BIOSPHERE RESERVES AND THE CONSERVATION OF TRADITIONAL LAND USE SYSTEMS

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ABSTRACT

The Man and the Biosphere Program was launched by UNESCO in 1971 to develop the knowledge, skills, and attitudes required for harmonious relationships between Man and Nature. A key project is the International Network of Biosphere Reserves, presently containing 269 sites in 70 countries. Sites are selected to include the ecosystems and human uses characteristic of particular biogeographic regions, and serve as centers for generating and sharing information needed to address interrelated environmental, land use, and socioeconomic problems in ecologically sustainable and culturally appropriate ways. The paper presents the unique role of biosphere reserves in the study of traditional land use systems and in demonstrating the means for conserving their biological resources within the context of accelerating environmental, social, and economic changes.

Keywords: agroecosystems, biological diversity, biosphere reserves, indigenous cultures, protected landscapes, traditional uses

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Introduction

The International Network of Biosphere Reserves is the best known project in UNESCO's Man and the Biosphere Program (MAB). MAB's mission is to help provide the knowledge, skills, and attitudes needed for harmonious relationships between Man and Nature, and, more specifically, for addressing interrelated environmental, land use, and socioeconomic problems. MAB is an important framework for cooperation among the many international agencies and nongovernmental organizations as well as the 114 participating governments which have elected to participate by establishing their own national MAB committees. Nationally, MAB provides an aegis for cooperation in using the results of interdisciplinary research to support management of ecosystems in ways which are ecologically, culturally, economically and institutionally appropriate and sustainable. MAB's benefits depend fundamentally on its ability to improve understanding of natural and human systems and their interactions, to apply this understanding in managing ecosystems, to strengthen research and management capabilities, especially in developing countries, and to break down the institutional barriers to cooperative, interdisciplinary approaches (diCastri, Hadley, and Damlamian 1981). In recent years, MAB has focused increasingly on human populations as integral parts of coevolving natural, cultural, and socioeconomic systems--on Man IN the Biosphere, both affecting and affected by changes at the local, regional, and global levels (UNESCO 1986, 1987).

Biosphere reserves are the permanent hubs for MAB's efforts to understand natural processes and human use systems in each of the world's biogeographical regions, and for using this knowledge to find ways to conserve biological diversity while improving the well-being of people. Because of their key scientific and educational role, they have been referred to as "landscapes for learning" and, indeed, the objective in each region is to include areas which have the greatest possible potential to generate and share useful knowledge (Gregg, in press). For this reason, the participation of indigenous tribal populations and traditional users--"ecosystem people", in the terminology of Dasmann (1984), who are culturally committed to and dependent upon ecologically sustainable uses--is a cornerstone of many biosphere reserves. Their practical ecological knowledge is essential for developing the scientific and educational purposes of these reserves, just as their involvement and support are essential in planning and demonstrating appropriate methods of sustainable uses.

Together, indigenous tribal populations and traditional users are playing and important and active role in the biosphere reserve program. This role will increase as the biosphere reserve concept becomes better known, as more reserves are designated in biologically significant areas where these people are an integral part of the ecosystems, and as more financial, logistical, and intellectual resources are directed toward these areas. The potential benefits of biosphere reserves to local people and

their ecosystems are only now beginning to be appreciated as practical experience is gained in different parts of the world. However, the evidence suggests that the biosphere reserve network, now containing 269 units in 70 countries (Figure 1) is becoming an important framework for demonstrating the process of integrating conservation and development, in accord with the objectives of the World Conservation Strategy (IUCN 1980). In the balance of this paper, I will be reviewing some of this evidence.

Roles, Objectives and Spatial Organization of Biosphere Reserves

From the earliest discussions which led to UNESCO's decision to launch MAB in 1971, it was intended that the program have a permament territorial and logistic base, which would address three fundamental objectives (Batisse 1986):

- to promote conservation of the world's ecosystems and the genetic diversity they contain (the conservation role),

- to establish a global information-sharing network for cooperation in carrying out interdisciplinary field research, training, and information exchange (the logistic role), and

- to provide the scientific basis for linking environmental conservation and resource development as a fundamental mission of research and educational activities (the development role).

When the MAB Program was formulated, the establishment of an international network of biosphere reserves became part of MAB Project 8, "Conservation of natural areas and the genetic material they contain." Although UNESCO's operational guidelines addressed the multiple roles (UNESCO 1974), the incorporation of the network within this project resulted initially in disproportionate attention to the conservation role, at the expense of the logistic and development roles. In the years following UNESCO's official designation of first 57 biosphere reserves in 1976, a large number of national parks and similar strictly protected areas were added to the network. By 1981, there were 208 biosphere reserves in 58 countries. More than 80% were national parks and equivalent reserves. Nevertheless, various early efforts to integrate the several roles were begun in Canada, France, Honduras, Mexico, and elsewhere. Some of these are discussed later because they serve as good examples of the incorporation of local people into biosphere reserve programs.

