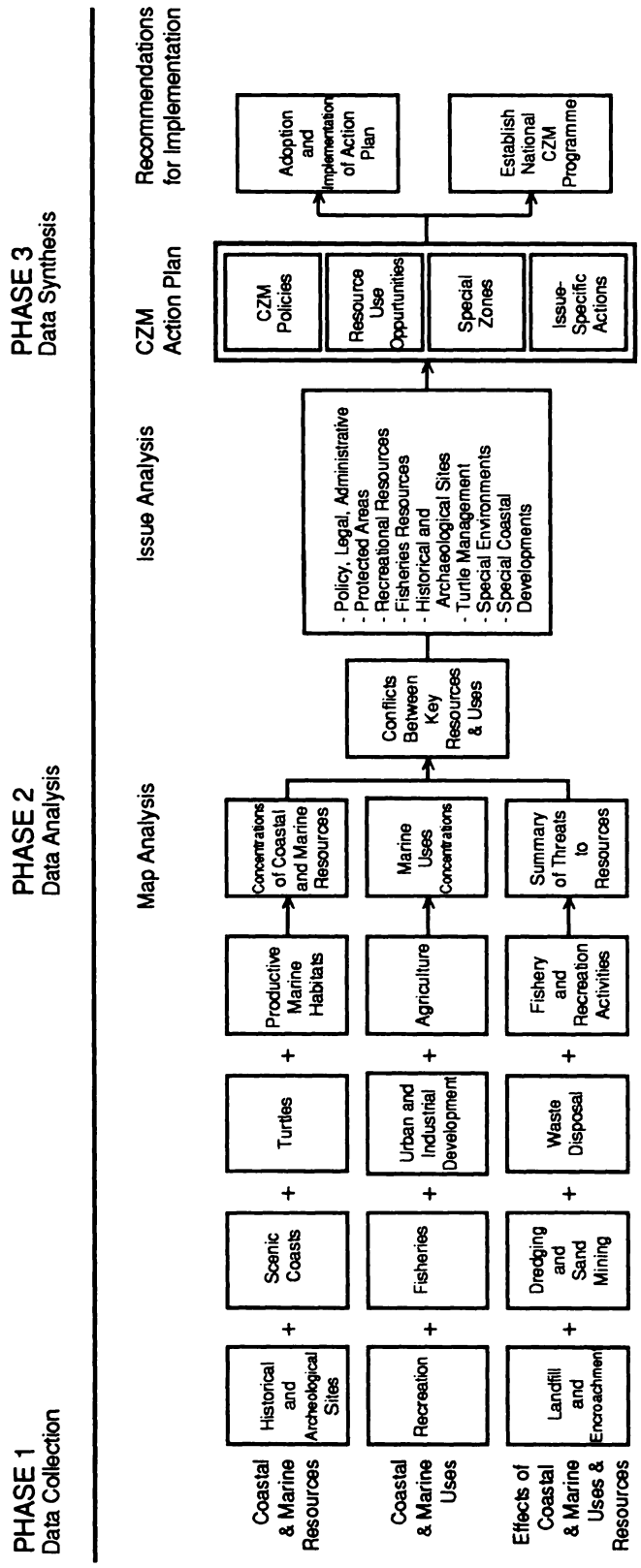

Figure 1. Coastal Zone Management Planning Process
(Oman Coastal Zone Management Plan, 1988 IUCN/James Dobbin Associates Incorporated)

- resolve urgent and important management issues;
- provide for appropriate levels of protection and management of CMHs and other sites of vital importance in context with the region; and
- anticipate the emergence of future management issues during the course of the development process and provide a framework to resolve them.

This type of planning will result in very different management and administration processes for the two examples. The process of determining management actions, however, is the same for both areas.

In the remainder of this paper, we will address the following related management questions. Are small CMHs likely to survive as discrete units? How can the above three management needs be tied together in the planning process? Is there a single prototype management and administrative system? If so, what is it?

Survival of Small "Cookie Cutter" Marine Protected Areas

The natural linkages among coastal, marine, and inland realms preclude the effective management of coastal and marine areas as independent entities (Salm and Clark, 1984). This is the principle obstacle to long-term survival of "cookie-cutter" reserves - small discrete sites cut out of large heavily developed areas. Of course there are exceptions. A remote rocky islet with a seasonal seabird colony may well survive management as a discrete unit. Generally, there is value in protecting small areas that are essential for safeguarding such vital habitats, but their management should be integrated with that of the surrounding region.

Integrated Planning

One solution is to include the planning of marine protected areas as part of general coastal land use planning, for example, through coastal zone management (CZM)(Dobbin, 1980). Establishment of marine protected areas in the broader context of CZM planning has been recommended as an effective technique for the management of upstream and other interactive activities and processes (Salm and Clark, 1984; Salm, 1987; Dobbin, 1976; IUCN, 1987a, 1987b, 1987c), and this has yet to be fully exploited. The goals of CZM are to build policies into overall land use planning to meet the needs mentioned above.

Appropriately conceived and developed CZM plans can achieve a vast multiple use reserve for the entire coastal zone of a nation. Within the coastal zone all valuable resource areas (CMH) can be managed to avoid damaging activities and pollution through development policies controlled by specific legislation, or contained by zoning plans. The entire coastal zone of the country essentially functions as a large conservation area in which all significant ecosystems receive protection without the deployment of permanent field managers. Thus only the minimal core areas need specific management attention. Management activities are free to focus on protection of CMHs or core areas, reducing conflict between user groups, and enabling the restoration of damaged areas. There are many parallels between planning for CZM and planning for biosphere reserves.

As for marine biosphere reserves, one could consider a nation's entire exclusive economic zone (EEZ) as a management unit within which special core areas may be identified as marine biosphere reserves (Dobbin, 1987). It is possible to use the existing regional institutional framework for the EEZ, such as legislation and regulations for fishing, pollution control, and fisheries management, to designate and manage biosphere reserves.

Land use policies can also be used to achieve *de facto* protection for a range of sensitive and scenic environments (including beaches, dunes, wetlands, estuaries, coastal cliffs and mountains, and headlands). This generally underexploited means of protecting critical habitats and scenic areas enables broad environmental protection without the need to define, legislate, and manage numerous small and scattered "cookie-cutter" reserves (Salm, 1987).

There are three action components of the CZM planning process as designed for the Sultanate of Oman which illustrate the integrated planning approach (Salm and Dobbin, 1987, 1989):

1. Establishment of planning policies which would provide a broad-brush approach to guide development in the coastal zone, and avert the emergence of new management issues. If built into the central planning system, an advantage of these planning policies is that they can achieve protection of a vast number of small, sensitive or productive coastal habitats, such as dunes and wetlands without requiring formal site protection or a management presence. For example, a setback policy for development along the coast can keep coastal structures off unstable dune ridges and beaches; and wetlands policy can restrict encroachment of tidal lands, and prevent landfill, dumping, and destruction of vegetation.

2. Establishment of protected areas to enable intensive management of specific sites of particular value including:

   - Nature reserves, which are designed primarily for the conservation management of wildlife and other natural resources;
   - Scenic reserves, which are designed primarily to safeguard aesthetic resources through the control and monitoring of development activities; and
   - Recreation areas, which are designed to protect prime recreation areas for the public through varying levels of control over adjacent lands, and which provide different types of utilities and services.

3. Definition of issue specific actions which recommend specific remedial actions for particular management issues in the coastal zone and assign these to a responsible agency for implementation. In this way, all concerned authorities are brought into the field of environmental management and conservation, and the burden of comprehensive CZM is spread among them (James Dobbin Associates Inccorporated 1983a, 1983b, 1987).

Three Models for Planning, Management, and Administration of Marine Protected Areas

Consider the three approaches used for marine protected area management in Indonesia, Oman, and Australia's Great Barrier Reef, each of which is affected differently by their respective environmental, social, economic, administrative, and political characteristics.

1. Indonesia

In Indonesia the Directorate General of Forest Protection and Nature Conservation (PHPA) has the mandate for all conservation activities, including the establishment and management of marine protected areas. Here, the marine protected areas are first gazetted to achieve rapid legal protection for a vast array of areas. Conservation management plans are then prepared for priority sites and, once funds are obtained, management is implemented. The marine protected area system includes a variety of representative environments, CMHs, and resource types, and aims to protect these and endangered species from damage or elimination.

Active site management is necessary to control localised, small scale, but destructive activities. Once conservation management plans are prepared and funds are obtained, a reserve manager is appointed whose task it is to interpret and implement the plan.

Actual formulation of the conservation management plans was guided as much as possible by scientific principles, including island biogeography theory, which influenced the location, size, shape, and distribution of zones; by social parameters which also influenced the design of zones, but which mainly influenced the types and levels of use and development of the different zones; and by economic parameters which influenced the extent of management activity. This approach requires that marine protected areas be large enough to enable direct control by reserve personnel of all activities and developments which may affect the included ecosystems.

This approach is appropriate to the Indonesian situation where there is heavy dependence on the marine environment by resident communities; a bewildering variety of candidate marine protected areas with vastly differing resource values spread over a huge area; and where it is funding, not manpower, which primarily limits marine protected area management activities. Manpower is readily available, and with a certain amount of training and supervision, can be directed towards management of marine protected areas.

2. Sultanate of Oman

In contrast, manpower is the primary limiting factor to marine protected area management and administration in the Sultanate of Oman. Here, the CZM model was developed primarily as a means to reduce dependence on a large force of administrative and field personnel, and to reduce the size and number of conservation areas.

Experience in the Sultanate has shown the CZM approach to have distinct advantages. First, it draws marine protected area management into an integrated land-sea-use planning process, effectively establishing the entire coastal zone as a vast multiple use reserve (Salm, 1988), similar in concept to a biosphere reserve. It should be noted here that the coastal zone planning process bears little resemblance to coastal zone planning in the United States. In the Oman project, a great deal of emphasis was placed on resources on the "wet" side of the coastline with field survey central to data collection and analysis. Second, there was complete integration and inclusion of all the relevant agencies who manage resources and activities in the coastal zone, as well as emphasis on spatial planning techniques and overlay mapping in order to locate resource concentrations, conflicts, and compatibilities (Salm and Dobbin, 1987, 1989). Third,

the Sultanate of Oman coastal zone management plans are based on a shared responsibility for administration and management of the coastal zone among concerned agencies. These factors reduce the requirement for huge conservation areas and a large management force. Management of defined marine protected areas remains the responsibility of the Ministry of Environment which also coordinates all CZM activities.

3. Australia (GBRMPA)

There are similarities between the CZM model of Oman and that of the Great Barrier Reef Marine Park Authority (GBRMPA), but they differ in certain important aspects. CZM ideally should tie terrestrial and marine elements into a single planning framework, thereby guiding inland development in such a way that reduces risk to downstream marine areas. The GBRMPA model is more one of marine zone management planning, being bounded by the tideline.

Prospective planning for the definition of conservation and activity zones is used both in Indonesia and Oman. This form of management planning entails evaluation of marine environments on the basis of their intrinsic values, and where necessary may require the control or exclusion of existing activities which conflict with resource conservation in the most valuable sites. In other words, zonation reflects intrinsic resource values. The GBRMPA model is more retrospective in the sense that existing uses play a significant role in the definition of zones. Zonation reflects current patterns of use, which is not necessarily what uses should be.

The Great Barrier Reef is an exceptional case with a number of characteristics which have enabled GBRMPA to be more accommodating of existing uses in overall design of the marine park. These include the sentiment of the reef as an object of national pride and the considerable public will to preserve it; the low resident population and vast areas with no history of resident communities dependent on its resources; relatively low levels of resource/use conflicts; and the great number of alternative undamaged sites for location of different resource uses, developments, and conservation areas.

By way of contrast, Indonesia has a disparate system of coral reefs, most of which are exploited by resident communities which subsist to a large extent on the reef resources. All parts of it are exploited by itinerant collectors of mother-of-pearl shell and turtles who use extremely destructive collection methods.

Focusing Management on Marine Protected Areas

These three case studies show that there can be quite different approaches to planning, management, and administration of marine protected areas dictated by the prevailing conditions. There is a common pattern for defining goals, deploying staff, isolating priority actions, and implementing management programmes. The primary goals of marine protected area planning are generally to prohibit the pursuit of any damaging activities, to control fisheries, recreation, and shore or inland developments as necessary, and to restore degraded areas.

