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02/07/97

The Bioreserve Strategy for Conserving Biodiversity

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Chapter for book **Practical Approaches to the Conservation of Biological Diversity** edited by Richard K. Baydack, Henry Campa III, and Jonathan B. Haufler. Island Press, Covelo, CA. (In Press)

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The bioreserve strategy is a promising but largely untested approach to conserving biodiversity. The strategy involves zoning regional landscapes into areas that range from total protection (minimal human activity) to areas of intensive human use. Zoning, in this context, does not necessarily refer to a formal regulatory designation, but rather to a societal agreement to limit certain human activities and uses on certain lands. This agreement may be expressed and played out in a variety of ways ranging from formal designation as reserves or parks to conservation easements or landowner agreements.

In this paper we:

(1) define biodiversity;

(2) review the development of the bioreserve strategy;

(3) describe briefly the elements of the strategy and the context in which it should be applied;

(4) discuss some strengths and weaknesses of the approach; and

(5) describe a case history of an initiative to apply the strategy to a portion of an ecoregion in Northern California.

WHAT IS BIODIVERSITY

Biodiversity has been defined as follows:

> "Biodiversity is the variety of life and its processes. It includes the variety of living organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary processes that keep them functioning, yet ever changing and adapting."

(Keystone Center 1991).

Detailed explanations of this definition can be found in Noss and Cooperrider (1994) as well as in many of the new books on conservation biology (Hunter 1996; Meffe and Carroll 1994; Primack 1993; Primack 1995). However, two important aspects of this definition need to be noted. First, biodiversity consists of more than just "the variety of species" or what is termed "species richness". Thus conserving biodiversity is a broader concept than just "endangered species management". Rather it involves the conservation of the full range of species, variation within species, biotic communities, and ecosystems. Second, the definition is dynamic and incorporates ecological functions or processes and explicitly recognizes that species and biotic communities change over time.

DEVELOPMENT OF THE BIORESERVE STRATEGY

The concept of "bioreserves" has been around in one form or another for hundreds if not thousands of years. Some indigenous cultures recognized areas in which human activities such as hunting were forbidden. More recently the movement to create national parks, national wildlife refuges, wilderness, and natural areas is derived, at least in part, from the recognition that areas in which human activities are constrained is necessary to conserve plant and animal life.

However, this approach of setting aside areas as parks, refuges, and so on has proved to be inadequate for at least three primary reasons (Noss and Cooperrider 1994). First, most such areas have been selected for purposes other than protection of biodiversity, or with limited consideration of this as a purpose. For example, most wilderness areas have been set aside based upon their fortuitous lack of roads together with high value for primitive recreation. This has resulted in a plethora of high altitude reserves areas but few located in lowland areas. Similarly, many national parks and monuments have been selected because of their spectacular geological features rather than because they represented or conserved biotic communities.

Second, many species and plant communities are not represented or are under-represented in any form of reserve systems (Crumpacker 1988). Given the manner in which reserves have been designated this is not surprising.

Finally, most reserves are too small to contain fully functional biotic communities. For example, the oldest and largest national park in the coterminous United States, Yellowstone, is not large enough to support viable populations of many species (Clark and Zaunbrecher 1987). Furthermore, there is scientific evidence that national parks are losing species and that such loss is correlated with their size--with smaller ones losing more species than larger ones (Newmark 1985).

In summary, the reserve system that we have in this country today was developed in an ad-hoc, piecemeal manner for a variety of purposes, rather than with systematic consideration of the need to protect biodiversity. As a result we have a system that is inadequate in terms of size and number of reserves.

To counter these limitations conservation biologists are developing and testing ways to improve upon the past approach. Three major modifications have been suggested.

First, and most central, is the systematic design of regional reserve systems. This process includes both designation of new reserves and improved design of existing reserves. A key element of the process is a systematic effort to ensure that all species and community types are represented in the reserve system. A second improvement is the "buffering" of core reserves (those areas where human activity is most constrained) with areas of increasing human activity and impacts. This increases the effective protection of the core reserves. Finally, the utility of reserves can be made more effective by connecting core reserves with corridors or other forms of connectivity that allow some movement of plants and animals between core areas.

THE BIORESERVE STRATEGY

These concepts of systematic design of reserve systems, buffering or core reserves, and connectivity are the central principles of the "bioreserve strategy" as proposed by Noss (1983), Noss and Harris (1986), Noss (1992), Noss and Cooperrider (1994) and others. The application of these principles to achieve biodiversity goals is described briefly here and in more detail in and Cooperrider (1994).

