INTER-AMERICAN INSTITUTE FOR GLOBAL CHANGE RESEARCH

Applying Ecological Knowledge to Landuse Decisions

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16.
Thinking outside the box: Tropical conservation in both protected areas and the surrounding matrix

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Biodiversity worthy of protection is often presumed to be a characteristic only of wilderness areas. This view results in the creation of reserves that restrict or even exclude human activities. Evidence supporting this assumption, based on data from limited groups of organisms, is incomplete. Valuable biodiversity elements may be overlooked and therefore lost in conservation efforts. The greatest amount of biodiversity for many groups of organisms exist outside protected areas in regions inhabited, used, and modified by traditional cultures and local inhabitants. These areas constitute an ecological mosaic that may include a wide diversity of ecosystems. Our hypothesis is that developing a means to integrate such areas into regional biodiversity planning could protect large numbers of species in the long-term. In 1999, the World Bank and the Mexican Government proposed the establishment of two conservation corridors: Celestún-Ría Lagartos and Calakmul-Sian Ka'an in the Yucatan Peninsula. While the importance of corridors is not a new concept in theory or practice, we here suggest that specific management strategies that focus on a mosaic of land uses by the people living in those corridors should be considered. Incorporating traditional agriculture, agroforestry, and natural reserves into a comprehensive management strategy could result in an improved design for the protection of biodiversity and development. Analysing planning and monitoring this initiative requires the integration of the social and natural sciences with a cross-sectoral approach that includes public policy and local communities in the study of land use patterns and regulatory processes. The aim is to (1) maintain ecosystem patterns and processes through the management and coordination of both established protected areas and the surrounding matrix, and (2) identify economical and environmentally sustainable livelihoods.

Agrobiodiversity in the Yucatan Peninsula

Mexico has used the establishment of protected areas as a primary strategy to guard its extraordinary biodiversity. A substantial investment by Mexican federal and state governments and various national and international conservation agencies has resulted in a suite of large reserves throughout southeastern Mexico. Twenty-five percent of Mexico's biosphere reserves are located in the Yucatan Peninsula. Yet we know that even greater biodiversity exists outside of protected areas; in regions inhabited, used, and modified by traditional cultures (Gómez-Pompa et al, 2003) and local inhabitants (de Jong, 1997). These collective areas constitute an ecological mosaic that includes an as yet rarely recognized high diversity of ecosystems. We postulate that developing a means to integrate these areas into regional biodiversity planning could protect large numbers of species (Gómez-Pompa et al, 2003).

The Mesoamerican Biological Corridor project, a transnational initiative in Central America and southern Mexico (Kaiser 2001), supported by the World Bank and governments of these respective countries, is designed to conserve biodiversity by linking protected areas from southern Mexico to Panama using a corridor of natural and “restored” habitats. This project includes the establishment of two portions linking reserves in the Yucatan Peninsula from Celestun to Ria Lagartos and from Calakmul to Sian Ka’an (Figure 16.1).