To be effective, marine protected areas require staffing. A low-level staff presence is relatively easy to achieve and its mere presence can often make a considerable contribution to control of

the most damaging activities. But management activities require further effort. The first action should be the identification and resolution of management issues: management should be issue-driven. By focusing on immediate problems, management is directed to resolving the most urgent issues, in addition to everyday problems (fuel orders, maintenance, personnel problems, surveillance, public contact, enforcement). In the process of everyday implementation of management, a host of additional issues, particularly those related to inadequacies in the administrative system, will become apparent. These can be dealt with on an *ad hoc* basis, if the system allows it, or they can be addressed in a comprehensive long term management plan. The advantage of this approach is that it allows management efforts to start on a small but focused scale, and to evolve toward the more comprehensive ideal as funds, personnel, and other essential institutional requirements become available.

Conclusion

Every nation has its particular marine environments, resources, and administrative opportunities and constraints, and these special conditions dictate the development of appropriate marine protected area management planning. A model that is applicable in one country would probably not be appropriate elsewhere - but the overall planning process does have universal elements.

A widely applied approach is the nature reserves model, where, in the more traditional view, marine protected areas evolve as independent units to be lobbied for and decreed before incorporation into land-use plans. This approach is used in Indonesia and suits the country's immediate needs. However a more effective means to achieve marine protected area administration and management is through advanced CZM, as in the model for the Sultanate of Oman.

One goal of coastal zone management is to establish protected areas as an integral component of regional land-use policy and planning. Thus it circumvents the more traditional view of marine protected areas as independent areas. Instead, the CZM plan uses traditional land-use planning methods and techniques as the vehicle, with policies and site plans as tools to facilitate the protection and management of numerous tracts of sensitive or valuable coastal and marine environments (Salm, 1987), leaving marine protected area management to focus on activities in the critical marine habitats or core areas.

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8. Setting Boundaries for Marine Biosphere Reserves

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Introduction

One of the principal objectives for establishing biosphere reserves is to conserve, or maintain, ecological processes. To achieve this objective it is first necessary to understand the spacial and temporal characteristics that define the natural boundary conditions of these processes. It is equally important to appreciate and account for the boundaries that are derived from man-made institutions and the uses made of ecosystems and their component parts. This paper presents a brief review of the most important three-dimensional and time-dependent characteristics of coastal processes, both natural and those arising from man's activities, that must be taken into account in designing and managing coastal biosphere reserves. It also provides a simple framework for analysing these in a way that complements the establishment of coastal biosphere reserves.

Evolution of the Biosphere Reserve Design Concept

The concepts that underpin the three objectives of biosphere reserves have been evolving since they were first formulated and have been reviewed by Batisse (1982, 1986, 1990). The biosphere reserve concept has practically always been applied to terrestrial systems (about 10 coastal biosphere reserves have been designated out of 271 total). While not often articulated at the outset, one emergent theme in the design of these reserves has been how to reconcile and manage the multiple, potentially competing objectives within a biosphere reserve area.

The task of resolving the objectives of biosphere reserves has generally been achieved through establishment of core areas, buffer zones, transition areas, and other zoning mechanisms. There have been notable successes in achieving the objectives for biosphere reserves, but the degree of success has varied with the approaches taken. This is partly because approaches have developed alongside the concepts involved. There are, for example, reserves for which it appears that buffer and transition zones were demarcated because of an intrinsic recognition of their desirability - a sort of "no-man's land" separating people from nature - rather than on the basis of well defined management objectives and a knowledge of the interactions involved. Often, later observation of what the zoning system actually achieved has led to a refinement of the biosphere reserve concept.

A recurrent reason for failure to achieve biosphere reserve objectives seems to be that the outer boundaries for the reserves, i.e. the transition zones, were preconceived and management plans

had to be designed to fit within already imposed boundaries. In many cases this stemmed from a simple redefinition of the functions of existing national parks and protected areas and their redesignation as biosphere reserves. In the failures, not enough attention was paid to first determining the limits of the relationships between, and interactions of, the natural components of the intended core areas (containing the ecological processes to be conserved) and the man-induced influence on them arising either in the surrounding buffer and transition zones or outside and then setting the boundaries accordingly. In the extreme case, boundaries of some core areas were decided without taking into account the real areal extent of the processes the boundaries were set out to enclose.

Yellowstone National Park is an example of this problem. While it obviously predates the biosphere reserve programme it nonetheless originated on the basis of at least one present day biosphere reserve objective - maintenance of ecological processes. One aspect of managing Yellowstone has been the long standing problem of conserving the elk population in its "natural habitat" within the Park. The boundary of the Park was set out in 1872 for the purpose of conserving a unique natural area for "the benefit and enjoyment of the people".

To those who established the park, the boundaries appeared to enclose a self contained ecosystem including the elk population that was regularly observed there. However the boundaries were set without taking into account that the most common winter range for elk was outside of the park boundary at a lower, relatively warmer altitude. The boundary was managed so as to keep the natural in and the unnatural out, and in time the area surrounding the park was usurped by agricultural or other developments. The elk, left with no suitable winter range and constrained within the park boundary by fences and other mechanisms, were repeatedly subjected to starvation and to freezing to death (Chase, 1987). Not only was the park simply too small, but the boundaries of the park were basically in the wrong place to conserve the elk within its ecological range. A similar situation exists for many large game parks in Africa and Latin America which have subsequently been designated as biosphere reserves.

The migrations of the elk in Yellowstone are comparible to seasonal movements of marine species such as sea turtles, dugongs, tuna and whales in and out of coastal areas. As the biosphere reserve design concept evolves and is applied more and more to coastal and marine systems it will be necessary to set boundaries on the basis of a foreknowledge of the nature and extent of processes both ecological and man-derived.

Law, Administration, Institutions and Coastal Processes

It is inherent that to meet the objectives of biosphere reserves, in particular the third which aims for integration of conservation and resource development, will require a multi-faceted approach. Such an approach is needed in order to define and understand the physical and biological components and processes that are part of the natural system as well as to determine the interrelations between uses of these natural components by man and the resultant effects of man on natural systems.

For the most part, terrestrial areas are owned, and or controlled, by some individual or institution. There may be conflicts over rightful ownership but generally these can be resolved

to the point of identifying that an individual, a regional authority, a government ministry or department has the right, or trusteeship, to determine the use, fate or disposition of a piece of land and its resources. Sometimes this right is shared, as in some traditional societies, but eventually some person or an institution is accountable.

By contrast, the traditional view of the marine environment has been that it, and its mineral and living components are a common heritage and are therefore generally available to all who have the wherewithal to gain access and derive a benefit. Thus, over time, traditional law of the sea has delineated only very few boundaries for zones such as the Territorial Sea in which permitted activities are defined. Restrictions have concerned such activities as the transit of ships of one nation to areas outside coastal waters of another rather than controlling access to living and mineral resources. The general principle of the right of access by many users has prevailed.

Under the United Nations Convention on the Law of the Sea (UNCLOS) text as finally negotiated in 1982 the rights and privileges of sovereign states was further defined and the concept of the Exclusive Economic Zone (EEZ) was conceived and adopted. The EEZ is an area extending outward 200 miles to sea. Within this zone the UNCLOS accords states certain privileges and benefits concerning marine resources. The UNCLOS also provides extensive definitions regarding access to the ocean for transport, passage, and other traditional uses, but the principle of the "commons" prevails. While there are many conflicts and uncertainties to be resolved in actually applying the UNCLOS (it still has to be ratified), the significant point is that the outer boundaries of the Territorial Sea and the EEZ are defined and accepted in practice by states within the context of a single set of legal principles and definitions embodied in one text which is theoretically applicable in the same way to all states.

On the landward side, the situation is less straightforward; and except for cases involving long range migrations of marine species into nearshore waters, coastal biosphere reserve planners will be more concerned with defining and managing landward processes and their boundaries.

Within territorial waters, and mainly on the continental shelf areas where marine resources tend to be concentrated the traditional "commons" approach has led to the present-day situation where a multiplicity of institutions and government bureaucracies are often managing or, more accurately, attempting to manage the same area. For example it is common to encounter in the nearshore and coastal areas of most coastal states the operational activities of coast guards, municipal authorities, fisheries departments, conservation departments, shipping authorities, ministries responsible for continental shelf mineral and oil licensing schemes, and so on. They usually pursue their separate aims with little reference to each other. In doing so most have developed their own legal and administrative jurisdictions and procedures as well as definitions of what comprises the coastal zone.

In one well-known case study of New Zealand it was shown that over 20 different jurisdictional definitions have been applied to the zone between about one-half mile inland from the upper tide line and approximately two miles out to sea (Sorensen *et al.*, 1984). In several cases more than 10 of these jurisdictions overlapped and were being administered by separate bodies. In some cases their objectives were in conflict.

Such overlapping jurisdictions, mandates and related activities are always influenced by socioeconomic and political factors. At the same time, socioeconomic conditions and politics are influenced by the jurisdictions, mandates and resulting operational programmes of various implementing bodies. For example it is commonplace that there are conflicts between traditional fishing activities and the development of tourism on many coral reef systems in tropical coastal areas. Many fisheries departments realize the need to conserve and manage mangrove systems because they are nursery and breeding areas for offshore shrimping grounds but they are often in competition with coastal developers who view mangroves as waste lands that can be land-filled and put to better uses such as building industrial complexes in their places. It is not uncommon to find that some institutions have more influence than others in deriving the authority they need to carry out their own programmes. Being responsible for successful programmes such as deriving income from off-shore petroleum, fish products or tourism often helps to influence political machinery. In some cases, of course, the implementation of a programme may seriously affect or even preclude others, for example, the destruction through land-fill of a mangrove system and its associated fishery before that fishery could be developed on a sustainable basis.

Socioeconomic and political situations and legal and administrative mandates all have realms of influence that differ in their boundaries and change with time in ways that sometimes resemble natural systems. To prepare any management approach to coastal and marine biosphere reserves these factors need to be understood and their influences taken into account in order to demarcate and coordinate the socioeconomic, legal-administrative and political boundaries and processes within which a biosphere reserve must function to achieve its objectives.

Coastal Systems, Living Components and Processes

Biogeochemistry

Ray (1975, this volume) and other contributors (Salm and Clark, 1984) to the emerging concepts for applying the biosphere reserve concept to marine and coastal areas (as well for conceptual approaches to marine protected areas in general) have pointed out the marked contrasts between terrestrial systems and coastal and marine systems.

One of the most commonly mentioned features is the three dimensional and fluid character of marine systems. Most biogeochemical processes in the terrestrial sphere are confined to from within a few centimeters below ground to not much more than 30 meters above ground, while in the ocean the processes are distributed throughout a greater vertical distance. This observation is more valid in the open ocean than near shore, with the continental shelf areas falling somewhere in between. In fact in many ways terrestrial and near-shore coastal systems differ little in such physical comparisons since in coastal areas most process do occur within a short range of the bottom substrate. For example, coral reef systems are often likened to tropical forest systems.

Probably the most important contrasting feature between land and sea is the range of distance over which basic nutrients are recycled. On land, recycling of most mineral and organic

nutrients takes place in a thin veneer above and within a few centimeters below the ground. By contrast, in a typical coastal upwelling zone, mineral and organic nutrients are commonly carried to surface waters from the ocean floor over ranges of hundreds to thousands of meters. Related to this is that these same nutrients are distributed more evenly throughout the fluid medium of sea water than their counterparts in the atmosphere over land. Thus in the marine environment there is the possibility for a wider spatial and homogeneous distribution of living matter in the water column that is less dependent on existing close to a bottom substrate compared to terrestrial systems. Pimm (1982) has pointed out that another critical difference has to do with population dynamics. Ocean food chains are based on short-lived phytoplankton that eventually support large, top predators with long life-times. On land, by contrast, very long lived trees and shrubs and slowly decomposing organic matter are the base of food chains that support shorter-lived top predators with the shortest lived species sandwiched in between.

There are other contrasts, not all of them completely understood and widely accepted. The important point for planning coastal biosphere reserves is to take into account that there are widely different features in the biogeochemical cycles on land and in the sea and that it is generally accepted that these lead to wide differences in their spatial distributions and points of concentration. These differences in turn will affect the determination of boundaries that are suitable for conserving coastal ecological processes.