Goals and Objectives

The goal of a bioreserve strategy is to maintain the biodiversity of a region in perpetuity. Four fundamental objectives follow from this goal (Noss and Cooperrider 1994):

(1) To represent, in a system of protected areas, all native ecosystem types and seral stages across their natural range of variation;

(2) To maintain viable populations of all native species in natural patterns of abundance and distribution;

(3) To maintain ecological and evolutionary processes, such as disturbance regimes, hydrological processes, nutrient cycles, and biotic interactions; and

(4) To manage landscapes and communities to be responsive to short-term and long-term environmental change and to maintain the evolutionary potential of the biota.

To these four, we have added a fifth:

(5) To provide for the social, economic, and spiritual needs of the local people.

A bioreserve strategy provides a systematic approach toward achievement of all five objectives.

Design Components

Fundamental to the bioreserve strategy is the concept of zoning the regional landscape into areas of varying restrictions on human activities. These consist of four major components: core reserves, buffers, and zones of connectivity, and matrix. These categories are described briefly below, and in more detail in Noss and Cooperrider (1994).

Core Reserves

Core reserves are the backbone of a regional reserve system. They are areas in which the overriding goal of management or stewardship is preservation of native biodiversity and ecological integrity. They may consist of all or portions of national parks, wilderness areas, research natural areas, state parks and preserves, national wildlife refuges, or other areas in which human demands upon the landscape are given a second priority. Ideally, the reserves of a region should collectively contain all native ecosystem types and seral stages as well as all native species found in the ecoregion.

Buffers

To increase the effectiveness of core reserves, buffer zones surrounding the core reserves are designated. These consist of zones in which increasing amounts of human activity and disturbance are allowed (Figure 1). For example, in Figure 1, the first buffer zone might allow only light (non-motorized recreation) and the second zone would allow for motorized travel on roads but no logging or mining.

Zones of Connectivity

A second method of increasing the effectiveness of core reserves is to ensure that there is connectivity between them. Connectivity here refers to the state of being functionally connected by movement of organisms, material or energy. Zones of connectivity allow for the movement of plants and animals and their genes from one core reserve to another. Corridors are one form of connectivity, but not the only one. For example, in Figure 1, some corridors are delineated, but other zones of connectivity are also present.

Matrix

Finally, the matrix contains all the rest of the land that does not fall into one of the above categories. In this area, human uses and demands upon the landscape receive priority in the traditional manner in which land is managed. The matrix may consist of agricultural lands, timberlands, pasture land, or urban and suburban development.

STRENGTHS AND WEAKNESSES OF THE BIORESERVE STRATEGY

The bioreserve strategy is for the most part an untested strategy--we do not know how effective such an approach will be in conserving biodiversity over the long-term (100 years or more). Neither do we know how effective such an approach can be in resolving conflicting human demands upon the regional landscape. Thus, the advantages and disadvantages of the bioreserve strategy, as described below, represent a preliminary assessment of the practicality of the approach.

Strengths

An important characteristic of the approach is the simplicity of the concept. The basic concepts of core reserves, buffers, and zones of connectivity are easily understood, even though the methodologies and details of design may be quite complex. Furthermore, this landscape zoning concept can be applied at various scales ranging from the watershed to the ecoregion.

A related strength is that people are familiar with and accepting of (to varying degrees) the practice of landscape zoning. In spite of the rhetoric of the private property rights zealots, land ownership in this country has never conferred an absolute right to do anything one wants on a property. This is true under both U.S. law and its predecessor, English common law.

Finally, by zoning the landscape into zones of restricted human activities and areas of intensive human activity--the bioreserve approach explicitly provides for areas of concentrated human activity. Much opposition to conservation efforts appears to come from the fear that more and more human activities are being restricted. By developing a "whole landscape" strategy, provision for human needs is made at the same time that some human activities are being restricted.

Weaknesses

The strategy is not without its pitfalls and limitations. Landscape level strategies that even hint at restricting human activity on private lands raise fears of increased government regulation and or "takings".An additional problem is the inflexibility of landscape zoning with set boundaries. Selecting, building public support for, and designating a core reserve can be a contentious and time-consuming process. If future information suggests that the reserve should have been in the next watershed, it may be difficult change the design and make the necessary adjustments.

A major difficulty with a bioreserve approach is that it requires a large knowledge base. Basic information is needed on:

(1) abundance, distribution, habitat requirements, and movement patterns of ecologically important (keystone, umbrella, threatened and endangered) species;

(2) distribution, abundance and condition of all ecosystem types (vegetation/biotic communities) and their seral stages throughout the ecoregion and an estimate of their "natural" landscape pattern; and

(3) natural disturbance regimes of the ecoregion — the temporal and spatial scales at which they occur, how they have been modified by humans, and how they can be mimicked in a semi-natural setting;

(4) area and level of protection of existing (de facto and de jure) reserves.

This is a large amount of information to acquire, synthesize and digest, but it represents only the most basic needs for biological information. Ideally, much more information on biology and natural history, land-use, and land-use impacts would be available and could be used.