At MAB's tenth anniversary conference in 1981, the delegates called for a detailed evaluation of the network in light of the experience in different countries. This assessment subsequently took place at the First International Biosphere Reserve Congress which was held in Minsk, Byelorussia, USSR in 1983. On the basis of this evaluation, the "Action Plan for Biosphere Reserves" was approved (UNESCO 1984). The Plan is a unique and strategic document. It sets forth the characteristics and functions of

biosphere reserves, establishes nine objectives for the international program, and recommends 35 actions for implementation between 1985 and 1989 by international agencies and organizations and national MAB committees. As part of each biosphere reserve nomination, UNESCO now requires that the administrator(s) of proposed biosphere reserves sign a declaration of commitment to pursue the general objectives of the "Action Plan" (Table 1), to prepare corresponding management guidelines, and to participate in sharting information through the MAB network. Under the Action Plan, the biosphere reserves share a common identity as parts of an international network with a common set of objectives which each area is morally, if not legally, committed to pursue.

In a preliminary analysis of a recent UNESCO survey to which 200 of the 269 existing biosphere reserves had responded as of July 1988, 72% of the sites reported that they are pursuing seven or more of the network's objectives, and 47% are pursuing all nine objectives (Gregg and Wargo 1988). Objectives relating to the conservation and logistic roles were more often reported and more likely to be considered important, than objectives relating to the development role, reflecting the large proportion of strictly protected natural areas and experimental research areas in the network. Traditional land use systems are important considerations in many areas. Conservation of harmonious landscapes resulting from traditional patterns of land use is reported as an objective in 29%, and conserving traditional agricultural cultivars or animal domesticates in indigenous production systems in 12% (Table 2). People are living within the boundaries of slightly more than half of the units, with populations ranging from a few individuals to more than 100,000. Human populations living in and around biosphere reserves were characterized wholly or partially as as agricultural in 66% of the units, pastoral in 33%, urban/suburban in 32%, and artisanal in 15%. Underrepresented in the network, but more adequately represented in tropical units, are populations described as hunter-gatherers (15% vs 50%), and nomadic (5% vs 15%). Research on indigenous populations and traditional uses is being carried out in many reserves, particularly in tropical regions (Table 2). About 17% are conducting research on traditional land use systems (31% in a tropical subgroup), 17% in cultural anthropology (vs 23%), and 10% in ethnobiology (vs 27%). Nevertheless, research on sociocultural systems, now occurring in about 27% of the reserves, remains much less emphasized than work on species biology (87%), ecosystem analysis (76%), and other fields of natural science. The results underscore the need to expand the scope of research to include the human populations living in the larger regions which provide the context the existing sites.

UNESCO recommends that biosphere reserves be organized into core areas, buffer zones, and transition areas (vonDroste zuHulshoff and Gregg 1985; Gregg and McGean 1985; Batisse 1986; Metagraphics, Inc. 1987; Figure 2). These zones describe the spatial distribution of uses and activities within the large landscape area which is typically required to implement fully the multiple

roles of the biosphere reserve.

The landscape must contain at least one core area. A core area is a strictly protected natural area containing minimally disturbed examples of the ecosystems characteristic of the biogeographical province (sensu Udvardy 1975), including, if possible, outstanding examples of mature or "old growth" communities. Although emphasis is on including a wide range of ecological communities and opportunities for studing natural processes, a biosphere reserve should maintain as much species diversity as possible, including wild relatives of economic species. The core area ideally should be large enough to sustain viable populations of wide-ranging animals, including upper level predators. Nature sanctuaries, scientific reserves, wilderness and primitive areas, and sacred lands within tribal homelands often make suitable core areas. In long-settled regions, such as central Europe, large natural areas may no longer be available, and core areas may consist of small nature reserves within the context of a large traditional landscape. Although most biosphere reserves are located in inland regions, UNESCO is developing guidelines for establishing a global network of coastal and marine biosphere reserves, and the U.S. has already initiated its own program.

A buffer zone includes the area adjacent or surrounding a core area where uses and activities are managed in ways protective of the core area. A buffer zone normally has a legal boundary which often coincides with the boundary of a national park, wildlife refuge, multiple use area, or other administrative areas. Buffer zones may support experimental research, ecosystem rahabilitation, recreation, silviculture and agriculture, scattered settlements, and other uses, and may directly serve conservation objectives by protecting important habitat, agricultural cultivars, and other genetic resources.