Life-cycles and Seasonal Distributions of Marine Organisms

As inferred earlier in the Yellowstone Park example, there are many analogies between terrestrial and marine creatures. Elk move with seasonal variations in temperature and food supply: Florida manatees with changes in locations of their nutrient supply which in turn appears to be a function of water temperature. Some land mammals breed and start rearing their young in one location and later on move to forage elsewhere; California grey whales have their nurseries in Skammons Lagoon and migrate to the Arctic for feeding.

Many similarities in migrational patterns exist particularly for large marine animals and fish. For many coastal and marine species however the most important manifestation of migrations has more to do with where various stages of a metamorphic development takes place. Many marine organisms and plants spend their egg, larval and early juvenile stages drifting around suspended in surface waters in the form of phytoplankton and zooplankton. In later juvenile stages they purposefully migrate or quite literally drop onto their adult habitats. In tropical reef systems it has been established that recruitmenr of some coral species may be 2-300 kilometers from where the resultant larvae actually settle. For salmon this means moving to sea from long distances inland. For tropical shrimp this means migrating from mangroves to the open sea, or for some species the opposite direction. Some eels spend part of their life in the Sargasso Sea and the remainder in coastal waters and estuaries of northern Europe. For many shellfish a molt brings about a change in density and the subsequent stage drops to the sea bottom substrate. If it happens that conditions are right it continues to grow, if not it dies.

To complicate matters, the points at which favorable conditions occur that support different life cycle stages in the sea can move about with time as the prevailing physical and chemical conditions change. This means that from time to time the occurrence of various marine species

can change markedly. The same thing happens on land, but generally to a lesser and more predictable degree because of the fundamentally different rate of change of terrestrial population dynamics and characteristics of food webs that are manifest between terrestrial and marine environments.

To adequately plan the physical and biological boundaries needed to achieve the biosphere reserve objective of conserving ecological processes, the components of the system, and their developmental and migratory patterns should be identified and delineated. In addition account needs to be taken of the dynamics of the conditions that support these patterns.

Defining the Coastal Zone

A final major point concerns determining the landward extent of a coastal area that needs to be taken into account in setting the management boundaries or a biosphere reserve.

Coastal waters are influenced by many land based activities and influences. The most important of these are associated with land-based sources of pollution, manipulation of coastal land areas by dredging or land-fill, perturbations of upstream processes in watersheds and estuaries and so forth. These in turn can bring about perturbations in thenormal levels of nutrients, temperature, turbidity, and productivity of coastal waters. The perturbations can affect the ecological processes that take place in the coastal zone which in turn have bearing on the design and management of coastal and marine biosphere reserves.

Another related factor: is that legal definitions of coastal zones are usually established according to some cartographic reference or for monitoring and enforcement convenience that could easily be illustrated and demarcated. Examples are "100 metres above mean high water", or "extending inland to a distance 100 metres on the seaward side, and parallel to State Highway No. 1". Natural processes and the effects of seemingly remote human activities do not recognize such boundary definitions. So in practice it is common that many existing laws that were conceived to regulate coastal activities and thereby conserve the coastal zone actually have little effect in achieving their aims.

Ecological processes to be maintained within coastal biosphere reserves will be effected by activities taking place inland. These need to be defined and their influences delineated in order to plan for boundaries of the coastal biosphere reserve system.

Summary

Outlined above are the main spatial and time-dependent factors that need to be taken into account in planning the various boundaries for coastal biosphere reserves. For convenience of analysis they can be classified into five major divisions. these are: (i) natural components and processes or "resources"; (ii) "uses" of the resources; (iii) "effects" upon the resources from uses; (iv) "socioeconomic conditions"; and (v) "legal, institutional and administrative conditions".

In order to begin planning for coastal biosphere reserves the component parts of each of these divisions of activities should be assessed. On the basis of this assessment conflicts and compatibilities including the differences in overlapping of the natural and man-induced boundary conditions applicable for each needs to be defined and delineated. On this basis issues and options are identified that have to be addressed in the final management plan for the coastal biosphere reserve. These ideas are presented diagrammatically in the Outline of a Protocol for Planning, Nominating, and Administering Coastal Biosphere Reserves (CBRs) (Agardy, this volume).

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9. Draft Guidelines for Biosphere Reserve Planning

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Introduction

As world populations boom and their needs become greater, humankind is brought into conflict with nature in ever-increasing ways. Efforts to promote harmonious use of natural resources have been short-circuited by urgent problems of hunger and economic stagnation which distract attention from pervasive and increasing environmental disasters. Although the limited history of what we can call natural resource management is studded with short-lived periods of intense public interest and governmental concern, these have usually been in response to ecological crises. Now, as we near the final decade of a technologically progressive but often tumultuous century, public interest in conservation and resource management finally seems to be consistent and forward-looking. A new focus on the environment, treating it not as a luxury but as a critical and economically valuable commodity, is emerging, and hopefully will endure.

The Man and Biosphere Programme (MAB) of UNESCO has survived the fits and starts of environmentalism to evolve into one of the most renowned international programmes aimed at protecting natural resources and promoting their sustainable use. From its genesis in the early 1970s, it has grown to encompass many activities, including its most well-known, the Biosphere Reserve Programme. MAB is a nationally-based international programme of research, training, and information transfer which seeks to provide the scientific basis to resolve conservation and development conflicts. It emphasizes multi-disciplinary research on the interaction between social and ecological systems and applies a holistic approach to understanding the relationships between man and the environment (UNESCO, 1987). The Programme is concerned with interactions in the whole range of bioclimatic and geographic elements of the biosphere, from polar to tropical zones, from islands and coastal areas to high mountain regions, from sparsely populated areas to dense human settlements (UNESCO, 1984). The ultimate purpose of MAB research is to provide practical information towards solving real resource management problems, and wherever possible, to promote environmental ethics.

The Biosphere Programme is in many ways the operational branch of MAB, where scientific research, public education, and planning are used to promote sustainable use of the environment. Biosphere Reserves are not analogous to national parks, sanctuaries, or other traditionally managed forms of protected area. Their design and operation is rooted in sustainable use rather than protectionism and promotes stewardship by human beings rather than their exclusion.

As a testing ground for MAB philosophy, the Biosphere Reserve Programme has been of limited success. In the early years of the programme, biosphere reserves were formed primarily to establish an international network of protected areas for monitoring and public education purposes. Most designations were merely superimposed on existing parks and protected areas and did little to promote sustainable use. In the 1980s, however, planners and natural resource specialists began to realise the value of biosphere reserve management in its own right, and the new generation of biosphere reserves are testimony to the value ofpromoting stewardship and practicing ecologically-based management (Robertson, 1988).

Because biosphere reserve planning fosters a man-in approach (Kenchington and Agardy, 1990), effective reserves are those in which users participate not only in the administration of the reserve but also in its initial design. The geographical limits of the reserve and its management regime are a reflection of the needs of the people who rely on its resources, whether for economic, cultural, or personal reasons. Thus the ideal biosphere reserve is one in which resource users are transformed into stewards of ecologically-based, functionally independent protected areas.

By January 1989, 273 biosphere reserves had been designated, establishing a solid network of well-managed representative ecosystems around the globe. The exemplary reserves are those that have provided an aegis for regional and interdisciplinary cooperation, have become important scientific monitoring and educational sites, have helped to protect traditional resource uses, and have promoted long-term sustainable development of natural resources.

Functional biosphere reserves are usually designed according to the model developed by Batisse (1986), which utilizes zoning to delineate areas according to the character and intensity of permissible human use. A reserve based on this model contains one or more core areas which are strictly protected for specific conservation objectives and which serve as in situ conservation units. These cores are surrounded by buffer zones where human use is regulated. The management regimes for buffer areas serve to protect the cores and maintain their functional health. Thus a biosphere reserve contains not only pristine areas roughly corresponding to sanctuaries or nature reserves, but also managed areas which buffer the core from external effects. The core and buffer areas are themselves within a more vaguely defined transition area or zone of cooperation, which in management terms is a modified buffer, serving as the outer limit of the reserve itself. Ideally, such transition areas encompass entire ecological units and in so doing are likely to include human settlements and areas of intense development.

Recently, US MAB draft guidelines have slightly modified Batisse's model and include the following components: core areas with either conservation or monitoring subzones; zones of regulated use (the term "buffer" has been played down); and transition areas, the outer boundaries of which may vary in time and space according to the nature of cooperative activities taking place (Gregg, 1989). The "Model Biosphere Reserve", if such a beast exists, is likely to change as such new interpretations arise and evolve as the MAB Programme itself matures and adapts to changing perceptions.

An effective design on which to base biosphere reserve planning is necessary but not in itself sufficient to ensure that a reserve will meet the objectives of the MAB Programme. Recognising

this, UNESCO has published an Action Plan for Biosphere Reserves which specifically outlines goals for prospective reserves and describes the catalytic role that national and international organizations should play in supporting the programme. The Action Plan lists several functions of biosphere reserves, including in situ conservation, research and monitoring, education and training, and cooperative management (UNESCO, 1984). Batisse (1986) organizes these objectives into three categories: 1) logistic role (monitoring and standardized research); 2) conservation role (education, site specific research, and management for protection of threatened resources); and 3) development role (preservation of traditional forms of resource use while promoting long-term sustainability).

The Action Plan of 1984 lists specific actions to be taken by UNESCO and the internationalcommunity in order to strengthen the role of reserves in global research and conservation. These action points include the following:

1) enhancing the role of the international network of reserves in ecosystem conservation;

2) improving and upgrading the management of existing reserves to correspond to their multipurpose objectives;

3) promoting the conservation of key species and ecosystems;

4) promoting coordinated research projects on conservation science and ecology;

5) developing monitoring activities which contribute to the understanding of global change;

6) enhancing the role of reserves in regional planning;

7) promoting local participation in the management of reserves;

8) promoting environmental education and training; and,

9) using the network of reserves to disseminate information about, and generate knowledge of, the conservation of the biosphere (UNESCO, 1984).

There are likely as many different opinions about how biosphere reserves should be planned as there are people with interest in resource management. To provide some guidance and a means for cooperative management, MAB has printed several guidelines for identification, evaluation, and selection of biosphere reserves (e.g. Fernald, et al., 1981; Gregg, 1989; Ray et al., 1983). Collectively, these guidelines spell out in detail the objectives that biosphere reserves should target, describing the process through which reserves can be designed and nominated.

Common to all the guidelines are four criteria for selection. These are representativeness, naturalness, biological diversity, and effectiveness as a conservation unit. Since the ultimate goal of reserve planning is to ensure that natural areas remain intact in the face of rocketing human population growth and human use of resources, these criteria are of an ecological nature. Representativeness is a criterion that reflects the logistic role of the reserve programme,

ensuring that each reserve will be a scientifically important site for research and an integral part of the global monitoring network. Naturalness and diversity are criteria that accentuate the conservation role of the programme. The potential effectiveness of the area as a conservation unit concerns its ecology, as well as the political and socioeconomic context within which the reserve must operate.

Clearly the criteria to be used to select sites for nomination as reserves will vary according to region and to site-specific priorities among programme objectives. In industrialised countries where a solid legislative framework for protected area management already is in place, the conservation role of a reserve may be secondary to its logistic and development roles. On the other hand, the importance of the development role may be paramount to the logistic and conservation roles in underdeveloped areas. Thus, although all biosphere reserves have ecological and conservation value, some will accentuate different characteristics. Indeed, the success of the biosphere reserve programme has largely to dowith its inherent flexibility and the adaptability of the design criteria.

Coastal Biosphere Reserves

Man's impact on the coastal zone, where marine and terrestrial worlds meet and where diversity and productivity are unrivaled, make resource management as, if not more, exigent than on land (Ray, 1988) The oceans cover nearly three quarters of the earth's surface and provide critical fisheries, mineral, and recreational resources for most of the world's nations. The coastal zones are now distinguished by having the highest rate of population growth, and by some estimates already support over two-thirds of the global population. Despite the obvious importance of coastal ecosystems, our track record in managing coastal and marine areas is not at all laudable. This is similarly true for biosphere reserve planning and management. While a significant number of the 273 reserves in existence are found in coastal areas, very few of these were designed about the coastal system and their functional limits often stop where the sea begins.

Why the reluctance to defend marine resources and traditional uses of these resources with the same vigour as is directed towards terrestrial conservation? One reason is that marine resources are regarded as a global commons and lack of private ownership or clear sovereignty complicate attempts at delimiting management areas. Additionally, there is a paucity of knowledge concerning marine ecosystems and their dynamics, making ecologically based management difficult. But perhaps the most important reason that coastal conservation is light years behind terrestrial protection is that as yet there is no proven model for comprehensive marine management. This is the case because marine resource managers have too often looked to terrestrial models for application in coastal areas. While the same principles may apply, their application in the marine enviroment is complicated by differences in scale and dynamics.