Finally, as alluded to earlier, the bioreserve strategy is a largely untested approach at the scale of the large regional ecosystem or ecoregion. We not only have little experience in applying these concepts at this spatial scale, but the relevant time frame for testing the success of such a system at the ecoregion level is decades and centuries. Thus it will be centuries before we truly know how successful such a strategy has been. However, this caveat applies equally well to all other regional biodiversity conservation strategies; we may learn pretty quickly if they are not working (by observing species extirpations and extinctions and other obvious signs) but proving success will require patience.

APPLYING THE BIORESERVE STRATEGY - THE NORTH COASTAL BASIN OF THE KLAMATH ECOREGION

We describe here a case history of an ongoing effort to apply the bioreserve strategy to a portion of the Klamath Ecoregion in northern California and south-central Oregon. This represents one attempt to apply such a strategy to a larger regional landscape. It differs from other efforts in other regions or even parallel efforts to apply a bioreserve strategy within the same ecoregion. We present it here as one example of an application which is neither better nor poorer than other applications of the bioreserve strategy but that is hopefully tailored to the region and its biological and socio-historical context.

Background - The Klamath Ecoregion and North Coastal Basin

The Klamath Ecoregion is one of 52 ecoregions defined by the U.S. Fish and Wildlife Service. It is located in northwestern California and south-central Oregon and consists of all the watersheds or hydrobasins that drain into the Pacific Ocean from San

Francisco Bay north to the Smith River (Figure 2). Thus the ecoregional boundaries are defined in terms of watersheds rather than some other criteria such as geology or vegetation type.

Any ecoregional delineation is bound to be arbitrary. Some interactions occur among ecoregions and thus any delimitated area is not going to encompass all species or ecological processes. However, the Klamath Ecoregion boundaries are biologically meaningful in many ways. It encompasses most of the range of coast redwoods. Mapping of potential natural vegetation of the ecoregion indicates that it contains virtually all of the potential natural sites for one vegetation types (Pine-Cypress forest) and most of the sites for four others (redwood forest, California mixed evergreen forest, montane chaparral, and fescue-oatgrass). Together, these four types make up more than 50% of the ecoregion

Within the Klamath Ecoregion there are three relatively distinct subregions-- the Coast Ranges, the Klamath Mountains, and the Modoc Plateau--which have relatively distinct geologic origin, climatic pattern, and vegetation.

The North Coastal Basin is a region defined by the California Water Quality control board, and is generally synonymous with the Coast Ranges geologic province. In terms of watersheds, it is defined as all the hydrobasins draining into the Pacific Ocean south of the Klamath River and north of San Francisco Bay (Figure 2). Most of the region contains highly erodable soils derived from marine sediments--making them highly sensitive to land use impacts such as logging.

The best known natural and scenic features are the redwood forests and the rugged coastline. And the most notorious residents of these areas are the northern spotted owl and marbled murrelet which have received so much notoriety in recent years. However, the region contains many lesser known features and species including unique coastal prairie and numerous species of endemic plants. The rivers once supported six species of anadromous salmonids as well as numerous lesser known species of fish and other vertebrates.

The redwood “rainforest” that most characterizes this region is unique in that it resides on the edge of the Pacific Ocean in a region that has a basic Mediterranean climate--that is, most of the rain comes in the winter months. This forest is a relict of more widespread rainforests that once covered much of the West. For most of the region the months of June, July and August (at a minimum) are virtually without rainfall. Being near the ocean, however, the region is regularly covered by fog during the summer months. Much of the effective precipitation in this redwood / fog belt comes from the phenomena of fog drip--the ability of the redwood trees to capture fog from the air and transport it to the ground where it is utilized by many other life forms (Dawson 1996). When forests of the region are overcut they lose much of their capacity to capture moisture from fog during the hot, dry months of summer. This is in addition to the well-documented ecological effects of deforestation common to most forested regions (soil exposure, accelerated erosion, sedimentation of streams, etc.).

Overall, with unstable soils and relictual forests with unique flora and fauna, the

North Coastal Basin is a region that is highly sensitive to land use impacts.

Unlike other portions of the ecoregion which contain over 80% public (mostly federal) land, the North Coastal Basin consists of approximately 90% privately owned lands--of which the major landowners are corporate timber companies. These, industrial timberlands have been severely overcut and the watersheds degraded (Burkhardt 1995; U.S. Fish and Wildlife Service 1997; other). California has a Forest Practices Act that theoretically regulates forest practices on private lands so ensure that they produce "maximum sustained yield of high quality forest products". Unfortunately, the agencies charged with implementing the act have never enforced the spirit of the law. For the most part, corporate timberlands have been cut to the point where there is little commercial timber left on them--particularly in the southern portion of the North Coastal Basin.