The core area(s) and buffer zone(s) of the biosphere reserve are surrounded by the transition area, or zone of cooperation. The zone is a focus for activities involving local people, scientists and other specialists, the administrators of participating administrative areas, and institutions having an interest in using MAB as an aegis for regional cooperation. The transition area supports regionally characteristic uses, and includes, where possible, indigenous tribal populations. It is the principal area for involving local people in improving their own well-being through culturally and ecologically sustainable types and patterns of development, and for implementing educational and training programs which help develop an enthusiastic constituency for the reserve. The transition area is normally open ended, and its dimensions vary in space and time depending on the cooperative activities taking place. It may eventually extend as a functional zone to the limits of a biogeographical or cultural region. The transition area is usually not mapped, although it may contain delineated research and demonstration areas which have elected to join as designated parts of the

biosphere reserve.

Increasingly, designation of administrative units as biosphere reserves is being discontinued in favor naming biosphere reserves after regions which make sense culturally and biologically. If local people personally identify with the region, and consider it home, it should be possible to foster pride in the project and enthusiasm for participation. A clear biological identity enhances opportunities for cooperative research and education, and thus the potential regional benefits of the reserve in ecosystem management. Regional names, such as the Pinelands BR (New Jersey), the Hawaiian Islands BR, and Lake Baikal Area BR (USSR), have practical advantage because they allow administrative areas to be added as opportunities arise (Batisse 1986; Gregg in press).

The zones of the biosphere reserve provide a flexible framework for local and regional cooperation in developing the means of conserving biological diversity in concert with improving the health and well-being of local people whose enthusiastic support will be the key to effective conservation. They facilitate the progressive application of biosphere reserve objectives through a process of voluntary cooperation involving large regions which, in many countries, would be impossible to delineate by law. For the administrators of national parks and other conservation areas, a biosphere reserve can offer a bridge to the surrounding region, and an aegis for working with local people and institutions in developing a regional conservation strategy. For local people, it can provide access to education and training, as well as technical and financial resources for appropriate development. For traditional societies, it can provide incentive for documenting land use practices and cultural history, foster cultural pride and create a climate in which maintaining traditional agroecosystems and their genetic resources may be possible (Oldfield and Alcorn 1987).

Case Studies

Czechoslovakia's Biosphere Reserves

In Czechoslovakia, the biosphere reserve designation has been applied to four existing protected landscape areas. The areas are legally established planning districts in long-settled regions where the original vegetation was almost completely cleared centuries ago. They support harmonious land uses, developed over more than 500 years, which define regional cultures. The judicious use of culturally and ecologically appropriate technologies to improve the productivity of these economic uses, while conserving biological diversity, is a major objective, involving the participation of the Czechoslovak Academy of Sciences and regional research institutions and universities.

In Bohemia, the 70,000-hectare Trebon Biosphere Reserve contains an ancient system of shallow artificial impoundments which, prior the development of modern transportation, were a major source of fish in continental Europe. The biosphere reserve is developing the knowledge and skills to manage traditional fisheries, as well as satisfy growing demands for recreation, agriculture and small industries. The core areas effectively protect the small remaining stands of native mixed hardwood forests, and provide benchmarks for research to support regional management of vegetation and wildlife. The reserve contains some of the last remaining natural stands of mature Bohemian pine, one of the region's most important commercial species. A major public education program has been initiated and a museum facility established in the town of Trebon to communicate the multiple objectives and benefits of the biosphere reserve to the local population. Czechoslovakia's biosphere reserves enjoy considerable governmental support, but developing mechanisms for continuing involvement of local people in setting the research and educational agenda remains an important challenge.

Waterton Lakes Biosphere Reserve, Canada

The Waterton Lakes Biosphere Reserve represents an early effort by a developed country to institutionalize cooperation between a national park and local people through a biosphere reserve program (Lieff, 1985). The biosphere reserve, designated by UNESCO in 1979, consists of the 52,597-hectare Waterton Lakes National Park in the Province of Alberta. From the start, cooperation with the local ranching community on resource issues of mutual concern was seen as an important objective. Following a major orientation workshop and a series of meetings involving the government agencies, universities, and the local community, it was agreed to establish a Biosphere Reserve Management Committee, chaired by local ranchers, to serve as a forum for identifying resource issues and the skills for addressing them. Beginning with less controversial issues, the Committee held public seminars in which technical experts provided perspective on problems and potential solutions. An early accomplishment was the development of a cooperative program for monitoring and controlling knapweed (Centaurea spp.), a thistle-like exotic species, unpalatable to livestock, which was reducing the productivity of the range. As local suspicions were reduced and confidence in the program improved, attention turned to more controversial issues, such as the management of seasonal movements of elk (Cervus canadensis nelsonii) between the park and the adjacent lands, where ranchers were complaining of damage to green crops and haystacks. The depredation was reduced through more effective fencing and scientifically-based revisions to provincial hunting regulations which increased the allowable harvest. Having demonstrated the benefits of science in integrating conservation and range management, the committee moved to establish an interdisciplinary Technical Committee to plan a regional monitoring and research program and communicate accom-

plishments and recommendations to the Management Committee. The Technical Committee has expanded research on the ecology of elk populations, and has intitiated experimental range research to further reduce conflicts between elk and livestock. During the past six years, a functional zone of cooperation adjoining the park has been established for implementing MAB concepts. An Education Subcommittee is now working on curricula to communicate the MAB concepts in local schools. Finally, as testimony to local enthusiasm, the Management Committee arranged for construction of an interpretive highway pull-out overlooking private ranchlands toward the park in order to explain the mutual benefits of the biosphere reserve concept to the park and the local community.