Traditionally, our approach to the conservation of coastal areas has been either to practice sectoral management of a single resource (e.g. a single fishery), or to delineate landmark areas as marine sanctuaries or parks (Kenchington and Agardy, 1990). Marine resource management has rarely been designed to conserve whole ecosystems with long term, sustainable use in mind. Notable exceptions are the management of the Great Barrier Reef in Australia, and to a more

limited extent, recent plans for managing the coastal Sian Ka'an Biosphere Reserve in Mexico. Our experience, albeit limited, with ecologically based planning indicates that coastal and marine management can lead to sustainable use if zoning is used to protect critical areas and to control development of less critical ones. For this reason, biosphere reserve principles appear to be perfectly suited for application in the coastal realm.

As on land, reserves in coastal areas can serve a variety of purposes. They have a logistic role, serving as monitoring sites in studies of global change and as centres for regional research (Agardy, 1989). They have a development role, in that a variety of compatible uses can be fostered to promote sustainability. And, they have a conservation role, focusing attention on ecologically critical areas and promoting the awareness of the linkages within the marine system and between the land and the sea.

This is not to suggest that biosphere reserves provide the only mechanism for coastal management. But coastal biosphere reserves should differ from other traditional forms of marine protected area management in several ways, rendering them more valuable in areas of increasing user conflicts. Firstly, coastal reserves will tend to be larger in scope than marine sanctuaries or parks, since they are designed to encompass independently functioning ecological units. This infers that the managed areas will be not only larger, but also inherently more complex, having both marine and terrestrial components. Coastal reserves should focus on the land-sea interface, but will include seemingly distant areas on land (e.g. watersheds) and in the sea (e.g. upwelling areas). Secondly, coastal reserves should contain different areas to meet the different roles of the programme, including core areas both on land and in the sea to satisfy the conservation role and regulated use areas to provide the potential for long-term development. Thirdly, coastal reserves must emphasize the role of monitoring, training, and information exchange, and act as important links in a global network of protected areas. Lastly, and perhaps most importantly, the success of coastal reserves will depend on community support in planning and administration, ensuring that the reserve will provide a lasting forum for cooperative management at all levels.

Coastal Biosphere Reserve Design

Much discussion in resource management circles has centred on whether, given the vagaries of political contexts and ecological considerations, a model coastal biosphere reserve could be created in order to provide guidance for planners. Case studies can provide excellent examples of coastal planning in action, but it is often difficult to extrapolate general principles from specific situations. Nevertheless, a generic plan can be used as reference for emphasizing certain points. In discussing optimal coastal biosphere reserve design, however, it must be emphasized that it is adaptability rather than rigid adherence to criteria that is of greatest practical value to planners.

Ocean and coastal systems are large-scale, dynamic, and poorly understood. Since the coastal zone represents the convergence of two vast systems, linkages are far-reaching and not always obvious. Coastal areas share characteristics of both the terrestrial and marine areas they separate, and are often characterised by higher species diversity and productivity than

neighbouring systems. Owing to this intrinsic complexity, the management of coastal areas requires more extensive assessments and planning.

Which characteristics of coastal areas have important implications for management varies in different regions. In tropical areas with abundant coral reefs, for instance, most important resources can be marked on a map, and relate to the substrate characteristics (i.e. the type of reef present). Thus, overexploitation of a tropical fishery stock can be contolled by legislation to restrict fishing in a given area. The regulated area can be delineated using maps and buoys, and the management regime is closely analogous to resource protection on land. Management of a living resource by delimitation of a regulated area is more difficult in temperate or deeper water areas where resources vary widely in time and space. In effect there is little linkage between the water column with its dynamic resources and the benthos. Yet more complex is mangement in coastal areas where oceanographic phenomena such as warm-core rings cause abrupt and unpredictable change in the structure of the ecological community.

This implies that the design criteria for a coastal reserve will differ in different regions (reinforcing the value of a flexible design). It does not imply that zoning in dynamic areas is impossible and should be abandoned in favour of traditional management or lack of management. Zoning plans require more intensive investigation into both the dynamics of the ecosystem and the patterns of human use within it, but the end result will be a method of management which satisfies as many users as possible while protecting the ecosystem from harm.

Setting the Limits of the Coastal Biosphere Reserve

The complexity of scales and linkages in coastal ecosystems complicates the setting of boundary and zoning delimitations in coastal reserves. The outer limits of a coastal reserve, which mark the confines of the transition zone, must themselves be dynamic, changing in response to changes in the conditions for cooperative management. When a coastal reserve is first nominated, the outer bounds of the transition zone will represent a conservative assessment of the potential for cooperation. Later, as the value of the coastal reserve becomes more widely known and as formerly reluctant entities join the ranks of participating parties, the outer limit of the reserve may expand. Although this also holds for land-based reserves, it rarely occurs.

The outer bounds of the coastal reserve are not only a function of the potential for cooperative management, although this is an ultimate limiting factor in the design. In addition to encompassing the area of effective cooperation, it is essential that the reserve include as many of the functionally important components of the ecosystem as possible. Thus, a coastal reserve which has a conservation objective to protect a shallow water coral reef should include not only the reef itself but the ecologically linked mangrove forests and seagrass beds which influence its community structure (Rogers, 1988). Similarly, a coastal reserve which is intended to protect an estuary should also include a portion of the watershed which supplies it with freshwater and nutrients, and the critical marine areas with which it is linked. Clearly, since every habitat on earth is linked to another, this boundary setting depends on identification of the most critical linkages, that is, those which drive the system to be protected. In effect, the minimum outer limit of a coastal reserve should encompass the smallest unit within the ecosystem which is

functionally independent of adjacent areas, in relative rather than absolute terms.

Ultimately, the outer limits of the reserve will mark the extent of the ecosystem needing protection as modified by such constraints as limits of knowledge, sociopolitical realities, and administrative concerns. In planning prospective coastal reserves, planners should formalise the outer boundaries of the reserve only after a thorough resource assessment and feasibility study have been completed.

Multiple use zones and cores must be identified within the outer boundaries of the reserve. Owing to the complex nature of coastal areas, it is likely that more than one core will be required to fulfil the conservation role of the reserve. It is critical that core sites include actual land/sea transition areas, as well as terrestrial and marine areas. Terrestrial core areas can be identified by similar means to those used in land-based biosphere reserve planning, where areas already protected and relatively pristine serve as core sites. Such conservation cores may be found in coastal or riparian parks and sanctuaries. Marine conservation cores are more difficult to identify, particularly in areas where marine parks do not exist. These cores should focus on high-diversity, high-productivity, or system-driving habitats or processes within the ecosystem. For example, a marine conservation core within a coastal reserve might include a portion of the seafloor with high benthic diversity, an upwelling area, or a zone of freshwater/saltwater convergence. Before such critical areas are identified, the dynamic properties of the ecosystem need to be studied over time. In temperate areas of high dynamism, this may involve using resource assessments to identify areas likely to be of high diversity or high productivity over the longest time periods.

It is likely that during the planning process many more potential core areas will be identified than could be practically delineated. An important stage in the planning process is then to rank critical areas according to their ecological importance and conservation potential.

Since the current political situation is such that biosphere reserve administrators do not have the authority to promulgate special legislation to protect resources within reserves, conservation cores which are not based on established protected areas must be managed according to mutual consent. In the coastal and marine context, the real value in designating such seemingly tenuous cores will be to focus attention on the critical components of the ecosystem and to forge public and political awareness of their value. If these objectives are met, coastal biosphere reserve conservation cores may act to set precedents for more rigorous protection in later years.

In addition to multiple conservation cores, coastal reserves should have monitoring areas, occurring either as subzones of conservation cores or as separate entities. These monitoring cores should be designated in ecologically important areas, often where a history of research and data collection already exists. They provide permanent sites for standardised data gathering, used in regional and global studies and fulfilling the logistic role of the reserve. Indeed, international programmes such as SCOPE and IGBP are already turning to the biosphere reserve programme to help build their network of coastal and marine monitoring sites for global change (Agardy, 1989).

Monitoring cores should also be established in heavily used areas or already degraded areas which are being rehabilitated. Such cores will not need buffer zones around them, and enable monitoring of environmental change on a local scale.

Both conservation and monitoring cores should focus on species and habitats that are critical to the biogeography of the region. Such habitats might be critical owing to their rarity, representativeness, productivity, or importance to the maintenance of the ecosystem itself. Prospective core areas must also be evaluated for their conservation potential. That is, resource assessments must highlight the degree of opportunity that the core area could provide in protecting the ecosystem.

Core areas should be evaluated objectively regarding the degree to which they are threatened. Where an area is ecologically outstanding but under threat of severe future degradation, it should not be considered a likely site for core designation. If a core designation is given to a threatened habitat, the attention that designation brings may help to conserve it.

Each conservation core, and where applicable, monitoring core, should have an area of regulated use around it to buffer it from degrading effects. Such buffer zones may extend far upstream in coastal areas containing watersheds, or may extend far offshore in areas where marine activity (shipping, minerals exploration and recovery, etc.) could have an impact on the core. The size and extent of the buffer zone will reflect the nature of the ecosystem in terms of its sensitivity to disturbance and extent of its linkages, as well as established and prospective patterns of human use. The buffer areas are regulated use areas and the limits and conditions of management must be explicitly stated.

Coastal Reserve Planning and Management

Planning effective coastal reserves requires a sufficient body of knowledge about both the biogeography of the region and ecology of the target areas, and also about the political, social, and economic factors which form the context for the prospective reserve. Feasibility studies are thus as important as resource assessments in providing background informationfor coastal reserve planning.

The need for a coastal reserve designation in a particular area may arise for a number of reasons including, *inter alia*

1) user conflicts are on the increase in an area lacking cooperative management;

2) habitats and/or species are threatened and traditional methods of protection have not been tried or have failed;

3) protected area designation exists, but public education, research, and/or monitoring programmes are lacking; or

4) a regional coordinating entity is needed to forge links between existing protected areas and interested parties.

In addition, UNESCO or MAB national committees may perceive the need for a reserve in a particular area in order to reinforce the global network of representative natural areas.

For whatever reason a need is perceived for biosphere reserve planning, a panel will be needed to oversee the process. The panel should be comprised of individuals with interest and experience in the area, with the commitment to carry through planning to the designation stage - an important factor in providing the necessary continuity to the process.

Since, in most cases, efforts to designate a coastal reserve will arise in response to a stated need, the panel will probably have preconceived notions about the objectives of a given reserve. The first task of the panel should be to discuss these needs and create a detailed list of objectives for the project. The nature of the reserve itself will reflect this statement of needs.

Once the panel has identified the objectives of reserve planning, two tasks should be undertaken simultaneously:

a) a biogeographic overview of the region and its important habitats and species, and

b) a systematic assessment of human uses of the area and of interested parties, along with a review of the types and effectiveness of environmental legislation that exists.

If these studies are thorough in scope, the end-product will be an accurate appraisal of the potential for reserve designation and success. In many regions such assessments will also provide a basis for other types of management regimes.

The panel should reconvene to select target areas for reserve consideration. In areas with complex ecological characteristics or a high degree of user conflict, the fine-tuning process will require much evaluation and debate. For each prospective coastal biosphere reserve nomination, once target areas are identified, feasibility studies should be generated.

The feasibility study is a full resource and resource use characterisation for specific areas within the biogeographic region. As such, it must include an overview of the region (the product of the panel's preliminary work), including physical features, ecosystem dynamics, and sociological considerations. After this introduction, the feasibility study should present a detailed assessment of resources in the target areas and should explain, to the fullest extent possible, the factors which contribute to the maintenance of the ecosystem and theregeneration of key renewable resources. Some of this may be accomplished through mapping or using dynamic computerised databases. Also included should be a list of resource use issues of regional and local significance, including conflicts in land use, ocean space use as well as access, socio-economic characteristics, and environmental concerns. In many cases, such issue identification will be best achieved through a process of interviewing users and using conventional sources such as reports and other published accounts. If possible, the identified resource use issues should be ranked according to their importance to the region as a whole.