The net result of all of these factors and more is that the North Coastal Basin ecosystem is severely degraded. The following are key problems and evidence of such degradation:

(1) redwood forests have been cut to the point where there are only a few remnants of true "old-growth" are left;

(2) all of the anadromous fisheries of the region are in decline (Moyle 1994),

(3) virtually all of the rivers of the region have been declared "impaired", primarily by sediment, under provisions of the Clean Water Act;

(4) coho salmon have been declared "threatened" by the National Marine Fisheries Service in the southern portion of the region and steelhead are also being

considered for listing; and finally

(5) numerous other species of plants and animals of the region are either formally listed as threatened or endangered or are in some way “at risk” although not formally categorized as such yet (U.S. Fish and Wildlife Service 1997).

Although there has been severe disruption of many of the forest and riverine ecosystems in this region--in some ways the region has more potential for ecological recovery than many other parts of California. This is primarily because of the lower human population density. The four counties that make up the total ecoregion have a population of 600,000 of which over 60 percent is concentrated in the southernmost county (Sonoma) which sits next to the greater San Francisco Bay area.

The unique challenges of developing a bioreserve strategy in this region thus revolve around the following characteristics of the region:

(1) limited amounts of public lands or existing reserves; high percentage of private lands;

(2) high percentage of lands owned by corporations with little incentive for long-term stewardship and virtually no regulatory enforcement of such;

(3) severely degraded forest and riverine ecosystems;

(4) ecosystems relatively sensitive to human disturbance because of relictual vegetation and inherently unstable soils combined with Mediterranean climate.

Obstacles to Biodiversity Conservation

The obstacles to conserving biodiversity in such a region are numerous They include (a) excessive demand for commodities, (b) degraded and fragmented habitat, (c) ineffectual regulation of forest practices and other ecosystem degrading activities, and (d) fragmented regulatory authorities combined with a large cohort of complacent or uninformed citizenry. Problems of implementing a bioreserve strategy in such a region are numerous and are shared by many regions (Trombulak et al 1996).

On the other hand, some attributes of the region differ considerably from many other areas where regional biodiversity conservation strategies are being developed. Most central is the high percentage of private land and the high percentage of corporate ownership. Many of the ongoing bioreserve strategies such as those described by Pace (1991), Noss (1993), Vance-Borland et al. (1996) and others are regions with a high percentage of federal or other public lands. In these cases, the strategies can rely heavily upon linking up existing reserves (in the form of national parks, wilderness areas) with other federal lands currently used for multiple-use purposes.

Overcoming Obstacles

Given the nature of the region, many citizen conservationists and biologists both within and outside government have realized that conserving biodiversity within the ecoregion will require a long-term, systematic and cooperative effort among citizens, government, academia and non-governmental organizations NGOs). Furthermore, these people have realized that in a region with such fragmented land ownership that it is unlikely that a single government agency will take the lead in such an effort. Thus a need was recognized for a NGO that could provide a leadership role in developing and implementing a bioreserve strategy for the region.

In response to this need a non-profit 501c3 organization, LEGACY, was formed in 1993 for the such a purpose. The mission of LEGACY is to promote conservation of native biodiversity in the Klamath Ecoregion through integration of local knowledge and science. A keystone project of the group is the development and implementation of a bioreserve strategy for the North Coastal Basin which is viewed as a long-term endeavor. As an NGO, LEGACY can play several key roles in implementing this strategy that might not be possible as a government agency. These roles include:

(1) Visionary - As a visionary LEGACY is developing and disseminating a vision of a sustainable regional ecosystem as well as a means to move toward that goal.

(2) Catalyst - By collecting, analyzing, synthesizing and disseminating information on biodiversity problems and ecosystem needs, LEGACY is serving as a catalyst to stimulate government agencies to fulfill their statutory obligations to protect elements of the environment.

(3) Partner - LEGACY is developing working relationships with both natural resource and regulatory agencies and also with other non-government organizations to pursue mutual goals. Of particular importance are the relationships with watershed groups, as will be described.

(4) Archivist - LEGACY is developing a means of archiving critical biodiversity

information that is not being kept elsewhere because of fragmented ownership and other jurisdictional problems.

(5) Educator - LEGACY is developing educational programs to inform citizens, students, bureaucrats, and politicians about important concepts of conservation biology and important ecological processes of the ecoregion.

Development and Implementation of the Strategy

Johns and Soule (1996) have outlined steps for implementing a bioreserve or wildlands reserve program. LEGACY is generally following these steps, however, their program is emphasizing five aspects which may differ from programs in other regions, (1) “soft reserve design”, (2) alliance with watershed groups, (3) use of geographic information systems both for data analysis and for education; (4) ever expanding partnerships, and (5) heavy emphasis on education.

Soft Reserve Design

Soft reserve design refers to a process in which the regional design is firs