Cevennes Biosphere Reserve, France

The 323,000-hectare Cevennes Biosphere Reserve in the hills of southeastern France is a landscape mosaic containing native beech, chestnut and oak-pine forests, and grasslands as well as areas traditionally used for agriculture, grazing, and settlements (Collin 1985, Engel 1985). Species diversity is relatively high, even by Mediterranean standards, and includes more than 1800 species of vascular plants and 50 species of mammals. Perpetuating this diversity involves maintaining the existing pattern of rural land uses in an area which is the contemporary expression of continuous human use since Roman times. This use has not always been compatible. Extensive clearing of beech forests for charcoal, as well as land conversions to agriculture and overgrazing by sheep in the eighteenth and nineteenth centuries caused serious erosion which was abated through extensive plantings of pine (Halffter and Ezcurra, in press). More recently, land conversions for pulpwood production and tourist facilities, financed largely by external interests, caused additional disturbance. Hunting by outsiders became a significant influence on wildlife populations. In recent years, natural succession on unutilized lands formerly supporting indigenous agroforestry has created an increasingly homogeneous landscape. Today, the central limestone plateaus have the lowest population density in France (1.5 people per km2). The population is declining in part due to deemphasis of traditional grazing and loss of markets for chestnuts, silk, and sheepskin.

The establishment of the Cevennes National Park in 1970 reduced land speculation and helped control recreational construction and use. Hunting is now restricted within the park to local populations. The park has had some success in fostering ecotourism, which focuses on public enjoyment and appreciation of the diversity of the traditional landscape mosaic. However, the park has statutory authority to regulate uses only in a 90,000-hectare central zone. In the remaining lands, the park can only advise local municipalities on conservation and land use issues. In practice, park programs have been confined largely to the former zone.

The biosphere reserve includes the central zone of the park, which coincides with the core area and buffer zone, as well as a surounding zone of cooperation. In this case, the zone of cooperation is actually delineated and, in some places, extends beyond the park's boundary to the limits of the Cevennes eco-cultural region. The biosphere reserve complements the park by providing a neutral framework for regional cooperation involving the park, local municipalities, universities, and the local people themselves in planning and implementing research and educational activities to maintain and restore the region's biological heritage while perpetuating traditional culture, and fostering regional pride. Among the reserve's ongoing projects is maintenance of populations of purebred Aubrac cows, an endangered local domesticate particularly well adapted to the mountain conditions, for use in genetic improvement programs with other cattle breeds.

Central American Biosphere Reserves

In Central America, the most significant opportunities for conserving remaining tropical forests are generally in the homelands of indigenous people, whose cultures are intimately related to these ecosystems (Glick and Betancourt 1985; Houseal and Weber, in press). Since 1980, biosphere reserves including parts of these homelands have been designated in Honduras, Costa Rica, and Panama, and additional biosphere reserves are being considered for nomination in Belize, Guatemala, and Nicaragua. In most cases, the designations link indigenous reservations with contiguous national parks, national forests, and other areas to create large biosphere reserves which provide a framework for cooperation among the participating administrative areas. The La Amistad Biosphere Reserve in Costa Rica, which includes nine Indian communities, exemplifies this approach (Torres, Masterson, and Hurtado de Mendoza, in press). Cooperation involving local people is often informal, and focuses on familiarizing the community with biosphere reserve concepts and programs. Several biosphere reserves have management plans that include mechanisms for involving indigenous populations in planning and management.

The proposed Kuna Yala Biosphere Reserve in Panama, which has recently been recommended by the Kuna tribal leaders for nomination, is a special case (Houseal, MacFarland, Archibold, and Chiari, in press; Wright, Houseal, and deLeon, 1985). This will be the first biosphere reserve managed exclusively by indigenous people, and illustrates the promising role of biosphere reserves in cultural self-determination. The Kuna Reservation is located in an isolated area of tropical forests extending from the continental divide to the Caribbean Sea. The Kuna, whose permanent settlements are located on small offshore islands and in near-shore villages, have a long-established tradition of fishing and coastal agriculture, as well as selective hunting and gathering in the interior mountains. The catalyst which ultimately led to the biosphere reserve nomination was a government project to