The feasibility study should be not only a supporting document for the panel but an objective assessment of the long term prospects of the reserve. Such an assessment must determine the

nature and level of interest in both developing a reserve nomination and in practicing cooperative management under the aegis of MAB. If there is little willingness to support a reserve, or if the political context is such that the reserve would have limited prospects for success over the long term, then the panel should review alternative options for conservation.

If the conclusion of the feasibility study is positive, the panel must next begin to involve managers and users of the resources in the planning process. Questionaires should be distributed to administrators of all protected areas in the region, as well as to scientific institutions with research interests in the area. Users and other interested parties should be brought into the planning process via public hearings and newsletters. The panel should reconvene periodically to review progress throughout this public education process.

Once sufficient background information is obtained, the design of the coastal biosphere reserve must be planned and specified. The final design will be submitted to MAB national committee for its review, and then to the Coastal Biosphere Reserve Coordinating Council. Once reviewed, the nomination(s) must be submitted to the MAB Director in the UNESCO headquarters for final approval. Accompanying the nomination(s) should be a short summary of the planning effort, an abbreviated version of the feasibility studies, a site-by-site characterisation of the core areas, and an implementation programme which includes a plan for monitoring the long term success and viability of the reserve.

A Protocol for Planning, Nominating, and Administering Coastal Biosphere Reserves

Much of the preceding discussion has been general and contextual, considering the difficulties in translating terrestrial models of resource management for application to the marine system and the conceptual issues inherent in marine resource management. From an operational viewpoint, these issues will vary in importance from region to region, and some may be irrelevant. However, a model for developing and administering coastal biosphere reserves can be outlined in order to provide some guidance to prospective marine managers. The model is outlined at the end of this section, and is presented as a flow chart in figure 1.

The first step toward coastal or marine biosphere reserve planning is recognition of the need for special area management (I), and action on that recognition to explicitly state objectives which biosphere reserve planning may hope to achieve. The initial formulation of the problem statement (i.e. "a need for biosphere reserve exists") may stem from external pressure from users or internally from MAB national committees or agencies with regulatory jurisdiction. In any case, the recognition of need will influence not only theplanning processes but also the selection of the overseeing panel.

It is imperative that the composition of the biosphere reserve selection panel be suitable to the task at hand (II). In all cases this requires that the fields of ecology, economics, and political science are represented. In addition, the planning process will benefit if academic experts share panel duties with managers who have hands on experience in the region. Selection of the

multidisciplinary panel will require some research as well as consultation with the public.

Before the panel actually starts to design the prospective reserve, it must discuss and agree on the reserve's objectives. Objectives may include better management of resources or habitats, consistent scientific research and monitoring, increasing the quality and quantity of public education and technical training, or providing a forum for conflict resolution. When stating the goals which panel members hope the reserve will achieve, some effort should be made to prioritise them in order to steer the planning process.

The next step in the model is data collection for resource assessment and user identification (IV). The panel should divide itself up into working groups, with a biogeophysical component, a socio-economic component, and a legal/administrative component. Each group will then gather information through research and outside consultation, beginning the ongoing process of involving the public in planning.

A note should be interjected about the nature of the terms "public" and "user". In order to fully understand the patterns of resource use and the needs of users, the panel must identify all interested parties. In most cases these will include exploitative users, such as fishermen and the energy industry, nonexploitative users such as scientists, the shipping industry, and recreational boaters, and indirect users such as environmental advocacy groups. All of these help make up what we refer to as the user public, and all should be consulted during the planning process.

Once key information has been gathered it should be compiled in such a way that it lends credence to the plan to create a biosphere reserve and provides the necessary background information to allow the reserve and its limits to be delineated. A feasibility study (VI), should be generated which summarizes this information and makes a case for special area management. It should focus not only on resource assessment, but also on producing a conflicts/compromise analysis suggesting how stated objectives could be met, based on information generated in step (V).

The process through which public consultation and reporting takes place will vary in different areas, and a rigid set of criteria may be restrictive rather than helpful. More stringent criteria can be developed for developing and submitting nominations (VII and VIII). These requirements will include a summary of the feasibility study, site-specific assessments which indicate those special characteristics of the targeted areas which make biosphere reserve planning applicable, and, most importantly, a plan for the long-term implementation of the reserve. Inherent in the latter will be a description of how the reserve will be monitored to ascertain whether stated objectives are being met.

If the reserve nomination is accepted by UNESCO, the panel must see to it that a governing council is established to coordinate activities and perform periodic reporting (IX and X). The nature of this council and its operation should be described by the MAB programme directorate.

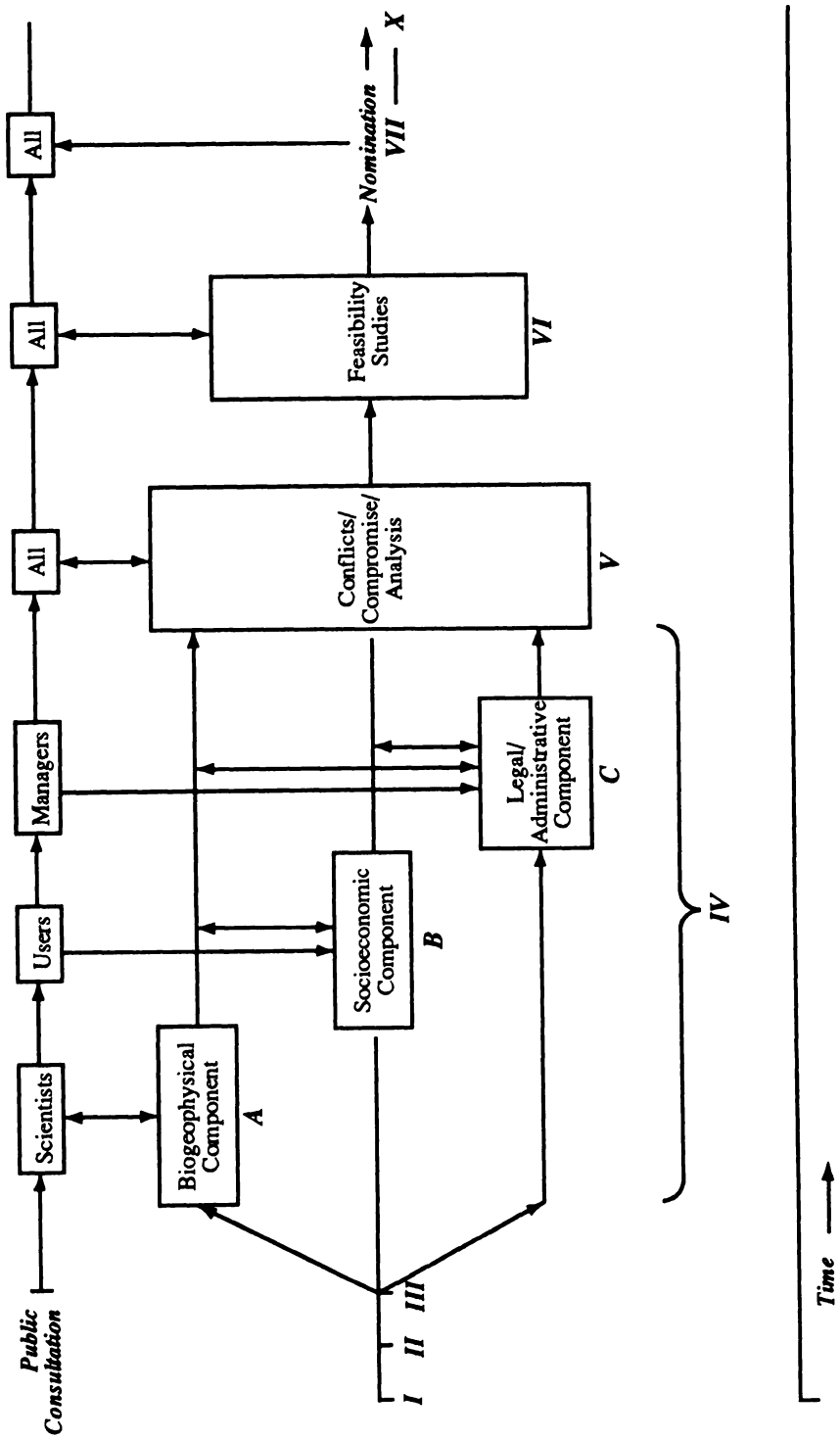

Figure 1. Outline of a Protocol for Planning, Nominating, and Administering Coastal Biosphere Reserves (CBRs) (Developed by Danny Elder, IUCN).

I. Realizing the need for a CBR

II. Selecting a CBR panel

III. Setting general objectives of the CBR

a) Resource or habitat protection

b) Scientific research monitoring

c) Public education and training

d) Conflict resolution

IV. Gathering key scientific and management information

a) Comprehensive database on kind, distribution, and abundances of resources

b) Information on critical ecological processes driving the system and network of linkages

c) Research and monitoring activities of past and present

d) Extent and seasonality of economically or culturally important resources

e) User conflicts

f) Existing management regimes and limits of jurisdiction.

V. Preparing feasibility studies

a) Summary of above information

b) Site by site details

c) Assessment of the potential of the prospective CBR in meeting stated objectives.

VII. Preparing a nomination

a) Summary of feasibility report

b) Site-specific assessments

c) Plan for implementation and monitoring success over the long term, including how the CBR will be able to adapt to changing environmental, socio-economic, and political situations.

VIII. Submitting nominations

a) Committee reviews

b) MAB considerations.

IX. Establishing a governing council

X. Periodic reporting and public hearings

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Part II

2. The Mer d'Iroise Biosphere Reserve

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Introduction

Created in 1988, the Mer d'Iroise biosphere reserve on the northwest tip of France covers 214 km^2. The core area of 50 ha includes five islets of the Molène archipelago and six small rocky islets located close to the Ouessant coast, all of which are occupied by seabird colonies. The buffer zone of 950 ha, includes the rest of the archipelago and the seashore fringe of Ouessant and Molène. Corresponding to the extraordinary diversity of geomorphologic features at the sea-land interface is a great diversity of natural environments: active and fossil dunes, shingle beaches and heaps, brackish coastal pools, rocky shores, coastal cliffs, maritime grasslands and heathlands. The transition area includes the 20,400 ha of Molène and Ouessant, which together have 1,585 inhabitants. Around the Molène archipelago, the seabed forms a wide rocky plateau from the intertidal zone to 20 meters depth with seaweed beds and small non-migrant populations of grey seals (*Halichoerus grypus*) and bottlenosed dolphins (*Tursiops truncatus*).

Administratively, the biosphere reserve is located within the limits of the Parc Naturel Régional d'Armorique and depends on the three Communes of Ouessant, Molène and Le Conquet. The way the different zones are managed and protected varies greatly according to provisions in local as well as national regulations and agreements. The Centre d'Etude du milieu of Ouessant is a useful means of promoting the biosphere reserve concept, and provides a reception point for schools, students and the general public. Training oppurtunities are available concerning the general environment of the islands and on specific themes such as bird migration. Scientists are in contact with local residents and meetings with inhabitants were held during the planning of the reserve.

Current knowledge and future research needs

Previous and ongoing research in a broad range of fields has yielded an important mass of knowledge on the physical, biological and human environment of the Mer d'Iroise. A number of multidisciplinary studies were presented at a MAB/UNESCO workshop in April 1988, on the theme of "*A comparative approach to research methodologies and expression of results related to micro-island systems located in the Mediterranean, the Atlantic and Northern Europe*".

than local. The context of a biosphere reserve is not only three dimensional, but really has no borders, although it does have political definition. Littoral and deep ocean currents bring migratory species of marine mammals, fish and seabirds from around the Pacific. And being at the "receiving end" of watershed manipulation, water diversions and waste disposal, the marine zone of the CCCBR responds to human forces well outside its borders or local surroundings.

Secondly, and related, is zonation. How do we apply the traditional biosphere reserve zoning to marine resource management? Biosphere reserve zonation *per se* must be expanded to encompass this fluid context.

These two elements - focus on boundaries and zonation - are examples of how the CCCBR may test and perhaps expand the biosphere reserve concept for marine areas in general. The CCCBR has characteristics and must address issues typical to marine areas globally as well as those particular to this biogeopolitical region.

What to do: first steps

The three central premises of the biosphere reserve programme - research, integration, and education and public involvement - offer a framework for the management of the CCCBR. Research in marine ecology is a necessary step for all coastal biosphere reserves. In the CCCBR understanding natural variability and human impacts in the marine system will be critical for the proposal of reasonable regulations and environmental management in sustained use and productivity.

Integration is a key guideline to follow in the CCCBR where so many traditionally disparate groups and activities are involved. Clearly, it will take a lot of thought and communication for different sectors of this biosphere reserve to understand one anothers' problems, and to cooperate.

Finally, education and public involvement in reserves around the world have proved that the more the public is aware of, understanding of and involved in the protection of their resources, the more successful the management of the area will be. Here, with almost six million residents and 29 million visitors involved, this is an "activity area" to be explored.

In conclusion, as a case study the Central California Coast Biosphere Reserve illustrates clearly the challenges and opportunities of conservation in marine environments. It has all the necessary building blocks to provide a model approach to problem solving on a regional basis, with many global implications given the wide diversity and foci available. Choosing and defining the first activities of the CCCBR will be critical to ensuring its longer term success.

1. The Central California Coast Biosphere Reserve

Laurie A. Wayburn

Introduction

Designated in November 1988, The Central California Coast Biosphere Reserve (CCCBR) encompasses over 850,000 ha of land and 948 square nautical miles of territory in the San Francisco Bay region. It integrates nine managements units under six political authorities. Covering four major ecosystems - terrestrial, estuarine, marine and island - with complete watersheds in its boundaries, it is also directly adjacent to the urbanised area of the San Francisco Bay, population over 5.5 million, and is visited by 29 million people a year. Located in one of the world's most productive marine regions, a major fishery, shipping port and site of chronic pollution, this biosphere reserve offers a significant opportunity to study the ecology of Pacific marine systems, document natural variability and trends and to identify human disturbances.

With some basic national legislation underlying the CCCBR's protected status, and the regional wealth of infrastructure available in research as well as public support, the CCCBR also presents the opportunity to address fundamental short-comings in current marine and coastal resource management and conservation. As a "master-integrator" concept, biosphere reserve status is uniquely appropriate for implementation in this region.

The challenge: poverty amidst wealth

With the wealth of resources, problems and people in the CCCBR one might think this was a situation typical only to a rich country - problems one wants. However, the lack of basic knowledge and understanding about marine and coastal ecosystems in the CCCBR is unfortunately typical of the situation throughout the world. The limited understanding here has the same consequences as elsewhere: a deterioration and degradation of resources and a lack of basic of sustainable resource use. Basic research is needed on many levels and topics here, from understanding the structure and function of the marine food web to the basic biology of marine mammals and seabirds, as well as of such factors as upwelling which affects productivity in our near coastal waters.

Issues highlighted by the CCCBR that apply to the marine biosphere reserve concept in general are "focus" and zonation. Firstly, focus - where and what are the limits or parameters for research? The biosphere reserve concept ranges from monitoring of physical and biological processes to integrating and harmonising human and natural systems. In marine and coastal habitats, the focus for biosphere reserves must clearly be more regional, national, and global

However further work is needed on systematic inventories of biota and concerning the functioning of ecosystems. There are three main ongoing research projects: a faunal comparison of more and less impacted areas of the archipelago seafloor; an investigation of the functioning of micro-insular ecosystems focussed on the island of Banneg where increasing gull populations are threatening the ecological balance; and a study of the evolution of human use of the reserve's insular environments.

Pollution, resource use and management

Oil spills following the stranding of the "Olympic Bravery" tanker on the north coast of Ouessant in 1976, and the "Amoco-Cadiz" wreck in 1978 in Portsall provided oppurtunites to study the impact of oil on coastal environments and the subsequent recovery of the area.

Traditional human activities, concentrated in the archipelago area, include fishing, seaweed exploitation, farming and grazing. The exploitation of the seaweed *Laminaria digitata* is one of the main economic activities within the biosphere reserve. Though strictly controlled, with the aim to maintain an equilibrium, the environmental impact of this activity requies studying. The exploitation of natural banks of maerl, *Lithothamnium calcareum*, may modify the sedimentology and hydrodynamics of the seabed, and generate or increase erosion problems on the sandy coasts. Another potential threat is the spread of alien seaweed species such as *Sargassum muticum* and *Undaria pinnatifida* which is farmed in Lampaul bay in the transition area.

The economical interests of the different professional categories working in the Mer d'Iroise marine environment are sometimes rather divergent and this can present management problems. For instance, fishermen have prevented harvesting of *Laminaria hyperborea*, fearing seafloor damage and job loss. Over the past ten years, new fishing technologies have resulted in higher yields but have also become more destructive. Regulation of fishing activities is required within the transition area and extension ofthe core area to marine areas should be considered.

Other uses also present threats: because of the immediate proximity of the Ouessant sea-route, the most heavly used traffic shipping lane in Europe, the Mer d'Iroise biosphere reserve is potentially at risk from pollution arising from sea vessels. And disturbance to seabirds and seals is arising from uncontrolled visits to the Molène archipelago by yachtsmen, scuba divers, and recreational fishermen as well as sea-kayak expeditions from Brest and the Hobbie-cat crossings between le Conquet and Beniget and Kemenez.

The main goal for the Mer d'Iroise biosphere reserve is to implement a rational management programme of the environment and of its resources. It should be based on scientific studies regarding the whole environment. Particular attention should be paid to the coastal marine environment. A solid, realistic management plan produced in collaboration with local people, the professionals, and the scientists should form the foundation for long term sustainable development.

3. Zoning of the Puerto Galera Biosphere Reserve

Porfirio G. Castañeda

Introduction

The Municipality of Puerto Galera is at the northeasternmost tip of Mindoro island. This is the largest island of the Philippines southwest of Luzon from which it is separated by a narrow channel which connects the South China Sea to the west and the Sibuyan Sea to the east. The area has a tropical monsoon influenced climate with a rainy season and tropical cyclones or typhoons accompanying the southwesterly winds from May to October. Puerto Galera is in a relatively sheltered location, protected from the southwesterly winds by Mindoro and the northwesterly winds by the mountains of Luzon.

Puerto Galera is a coastal municipality with a total land area of 22,398 ha. Its interior terrestrial portion includes the central Mindoro highlands and the watershed extends from Mts Alinyaban, Talipanan, and Malasimbo. The 42 km coastline is deeply indented by bays and coves with fine white sand beaches. The largest is Puerto Galera Bay which is deeply lobated with inlets and coves and surrounded by steep hills. With Medio Island at its entrance restricting passage it is an ideal harbour and rough weather shelter for ships.

Socioeconomic situation

The population of Puerto Galera grew from 1,275 in 1903 to 12,163 in 1980. Human settlements are concentrated on the narrow coastal plain which is the only agricultural area. However this activity is of secondary importance to fisheries, which are concentrated in the nearshore area and utilise traditional gears such as gillnets, beach seines, and fish pots and traps. Motor equipped outriggers take offshore tuna on a seasonal basis.

Puerto Galera's coastal areas are its most important asset. The coral reefs fringing the coastline are not only beautiful but together with mangroves and seagrass beds provide for and support the productive fisheries. The seemingly isolated inlets, bays and coves, with their white sand beaches have always been a traditional vacation area for the affluent people of Manila and Hong Kong who come in their yachts and stay in their vacation houses.

Problems

Until recently, Puerto Galera's main problem was land use conflicts in the hinterlands. In the coastal zone, destructive fishing by transient fishermen using dynamite and sodium cyanide caused significant coral damage and an associated decrease in fisheries production. This was

exacerbated by silt flow generated by slash-and-burn agriculture, indiscriminate logging and the cutting of mangroves for fuel.

In the last decade new problems have arisen as a consequence of tourism. The tourist trade has increased massively since the late 1970s, boosted principally by the arrival of low budget backpack tourists, whose needs are met by small scale developments such as beach huts. The local population is now bloated by 300 to 1,200 tourists monthly.

Problems include damage to corals and seagrasess by waders, snorkelers, and boat anchors and chains; solid waste pollution of the white sand beaches; conversion of mangrove areas for tourist developments; sewage pollution (from open sewers and tourist establishments); land ownership conflicts; displacement of artisansal fishermen from their traditional fishing areas; and a decrease in fisheries productivity. Tourism has also generated negative socioeconomic impacts in the area such as an increase in the prices of prime commodities such as rice. However, the greatest concern is the environment and the destruction of the beautiful coastal area which is the very attraction for tourists.

Coastal zone management proposals

The coastal zone of Puerto Galera is within the transitional area of the biosphere reserve and as such, management objectives should take into primary consideration the cooperation and welfare of the community and at the same time be in concurrence with the concept and purpose of the biosphere reserve.

The goal of management is to protect the coastal zone ecosystems and at the same time allow for the continuation of compatible human activities. The Puerto Galera coast is long and narrow with a patchily dispersed population and the application of a conventional multiple use zone plan to the entire area would be prejudicial to some portion of the populace. In addition, intact ecosystems such as coral reefs, mangroves, and seagrass beds do not occur in any one contiguous unit large enough for delineation as a management component, and the area is subject to a range of uses. The Municipality is divided into smaller political administrative units known as barangays and it is proposed that each barangay with its human community and the corresponding territorial jurisdiction form a management unit. Within each management unit will be apportioned :

- replenishment areas (core areas): areas of intact or relatively intact coastal ecosystems (corals, seagrass, mangroves, beach systems and estuarine areas)

- multiple use areas: areas around or adjacent to the replenishment areas where compatible and non-debilitating human activities are accommodated such as recreation areas, traditional fishing grounds, areas for rehabilitation and mariculture areas.

The underlying principle is sustainable use and development to maintain low key tourism with a "backyard" status and traditional fisheries. The implementation of management should be done by the community and this requires an extensive information and educational programmes, community organization and technical training.

4. The Virgin Islands Biosphere Reserve

Edward L. Towle
Caroline S. Rogers

Introduction

The Virgin Islands National Park, which covers 52 sq km on the island of St John, was in the initial network of biosphere reserves established by UNESCO in 1976. St John is a sparsely populated, underdeveloped island situated in the middle of the chain of approximately 50 Virgin Islands which stretch along the Peurta Rican shelf between the Lesser and Greater Antilles.

The reserve covers some 2,861 ha of land, primarily tropical woodland, with a natural core area, and 2,287 ha of marine waters, which were added to the National Park in 1962 "... *in order to preserve for the benefit of the public significant coral gardens, marine life, and seascapes* ...". Activities within this area, which is the focus of much of the user activity of the 900,000 annual visitors to the island, include artisanal fisheries, recreational boating, and SCUBA diving.

Use levels in the reserve have tripled since 1966, with many visitors coming by ferry on a daily basis from the nearby and densely populated island of St Thomas. Increasing use, rising land values, and hotel construction together presented a major challenge as to how to tranform the National Park into a biosphere reserve, and to provide a model for other areas in the eastern Caribbean.

Towards an approach

Following the organisation by the National Parks Service in 1982 of the Virgin Island Resource Management Cooperative (VIRMC), the Virgin Islands Biosphere Reserve was formally designated in 1983. At the same time, a *Workshop on Biosphere Reserves and Other Protected Areas for Sustainable Development of Small Caribbean Islands* was convened, drawing together representatives from most of the Lesser Antilles islands. Delegates expressed concerns over the experimental and complex nature of the biosphere reserve complex, the relevence of "cookie cutter"zoning to less developed islands, and the management of marine and terrestrial areas as a single unit. The Caribbean Conservation Association was asked to tke a lead in looking at key issues concerning a Lesser Antilles Biosphere Reserve, and to consider the five criteria for selection which are elaborated upon in Alan Putney's case study: representativeness, sharing of resources, multiple zones, multiple island design, and local involvement.

Towards a programme (1984-1988)

A broad range of activities have subsequently been undertaken in the Virgin Islands Biosphere Reserve under the aegis of VIRMC, including extensive management and monitoring focussed base line research; development of a training and research facility; production of documentary materials; and formation of a citizens group.

The Virgin Islands Biosphere Reserve is not entirely appropriate as a model for other islands of the eastern Caribbean, being at the far end of the development spectrum and exceptional in its long history of involvement with the National Parks Service. However there are a number of lessons to be learned from the Virgin Islands experience, particularly relating to practical management of a highly visited area.

In the island context we do not have an intact ecosystem or one immune to external forces and intervention. The Virgin Islands Biosphere Reserve is slanting its research initiatives towards improving management of landscape areas where culture and nature are interdependent, and towards sustainable development through ecosystem restoration and timely interventions.