construct a road, with support from USAID, through the reservation to link the the Pan American Highway with the coast. Recognizing the need to control entry by peasant settlers from the Panama's interior, prevent outside interests from dominating a profitable Kuna-managed tourist trade, and protect their way of life, members of the community attempted to develop a permanent agricultural settlement where the road enters the reservation. Climate and soils in this virgin rainforest area proved extremely unfavorable to farming and cattle-raising, and the project was abandoned. The Kuna's problems were brought to the the attention of USAID, which, with Kuna support, subsequently enlisted CATIE (Centro Agronomico Tropical de Investigacion y Ensenanza) in Costa Rica to prepare a land suitability analysis for the region. The analysis, which recommended maintaining primary forest as the optimal use, marked the initiation of an intensive cooperative planning effort, which between 1982 and 1987 attracted more than $1 million from national and international sources (Chapin 1987). Through the project, the Kuna have received extensive training in planning and management. Together, the Kuna and their collaborators developed a management plan which stresses phased development of tourism as well as fisheries, agroforestry (reportedly utilizing 48 species of trees and 16 crop plants in various combinations), traditional uses, and a strong emphasis on research and education. Every research project has a Kuna coinvestigator who participates actively in designing and implementing the research.

The coordinated pursuit of conservation, logistic, and development roles, and the emphasis on maintaining the Kuna's traditional uses and strengthening their already strong cultural cohesiveness, made the Kuna Homeland a prime candidate for biosphere reserve status. The Kuna's decision to pursue nomination reflected awareness of the intangible benefits of recognizing the unique coevolution of Man and Nature embodied in the relationships between the Kuna and their Homeland. It also reflected their awarenesss of the pragmatic benefits of the international network in sharing information, generating technical and financial assistance, and providing, through international recognition, an additional barrier to outside intervention in Kuna affairs by implicitly recognizing the Kuna's land title, which prohibits landownership by non-Kuna, and their automomy over planning and management of the ecosystem. Although the Kuna's situation is atypical, it nevertheless illustrates an emerging relationship between biosphere reserves, cultural self-determination, and the conservation of biological resources.

Mexico's Biosphere Reserves

Among developing countries, Mexico's success in implementing the biosphere reserve concept has been exceptional. Beginning in 1975, the country was among the first to launch its biosphere reserve program. Its architects realized early that conservation objectives would be difficult or impossible to carry out in a

developing country if they were undermined by rural people faced with an increasingly difficult subsistence. Involving local people in developing economic alternatives to improve their standard of living was recognized as a principal means for promoting biosphere reserve objectives. Under this approach, community leaders are involved in planning and implementing the reserve's research and demonstration program. Local commitment to conservation objectives develops progressively as local people come to associate practical economic benefits and opportunities with their participation in the biosphere reserve (Halffter 1981, 1985; Halffter and Ezcurra, in press).

Mexico establishes biosphere reserves by executive decree and is thus is one of only a few countries to use biosphere reserves as a separate legal category of protected area. The approach has been made possible by the relative weakness of national park and other protected area systems, and the need to build centers to demonstrate ways to integrate conservation and development. Mexico's biosphere reserves have considerable administrative independence. Under the authorizing decree, a Federal or state-affiliated research institution normally has both research and management responsibilities. The capability of these institutions to provide continuity in the biosphere reserve program has been an important factor in the program's success. Finally, the association of the sites as part of a global network has helped gain governmental support within Mexico, as well as assistance from other nations and international organizations.

The Mapimi Biosphere Reserve in the State of Durango, exemplifies the "Mexican modality" (Halffter 1985). The Reserve is located in a remote desert region where marginal livestock grazing and the harvesting of candelilla (Euphorbia antisyphilitica) are the traditional economic activities. Here, an important objective was to improve the prospects for survival of the endangered desert tortoise (Gopherus flavomarginatus) which was being harvested by local people for its meat. Researchers from the Institute of Ecology enlisted the help of local people in various range improvement and alternative development projects. Although the success of these projects varied, the confidence of the local people was well established by the time the Reserve was designated. As the local people increasingly saw themselves part of an integrated biosphere reserve program, the desert tortoise has become symbolic of the benefits they derive and their hopes for the future. Illegal harvesting has been reduced. In one instance, poachers were apprehended by local people, summarily dispatched from the area, and their inventory of marked tortoises returned to the environment (Ezcurra, personal communication).

Other Mexican biosphere reserves are being developed under a wide range of ecological, cultural, and socioeconomic conditions. All are based on local participation. The 140,000-hectare Sierra de Manantlan Biosphere Reserve in the State of Jalisco, designated this year, is a biologically rich region which contains the critical habitat for the perennial corn (Zea diploperennis)-- the

symbolic catalyst for its establishment. The reserve has less than 1% Federal land, and is being developed as a partnership between researchers at the University of Guadelajara, various government agencies, and local villages. The reserve provides a framework for small-scale rural development projects, and is developing a growing base of local political support needed to counteract the trend toward forest exploitation financed by external interests (Santana, Guzman, and Jardel, in press). Another example is the Sian Ka'an Biosphere Reserve in a sparsely populated area of the State of Quintana Roo (Yucutan Peninsula), in which conservation of traditional Mayan agriculture and forest utilization practices is a major objective (Tangley 1988).