The biosphere reserve framework, which we are experimenting with and learning how to use, forces us to expand our geographical, conceptual and disciplinary boundaries. It forces us to focus more on mechanisms of intervention and constructive management for sustainable use, not just for the National park, but the entire insular system of St. John and its surrounding marine environment. It also forces us to perceive of St. John as an important part of an archipelagic system of dynamic change,... systemic, institutional, demographic... already linked in a vaguely defined Lesser Antilles cluster or network, still lacking a name. That is the network we need to understand.

5. La Reserva de Recursos Marinos de Galapagos

Mario Hurtado

Introduction

This paper presents some points regarding the establishment of marine resources reserves in Ecuador which it is hoped will be pertinant to the discussion on the establishment of marine biosphere reserves.

The Galapagos Archipelago is situated some 600 nautical miles from the continental mainland, and is formed of 19 islands and 42 islets. The total land area is 788,000 ha of which 96.7% comprises a national park. The surrounding marine waters to a distance of 15 nautical miles form the Galapagos marine resources reserve, with a total area of 70,000 square kilometers. The region is renowned for the richness and high degree of endemism of the fauna. It has mixed biogeographical affinities and an extremely diverse range of habitats. The environment is relatively undisturbed and is of great value for scientific research.

The area is subject to both extractive and non-extractive uses. Artisanal fisheries are principally coastal, exploiting a broad range of species. Foreign fleets operate in the offshore waters of the marine resources reserve in cooperation with Ecuadorian fishermen. Tourism is now a major, non-extractive use of the island environment.

The "Reserva de Recuros Marinos" (RRMG) was designated in 1986 - the first reserve of this kind to be created. Early conservation efforts in the region had an entirely terrestrial focus despite the central role of fisheries in the island economy. Marine issues started to be addressed from the early 1970s, and scientific research into the marine environment was taking place by the end of this decade. Opposition by fishermen led to a number of delays and postponments on a decision concerning the protection of marine areas. The fishermen felt that their rights and livelihoods were being placed below those of the species they depend on. The growth in tourism and decline in fisheries provided a new impetus for marine environmental protection, and fishermen were assured that their activities would be an integral component of new plans for the region.

Development of a management plan

During the 1980s, formulation of detailed plans concerning the management of the marine environment within the existing institutional and management framework was carried out in cooperation with Woods Hole Oceanographic Institute. Other international organisations became involved in planning at the time when the RRMG was designated. At the time of writing

(August 1989) the management plan has yet to be formally approved since its role in the control of non-extractive uses is still under discussion. But its application to the control of fisheries during 1988 implies that the plan will be accepted and implemented on a step-by-step basis.

The management plan was designed to contain the following elements: to emphasise protection of the natural environment; to consider the needs of the islands' population, particularly with regard to artisanal fisheries; to formally establish protection of the marine environment; to use best available scientific information; and to be simple, economical and politically realistic, while minimalising the need for new administrative structures. Different uses, from fisheries to tourism and scientific research, are allowed within the constraints of a zoning system which delineates areas for general use, industrial fishing, and artisanal fishing as well as strictly protected and buffer areas.

6. Bijagos Archipelago, Guinea Bissau

Pierre Campredon

Introduction

The Bijagos Archipelago consists of 50 islands covering an area of approximately 120 by 95 kilometers. Eighteen of the islands are permanently inhabited, with a mean population density of 25 people per square kilometer (excluding the mangrove area). The population is of a single ethnic group, the Bijagos, who have maintained their strong traditional culture.

Most of the land area is covered by vegetation; principally mangroves, savanna, and palms which are harvested for oil. The local environment provides for almost all of the needs of the population - food, energy, clothing, transportation and utensils. Cash is obtained from the sale of palm oil and nuts. Agricultural products include rice, cajou, and mango.

As an important breeding habitat for fish, the archipelago is of central importance to Guinea Bissau's fishery which has an estimated potential of 250,000 tons annually. The marine resources are not used intensively by local communities, and more intensive use by artisanal fishermen from Gambia and Senegal is leading to some conflict. There is some threat of overharvesting by commercial fisheries.

Resource use and management issues

Tourism is providing an impetus for rapid development of hotels and infrastructure, as well as growth in recreational fishing. Transportation to the islands is mainly by a weekly ferry, but additional small boats and planes carrying tourists are now augmenting this service.

The archipelago provides habitat for 10-15,000 breeding pairs of waterbirds, and an additional million waders overwinter here. Also present are manatees, hippopotamus, crocidiles and marine turtles.

The formerly harmonious relationship between the Bijagos population and its environment is in danger owing to the intensifying external pressures for development. The establishment of a biosphere reserve may provide a solution to preserve the existing equilibrium in the archipelago, enabling conservation and sustainable development of the area.

The biosphere reserve would bring in the technical and financial assistance which will be required for its successful operation, and would promote an increased awareness among the public and government authorities of the need to protect and manage its resources. Management would be facilitated by the establishment of contact and exchange with other biosphere reserves.

A number of problems will have to be addressed in the establishment of a biosphere reserve for the Bijagos Archipelago, particularly: lack of information on ecological processes and biology of species; an overlap in management responsibilities of different ministries, sometimes leading to conflict; pressure from those lobbying for economic development; and shortage of local technical and financial means.

7. Application of the Biosphere Reserve Concept to Coastal Marine Areas of Brazil

A.C. Diegues

Introduction

Brazil's coastline of over 8000km is one of the longest of any country in the world and represents an impressive diversity of coastal and marine ecosystems. These include over 2.5 million hectares of mangrove; large estuaries, river mouths and delta, such as the Amazon; coastal lagoons; sandy and rocky beaches; islands; and coral reefs.

Coastal uses and problems

Huge areas of these valuable ecosystems are being destroyed or degraded as a result of coastal developments such as ports, industries, urban centres and intensive agriculture. Commercial overfishing of the more valuable fisheries is widespread, and, since 1967, industrial fisheries have benefitted from substantial aid from government. This is having an impact on not only on natural diversity, but on cultural diversity as small scale fishing communities are being broken up and lifestyles dramatically changed through economic necessity. Exploitation of non-renewable offshore resources is increasing, and offshore drilling now accounts for over 80% of Brazil's oil production. As a consequence, pollution and accidents are a significant threat to local ecosystems.

A survey of CIRM (Interministerial Commission for Sea Resources) carried out in 1986 revealed that coastal systems throughout the country are exhibiting signs of stress. Critical areas were identified around industrial and metropolitan centres where habitats have been destroyed and marine fauna and flora are heavily contaminated by pollutants such as mercury. Severely degraded systems were identified in areas where coastal development is taking place, and their situation will worsen unless protective measures are taken. Elsewhere pollution arising from small scale development and tourism has had moderate effects on coastal systems, and even in more remote areas activities such as mining, use of pesticides, and overfishing are beginning to have slight effects on the ecosystems.

The need for coastal management and coastal marine protected areas

The rapid destruction of coastal ecosytems needs to be addressed urgently by appropriate coastal management measures. CIRM initiated a coastal management programme in 1985, including the preparation of coastal zoning plans, establishment of database facilities, training, and infrastructure support. A Coastal Management Bill which defines priority ecosystems for protection was approved by Congresss in 1989. Guidelines have been developed to facilitate

planning on a regional and national basis.

In total, 3% of the Brazilian National Territory is included in protected areas, but only three areas, covering 138,000 ha, can be classified as marine. Twenty two areas have a coastal component. In practice, few of the existing Brazilian protected areas are effective in achieving their goals - a consequence of private ownership of land and inadequate protection. Areas are being cut by roads or flooded by dam construction, and hunting, fishing and deforestation are uncontrolled.

Four of the protected area categories used in Brazil are appropriate for coastal areas: National/ State Parks; Biological Reserves; Ecological Stations; and Environmental Protection Areas. The latter are defined as areas where wildlife, genetic diversity, and other natural resources should be conserved through their adequate and sustainable use for the benefit of the local population. A management plan should be established to harmonise multiple human activitiies. Potentially damaging activities are subject to an Environmental Impact Assessment.

The biosphere reserve concept in the Brazilian context

The Environmental Protection Area is the closest category in Brazilian legislation to the model of the Biosphere Reserve, different principally in that it does not require the establishment of a strictly protected core zone. New category definitions to be drawn up by IBAMA - the Brazilian Institute for the Environment - will provide for the establishment of core and buffer zones in Environmental Protection Areas and this will enable the establishment of biosphere reserves in coastal areas.

The biosphere reserve provides a means to integrate the needs of existing traditional populations with ecosystem conservation - an important alternative their expulsion from such areas. Previous attempts to impose protected area status to regions occupied by traditional communities have led to social revolt as livelihoods are lost. The presence of traditional users can be a valuable insurance of conservation as more destructive users are excluded, and traditional management schemes may provide an important contribution to the drawing up of management plans. The definition of a buffer zone is a useful means to limit the impact of other coastal uses on the core area, which could be an existing national park. The biosphere reserve is seen as a means to resolve the conflicts between conservation and development.

The idea of biosphere reserves is making its way in Brazil. The priority area for the establishment of a protected area of this kind is the Atlantic Forest, one of the most important ecosystems extending along the Brazilian coast which has become severely degraded particularly in the northeast. Several important urban centres as well as innumerable traditional fishing villages are located in this system which includes mangroves, sand bars, estuaries, bays and islands. A consortium of the various states (Consórcio da Mata Atlântica) which include parts of the Atlantic Forest is being created. Its main strategy is to establish the "Biosphere Reserve of the Atlantic Forest" to cover the different coastal ecosystems.

8. Latin America: Marine Realm and the Biosphere Reserve Concept

J.C. Castilla

Introduction

The Latin American countries of Central and South America belong to the Neotropical Realm, and between them contain most of the 14 biomes characterised in UNESCO's *Action Plan for Biosphere Reserves*. Over 30 biosphere reserves have been established in the region since 1976, most of which are essentially terrestrial in character. The region offers a wide variety of oceanic and coastal environments from highly productive to nutrient poor oceanic waters and from tropical to cold temperate shores. The region has two major subrealms - tropical and temperate - and in addition there are striking differences between the Atlantic and Pacific basins. A number of studies have looked at the definition of biogeographic zones but a consensus has not been reached.

Coastal zones uses and issues

The ever increasing demand made upon Latin America's marine coastal resources (rocky and sandy intertidal and associated shallow environments) for human sustenance, recreation, and, particularly, commercial gain pose a threat to their long term viability. A good example is the collection of intertidal invertebrates in Chile where the expansion of international markets has led to the augmentation of an artisanal activity by a multi-million dollar industry involving the use of new tools such as compressed air. Several species are now overexploited.

In this context, marine reserves and marine biosphere reserves could play a dual role in Latin America. On the one hand they will serve to preserve and maintain unique species and ecosystems and promote a better understanding of their structure and dynamics; and, on the other, they could prove to be a key factor for the rational use and management of marine economical resources.

Potential for marine parks and biosphere reserves

No truly marine parks, reserves or biosphere reserves have yet been established in the temperate regions of Latin America. The concept of biosphere reserves appears to be more relevant to terrestrial than to marine areas, and there a number of problems which may hinder its development in marine environments in this region where there is little previous experience to build on. These include the inadequacy of knowledge about the biomes, biogeography and functioning of coastal ecosystems; the commercial importance of marine resources which, in the view of users in a developing ecomony, may be incompatible with conservation; the high

dependence of coastal communities on intertidal resources, for both food and income; the need to consider local culture; and the absence or non-enforcement of long term environmental policy in many of the region's countries.

Application of the biosphere reserve concept will depend on achievement of a number of goals. The following can be singled out: to assist in the maintainance or improvement of those few scientific reserves or parks which are actually in operation, on the basis of a comprehensive review; to support basic and applied scientific research in such areas; to select a number of terrestrial parks with a maritime border and demonstrate plans to extend these into the marine realm; and to apply the experience of the Galapogas Islands Biosphere Reserve to other island ecosystems of Latin America, such as the Juan Fernandez Archipelago and Easter Island which are already designated as terrestrial sites.

9. The Acadia Boreal Biosphere Reserve Nomination

Tundi Agardy

Introduction

The idea of creating a bilateral coastal and marine biosphere reserve in the Acadia Boreal region of northeast America developed from the perceived need to address increasing conflicts between a growing population and a fragile and finite resource base. The biosphere reserve approach offers a means to satisfy the needs of both conservation and development in marine areas.