Conclusions

The biosphere reserve concept has been widely cited in national and international strategies for maintaining biological diversity and integrating conservation and development (Interagency Task Force on Biological Diversity 1985; U.S. Congress, Office of Technology Assessment 1987; World Resources Institute 1986; IUCN 1980). Experience in biosphere reserves figures prominently in a recent report to assist the World Bank's efforts to consider indigenous people in integrating conservation and economic development (Poole 1988). United Nations agencies (e.g., FAO, UNEP) and international nongovernmental organizations (e.g., IUCN) have joined in implementing the "Action Plan for Biosphere Reserves". However, the potentially important role of indigenous cultures in developing the conservation role of biosphere reserves has yet to be fully realized.

On the basis of experience in particular areas, we know that biosphere reserves can provide a framework for documenting traditional land use systems and improving their productivity in culturally appropriate ways. We know that biosphere reserves can provide an aegis for demonstrating how to integrate the conservation of significant natural areas with efforts to improve the well-being of indigenous populations living within or adjacent to these areas (Clay, 1985; McCaffrey and Landazuri 1987, Van Orsdol 1987), to the mutual benefit of both. We know that they can help indigenous societies protect their land use traditions in the face of growing external pressures. We suspect, although time has been insufficient for convincing demonstrations, that they can be a useful means to maintain traditional cultivars and animal domesticates (Oldfield and Alcorn 1987; Halffter and Ezcurra, in press).

It has been suggested that biosphere reserves can help build the ethical basis for a world community based on sustainable partnerships between human societies and Nature (Engel, in press). If this is to occur, indigenous societies may well be in the best position to provide moral leadership through practical example. The following statement by Aurelio Chiari, delegate from the Kuna Nation to a MAB Symposium on Biosphere Reserves at the Fourth

World Wilderness Congress in September 1987, suggests this particular potential:

"For the Kuna culture, the land is our mother and all living things that live on her are brothers in such a manner that we must take care of her and live in a harmonious manner on her, because the extinction of one living thing is also the end of another.

We preserve the forests because for us they are a pharmacy where our medicines are stored. They are a refrigerator because they keep our meat fresh. They are a store for construction materials because we obtain materials for our houses and boats from them. Some are also sacred and we must defend our religious beliefs.

The concept of a biosphere reserve, even though we don't have this term in our society, has been with us since the existence of our culture. The worry that my people have always had about the strong pressures of deforestation has created the impulse to plan the adequate use of the resources. We have done this through the Kuna Wildlands Project which has prepared a management plan and is now implementing it.

I will be the messenger to the Kuna Congress about the international concern shown here and I will tell them that we are not alone in our efforts."

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Figure 1. Map of the International Network of Biosphere Reserves as of March 1988 (sources: UNESCO 1984, Metagraphics, Inc. 1987; UNESCO listing of biosphere reserves, March 1988)