Coastal biosphere reserve sites

Since it was established in 1986 the Acadia/Boreal Selection Panel has worked on the conceptual development of prospective biosphere reserves. Three candidate reserve were identified, of which the two discussed below are transboundary.

The Fundy/Maine reserve would span the mouth of the Bay of Fundy, and include several parks in the US and Canada, as well as areas of significant tidal mixing and high species diversity. Highly protected core areas exist in the form of well managed parks and reserves while buffer and transition zones would reflect the high human dependency on local marine resources. The potential for bilateral cooperation is good, and the area has a long history of scientific research, being perhaps the best studied coastline in the world. The reserve would cover 700 square nautical miles.

The Cape and Banks proposal also includes areas of traditional human use and dependency. The arc shaped reserve would extend from Cape Cod Bay towards the northern end of the Scotian shelf, and include a major cetacean feeding site, a protected beach system with important seabird colonies, highly productive fishery areas, and the Oceanographers Canyon. The 180,000 square nautical miles delineated in the proposal forms a coherent ecological unit which is determined by oceanographic processes. Coastal communities on the northern and southern flanks utilise the same fisheries resources, centered primarily on Georges Bank where there is a long history of research.

Potential role of biosphere reserves

The panel recommended a zoning pattern based on four types of area: core areas which are strictly controlled, based on existing terrestrial parks; buffer areas of controlled resource use surrounding the core; areas of intense ecological interest which are focal areas in terms of

ecological importance, but inadequately protected to be core areas; and zones of cooperation which focus on cooperative scientific and educational activities.

The above biosphere reserves could serve a number of functions including:

- provision of mechanism for cooperation between the US and Canada in a highly disputed boundary area;
- provision of a link between state, provincial, and federal goverments and the often overlooked NGOs;
- inclusion of different coastal communities in the planning process, thereby linking them with common resource use and dependency;
- contribution to the network of sites conducting baseline and monitoring studies on coastal systems;
- demonstration through land-based "anchor" areas with interpretative centres the importance of coastal areas to the sustained well-being of all peoples

In conclusion, the development of a transboundary reserve would be of value both for the cooperative spirit instilled in the planning process, and for providing a framework for the sustainable future of the region.

10. Coastal Protected Areas of the Arabian Peninsula

A.R.G. Price
R.V. Salm
J.A. Dobbin

Introduction

Studies of the environment, resources, wildlife and uses around the coasts of the Arabian Peninsula are well advanced, and have led to considerable progress in environmental management and conservation. This paper presents a summary of progress in the establishment of marine and coastal protected areas around the Arabian Peninsula region. The region considered includes: Kuwait, Saudi Arabia, Bahrain, Qatar, United Arab Emirates (UAE), Sultanate of Oman, North Yemen, South Yemen and Jordan. The applicability of the biosphere reserve concept to the region is also discussed.

Existing coastal protected areas and current initiatives

There are only eight officially protected coastal areas patchily distributed around the Arabian Peninsula, including some primarily terrestrial areas that extend to and include the coast. The degree of protection varies according to different legislations.

At least 100 additional candidate sites for coastal protected areas have been identified. The approach and selection procedure is described for two countries: Oman (Gulf of Oman and Arabian Sea) and Saudi Arabia (Arabian Gulf and Red Sea) which together are geographically representative of the whole region; while differing environmentally and biogeographically, and having different conservation problems and management requirements.

The principles and selection procedure used in these two countries may be of value as a "prototype" for selecting coastal protected areas in other parts of the Arabian Peninsula. These cases illustrate the need for and value of considering coastal protected areas within overall coastal management initiatives. Integrative, holistic coastal zone management is the approach being followed in several Arabian Peninsula countries.

Sultanate of Oman

In 1986 IUCN completed a study to define a system of protected areas for the Sultanate. This was the first attempt to formulate a coordinated national nature conservation programme, including the definition of conservation policy, legislation, staffing and administrative needs,

and the identification of number of potential conservation areas. Sixty three proposed protected areas have a coastal component of which five already have some protected status.

The conservation policy and legislation components of the IUCN system plan are currently under review by the government. Although the proposed nature conservation areas have not been formally established, government planning authorities and the Ministry of Environment are proceeding to plan around them. The IUCN coastal zone management project considers each proposed protected area within the sector for which a coastal zone management plan is being prepared and recommends revision to the proposals and zoning details where required. Detailed management plans have been prepared for three of the decreed protected areas.

The Sultanate's five protected areas cover a range of environments, species, objectives and management issues, varying from the remote Daymaniyat Islands where there are minimal resource use conflicts and globally significant habitats for hawksbill turtles and seabirds to the the Qurum mangroves which lie in the heart of a prime residential area. The beaches in the Ra's al Hadd - Ra's al Junayz area, where 6,000 - 13,000 green turtles nest each year, currently receive the most intensive management.

A number of other factors contribute to the protection of coastal areas outside the country's protected areas system. The proposed protected area at Barr al Hikman is a good example of an area conserved by local tradition, as local Hikman residents prohibit all fishing on the reefs for commercial purposes and allow domestic fishing only in times of adversity.

Fisheries legislation prohibits spearfishing, the collection of shells and corals, and their export without a permit, and dive clubs ensure that their members respect this legislation. Land-based pollution of coastal environments is negligable, and a rigorously enforced requirement for a "No Environmental Objection Certificate" from the Ministry of Environment ensures that any new developments are unlikely to have a damaging impact on sensitive coastal areas.

The government's commitment to coastal zone management has resulted in significant contributions to conservation of coastal and marine environments. Coastal zone management is a multipronged approach which, through a combination of policy, law, protected areas, and issue-specific actions manages the entire coastal zone as a vast multiple use reserve.

Kingdom of Saudi Arabia

As a part of its long term planning for the region, Saudi Arabia's Meteorology and Environmental Protection Administration (MEPA) commissioned an appraisal of natural resources and management requirements for both its Arabian Gulf and Red Sea Coasts. A major objective is development of a national coastal zone management programme. The distribution of key resources has been determined and many of the key management issues highlighted. These studies, in conjunction with earlier initiatives of MEPA, the Environmental Protection Coordination Committee (EPCCOM), and IUCN, enabled identification a total of 11 environmentally sensitive areas (ESAs) plus seven recreational areas in the Gulf. In the Red Sea, 46 ESAs including some recreation areas have been identified. ESAs are areas which merit special protection or management, and are vitually snynonymous with "critical" habitats or areas. They

represent potential candidate sites for a system of protected areas or "marine protectorates".

ESAs in the Red Sea were identified primarly on the basis of the unique and valuable resources or important ecological processes. On the Saudi Arabian Gulf coast, where coastal development has been much greater, the selection procedure for ESAs was taken a step further. Information on the location of key natural resources was compared with the location of coastal and marine uses and human activities to identify the main areas of conflict where site specific management measures were most urgent.

At present, the protected area system being proposed remains provisional. Further analysis of the main socioeconomic issues and precise formulation of management objectives are required. Much of this work is being undertaken by the National Committee for Wildlife Conservation and Development (NCWCD) in collaboration with MEPA. Specific actions should follow within the framework of an overall national coastal zone management programme which should consider management categories, creation of management plans and determination of legislative and regulatory structures. In the meantime, it has been recommended that ESAs along both the Saudi Arabian Red Sea and Arabian Gulf coasts are given temporary protective status until the national coastal zone management programme is developed. Some ESAs several could be combined into larger areas to facilitate management.

Recommendations for meeting future needs

In view of the increasing environmental pressures in the region, formal establishment of at least some of the 100 proposed coastal protected areas is a high priority. It is suggested that these are established within an overall national coastal zone management programme and it may be appropriate to nominate some of these as coastal or marine biosphere reserves.

The objectives of Biosphere Reserves can be summarised as: conservation, research and monitoring, and education and training. The criteria for selection are respresentativeness, diversity, naturalness, effectiveness as a conservation unit, and uniqueness. Sites which may be considered for designation as biosphere reserves include Barr al Hikman and Kuria Muria Islands in Oman, both of which are proposed National Nature Reserves; and for Saudi Arabia, Karan, Jana, Jurayd, Al Arabiyah, Qurayn and Harqus islands, possibly grouped, in the Arabian Gulf; and Tiran Islands, Outer Wedj Bank, and Outer Farasan Bank, which have already been nominated as Nature Reserves, in the Red Sea.

11. Ecosystem Research in the Schleswig-Holsteinisches Wattenmeer

Bernd Scherer

Introduction

The Schleswig-Holsteinisches Wattenmeer National Park was established in 1985, and was designated as a biosphere reserve under the MAB Programme in 1990. The park is managed according to the principle stated by Ray and McCormick Ray at the Fourth World Wilderness Congress that a simple setting aside of small areas from human activity is not a realistic approach for conservation or management and of the applicability of the biosphere reserve concept to this area.

Research

The planning of a biosphere reserve is dependent on a sound scientific knowledge of ecosystem properties. An extensive and interdisciplinary research programme has been designed for the Schleswig-Holsteinisches Wattenmeer National Park, covering baseline studies, monitoring and ecosystem research.

The Wadden Sea, on the southeastern coast of the North Sea, has faced the pressure of human settlement and influence over a lengthy period and man is an integral part of its ecosystems. In this context, the ecosystem research programme has been designed to consider complete ecosystem units, comprising a mosaic of different ecological types, and to include contributions from social and economic sciences. The goals of the research are to gain a fundamental understanding of the functions of the natural and man-made systems within the Wadden Sea; to develop scientifically sound strategies for the improvement of the Wadden Sea environment; and to incorporate tools such as GIS (geographical information systems) into the long term survey and assessment of the Wadden Sea environment.

The final report of the various research activities will be published in 1995. Interim papers are availablbe from the National Park Office: Nationalparkumt "Schleswig-Hoolsteinisches Wattenmeer", Ecosystem Research, Schlossgarten 1, 25832 Toenning.

12. Development of a Lesser Antilles Biosphere Reserve

Allen Putney

Introduction

The diversity of the thirteen political entities in the Lesser Antillean island chain makes regional cooperation on resource management difficult but this cooperation is imperative given the small size of each entity. The MAB programme, and in particular the biosphere reserve concept, provides an international framework which could facilitate cooperation at a practical level.

Regional applicability of the biosphere reserve concept

Certain specific characteristics of the region need to be considered in determining the applicability of the biosphere reserve concept. The following points were were discussed at the *Workshop on Biosphere Reserves and Other Protected Areas for Sustainable Development of Small Caribbean Islands* held in May 1983 on St John.

- While natural diversity is not particulary high compared to other tropical regions, there are considerable cultural, institutional and political differences.

- Their small sizes means it is difficult for any one political entity to meet training and support requirements of technicians or research programmes.

- Potential core areas for representative areas are not contiguous but scattered over several islands.

- Physical space is limited and pressures on natural resources high in these densely populated islands. Impacts from even minor developments could push critical resources beyond their tolerance thresholds.

With regard to these characteristics, five basic criteria are suggested for the design of a Lesser Antilles biosphere reserve. Selected areas should:

- be representative of the region's natural ecological systems and of its human institutional systems;

- encourage the shared use of the region's limited expertise and resources in education, research and training;

- include the full spectrum of zones with potential to achieve biosphere reseves, with a core zone to protect natural ecosystems and genetic diversity, a traditional use zone for study and documantation of traditional use patterns, an experimental zone for manipulative research on resource utilisation, and a rehabilitation zone to study restoration techniques for degraded ecosystems;

- incorporate as many islands as possible in order to provide a framework for cooperation in solving practical problems of natural resource managment;

- offer the potential to involve local communities in research, study, and education as a means of improving their livelihoods and sharing experiences.

Such a design has far reaching implications, requiring close cooperation between different government departments, institutions, interest groups and resource users. The establishment of such a framework presents a daunting challenge.

Specific areas have been considered with regard to these criteria for both a regional and sub-regional approach. The 1983 workshop considered in some detail the development of a Lesser Antilles biosphere reserve, focussing on the issue "*will it be more effective to promote the assimilation of a variety of national initiatives into a single international framework, currently little known; or to focus on the most promising national initiatives, slowly building towards regional collaboration through a diversity of organisational frameworks ?*". The weight of opinion went with the latter option.

Since this time the concept of a Lesser Antilles Biosphere Reserve has been discussed at various technical meetings. However, funding has never materialised to do the background work that would be necessary to develop a constituency for the concept within this complex multi-national and multi-institutional situation.

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