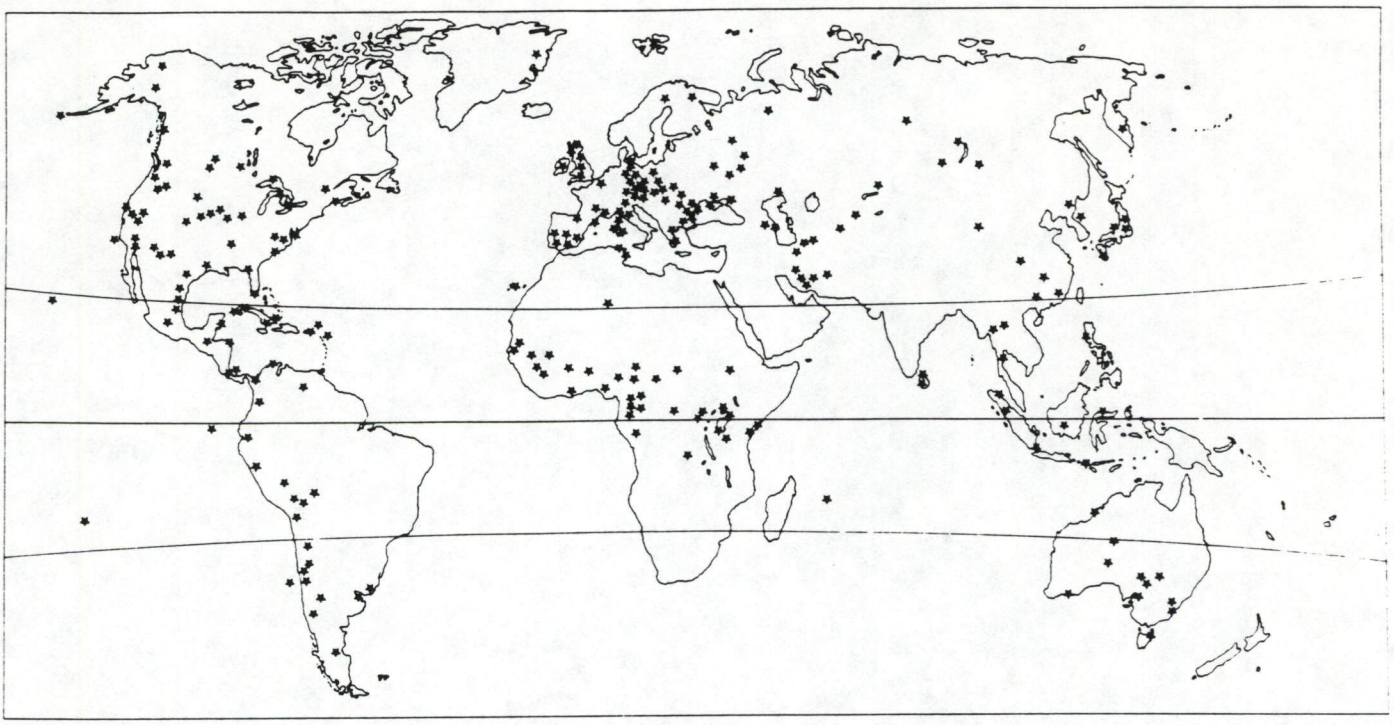
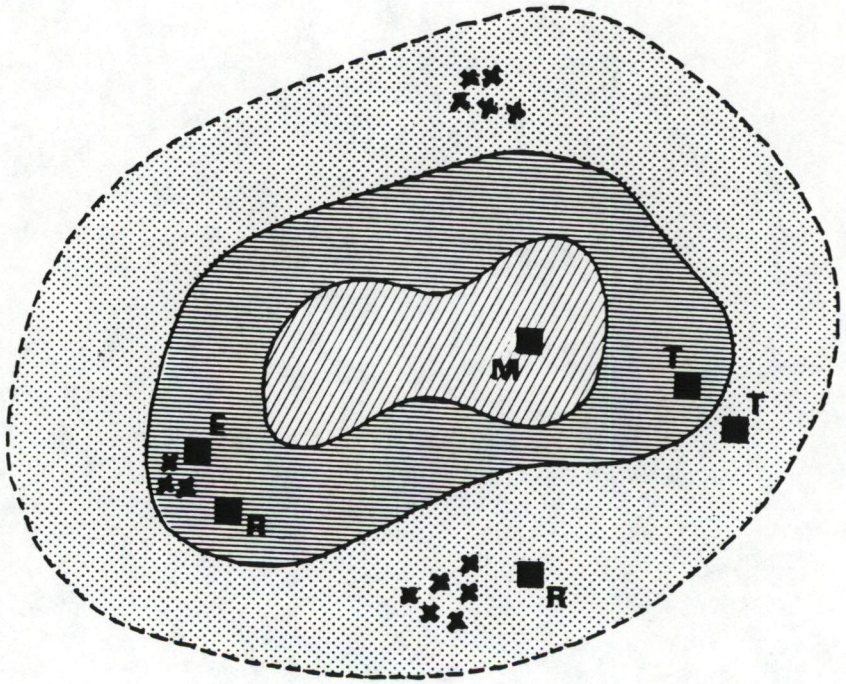


Figure 2. Schematic Zonation of a Biosphere Reserve (from Batisse 1986)



Core area (strictly protected)

Buffer zone (strictly delineated)

Transition area

Human settlements

R Research station or experiment

M Monitoring

E Education and training

T Tourism and recreation

Table 1. Objectives of the International Network of Biosphere Reserves (from nomination form, UNESCO 1988). The percentage of responding sites reporting each objective, and the average importance of the objective (from 1, very low importance, to 5 very high importance) are indicated in parentheses.

Conserve natural or minimally disturbed ecosystems (98%, 4.6)

Provide the legal or administrative basis for resource protection and management (72%, 2.7)

Conserve specific genetic resources *in situ* (93%, 4.1)

Conduct experimental problem-oriented research on ecosystem management and conservation (85%, 3.3)

Conduct long-term environmental monitoring (98%, 3.8)

Promote regional planning and integrated rural development (68%, 2.0)

Promote local participation in land use and management (70%, 2.0)

Promote environmental education (of local people and visitors) and training (81%, 3.2)

Generate and share knowledge about conservation and management of the biosphere (69%, 2.2)

Table 2. Biosphere Reserves, Traditional Land Use Systems, and Related Research (based on preliminary analysis of UNESCO survey)

Country & Name of Reserve	Biome 1/	Subsistence 2/	Conservation Objective 3/	Ongoing Research 4/
Algeria, Tassili	7	YES	b	
Argentina, Costero del Sur	7	YES	b	b
Reserva de Vida Silvestre	7	YES	b	
Australia, Uluru (Ayer`s Rock)	7	YES	b	a, b
Bulgaria, Djendema	12	NO	a	
Kamtchia	12	NO	b	
Srebarna	12	NO	b	
Canada, Waterton Lakes	12	YES	b	
Central African Republic				
Bamingui-Bangoran	4	NO	b	
Chile, Lauca	12	YES	a, b	
China, Wolong	12	YES	a	b
Wuyishan	2	YES	a, b	
Xilin Gol	11	NO	a	
Columbia, Sierra Nevada de Santa Marta	4	YES	a	a, b
Costa Rica, Talamanca-La Amistad	4	YES	a, b	a, b
Cuba, Sierra del Rosario	13	NO		a
Czechoslovakia, Krivotlasko	12	NO	b	
Palava	5	NO	b	
Slovak Karst	5	NO	b	b
Trebon	5	NO	b	
Ecuador, Galapagos	13		a	
Egypt, Omayed	7	NO	b	
France, Cevennes	5	YES	b	a
Gabon, Ipassa-Makokou	1	NO		b
Honduras, Rio Platano	4	NO		a, b
Hungary, Aggtelek	5	NO	a, b	
Hortobagy	5	NO	a, b	a, b
Kiskunsag	5	NO	a, b	
Lake Ferto	5	NO	a, b	
Pilis	5	NO		a
Indonesia, Cibodas	13	YES		b
Gunung Leuser	13	YES	a, b	
Ireland, Killarney	5	NO	b	
Japan, Mount Hakusan	2	NO		a
Mount Odaigahara and Mount Omine	2	NO	b	

Kenya, Mt. Kulal	7	YES	b	b
Mexico, Montes Azules	1	YES	a, b	a, b
Sian Ka'an	1	YES	a, b	a, b
Peru, Huascaran	12	YES	a	
Manu	1	YES	b	a, b
Poland, Babia Gora	5	NO	b	
Rumania, Rosca-Letea	11	NO	b	
Senegal, Delta du Saloum	4	NO	b	
Spain, Donana	6	YES		a
Mancha Humeda	6	NO	b	
Marismas del Odiel	6	NO	b	b
Montseny	6	NO	a, b	b
Ordesa-Vinamala	6	NO	b	b
Sierras de Cazorla y Segura	6	NO	a, b	
Sierra de Grazalema	6	YES	b	a, b
Sierra Nevada	6	NO	a, b	
Sudan, Dinder	7	YES		b
Tanzania, Lake Manyara	4	YES	b	
United Kingdom, Caerlaverock	5	NO	a	
Cairnsmore of Fleet	5	NO	a, b	b
Loch Druidibeg	12	NO	a, b	b
Moor House-Upper Teesdale	5	YES	b	
Isle of Rhum	12	NO	b	
St. Kilda	12	NO	b	
USA, Aleutian Islands	9	NO	b	
California Coast Ranges	2	YES	b	
Carolinian-South Atlantic	5	YES	b	
Central Gulf Coastal Plain	5	NO	b	
Central Plains	11	NO	b	
Denali	3	YES		b
Everglades	4	YES	b	
Fraser	12	NO	b	b
Glacier	2	NO	b	
Great Smoky Mountains	5	YES	b	a
H. J. Andrews	12	NO		b
Hubbard Brook	5	YES		b
Jornada	7	NO	b	b
Konza Prairie	11	NO	b	
Noatak	9	YES		b
Organ Pipe Cactus	7	YES	a	a, b
San Joaquin	6	NO	b	b
Virgin Islands	13	YES		b

USSR, Kavkazskiy	12	NO		a
Oka River Valley	5	YES	b	b
Sikhote-Alin	5	YES	a, b	
Tsentralnosibirskiy	3	NO		b
Yugoslavia, Velebit Mountain	6	NO	a, b	
Zaire, Luki	1	YES		a, b
Vallee de la Lufira	4	NO	b	

1/ (1) = tropical humid forests; (2) = subtropical and temperate rain forests or woodlands; (3) temperate needle-leaf forests or woodlands; (4) = tropical dry or deciduous forests or woodlands; (5) = temperate broad-leaf forests or woodlands and subpolar deciduous thickets; (6) = evergreen sclerophyllous forests, scrubs, or woodlands; (7) warm deserts and semi-deserts; (8) cold-winter (continental) deserts and semideserts; (9) = tundra communities and barren arctic desert; (10) = tropical grasslands and savannas; (11) temperate grass-lands; (12) mixed mountain and highland systems with complex zonation; (13) mixed island systems. (from Udvardy 1975)

2/ subsistence activities reported in the transition area

3/ (a) = conserve traditional agricultural cultivars or animal domesticates within indi-genous production systems; (b) = conserve an harmonious landscape resulting from traditional patterns of land use

4/ (a) = ethnobiology
(b) = traditional land use systems