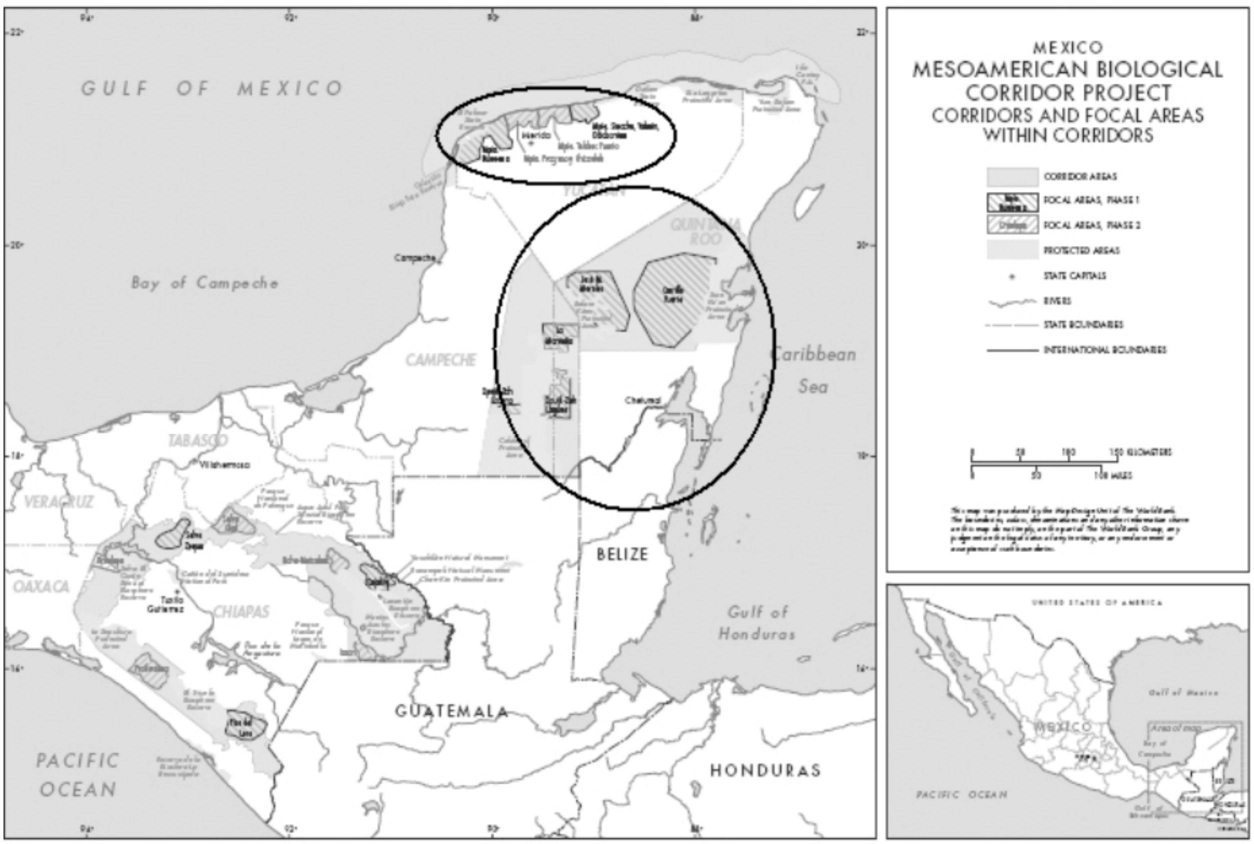

Figure 16.1. Mesoamerican Biological Corridor in the Yucatan Peninsula delineating the proposed corridor linking Celestun with Ria Lagartos and Calakmul with Sian Ka'an.

While the importance of corridors is not a new concept in theory or practice, strategies that utilize the mosaic of land uses created by the people living in those corridors has not been developed. Projects such as the Mesoamerican Biological Corridor have failed to consider all stakeholders and actors. This has resulted in slow adoption and minimal progress to date. Furthermore, interactions among governments, agencies and local producers have been difficult.

Currently, potential corridors in the Yucatan Peninsula are rapidly being converted from secondary forest to agriculture and cattle ranching. In addition, there are increasing frequencies of fires and hurricanes (Allen et al., 2003.; Boose et al., 2003) that impact within and outside of protected areas and are rapidly converting a major part of the region to a state of arrested succession (Mizrahi et al., 1997) comprised of young secondary forest with scattered individuals and patches of remaining mature forest. Agricultural development can fragment a matrix of continuous forest punctuated by small clearings of agriculture and settlements into a heterogeneous mosaic with small habitat patches spread across a matrix of developed lands. This matrix consists of lands in slash and burn agriculture and under cattle grazing.

Agroforestry projects, successional habitats, existing mature forest fragments, degraded forests and restoration projects are all critical reservoirs for biodiversity in that they provide habitat and refuge for a unknown number of species (Medellín and Equihua, 1998; Perfecto et al., 2003). Secondary forest in slash and burn agriculture in particular are fundamentally important habitats for conserving and restoring biological diversity (Kammesheidt 2002), for increasing forest cover for wildlife (DeWalt et al., 2003), carbon sequestration, timber and non timber products, watershed protection, and for their potential in linking protected areas. Such agricultural landscapes have been ignored in conservation strategies, and too often are viewed as incompatible with biodiversity conservation. The local inhabitants, primarily Maya *campesinos* (rural subsistence family production farmers), are recognized as the keepers and users of the knowledge in the management of these natural resources (Gómez-Pompa and Kaus, 1998). They have developed a complex management system that integrates its environment at different scales, e.g., home-gardens, slash and burn (*milpa*), and successional vegetation, and have used this approach for millennia (Gómez-Pompa et al., 2003).

Regional conservation strategy

Landscape fragmentation theory suggests that more than 60% of the land area would need to be protected in order to maintain connectedness across a region if protected areas are randomly distributed (With and King, 1999). Lesser amounts of land can still be protected and sustain connectivity if they are chosen to have a low fractal dimension. However, protecting even this lesser amount of land in conservation reserves may not be economically feasible. As can be seen in Figure 16.1, each current reserve is completely disconnected and there is little chance of developing a reserve network even with efforts to design linkages, such as the Mesoamerican Biological Corridor Project. Recent research has demonstrated that all corridors are not alike. Their effectiveness depends on the surrounding matrix and the species of interest. For some species, the boundary comprises its niche. Even the classical pattern of land protection will likely not succeed if the corridor width is too narrow or the corridor is broken by fire or natural disaster, or if animals are small and the length of the corridor extends beyond the dispersal distance.

The first step in creating connectedness between reserves is the recognition and development of land-use techniques that foster linkages. The architecture of agroforestry, for example, may serve as connective or even home range habitat for birds (Greenberg et al., 1997; Reitsma et al., 2001) and be complementary to protected undisturbed forest in habitat management plans for monkeys (Bearder, 1991; Gallina et al., 1996). To make this effective, it may require that agroforestry lands form a conduit between reserves and are not just randomly placed. Similarly, agricultural practices such as *milpa* fields can rotate through an existing forest matrix resulting in patches of secondary vegetation of different ages and sizes. Careful maintenance of late-seral species may allow such patches to develop the more open understory architecture exhibited by a mature forest (Allen et al, 2003) with greater use by insects and birds (Rotenberg et al, unpublished data).

Often overlooked, small scale community reserves exist throughout the Peninsula, Jiménez-Osornio and colleagues (2004) identified six communities in the state of Yucatan that have community reserves. In the municipality of Calakmul, Campeche, four out of five communities involved in an agroforestry project identified ownership of community reserves (Rorive, 2006). Reserve size and purpose varies from community to community, requiring that additional social and biological studies be made with regard to the structure and purpose of these reserves. The total area in these small-scale reserves is substantial and they together with the extant *ejidal* lands may plausibly serve as corridors between the larger reserves. The challenge is to improve the biological functionality of these small individual reserves, and creating a system that promotes them at biological, socio-economic and political levels.

If reserve connectivity is designed in a scale-free pattern that might allow for random acquisitions of reserves, an optimal system of connectivity will be created when the large reserves (hubs) will have multiple connections with various small reserves (nodes) (Figure 16.2). Increasingly, research has shown that highly stable systems, such as the organization of metabolic networks, the internet, and food webs are distributed in scale-free networks. These patterns appear to have greater resilience to perturbation than randomly-derived connections (Albert and Barabasi, 2002; Barabási and Bonabeau, 2003).

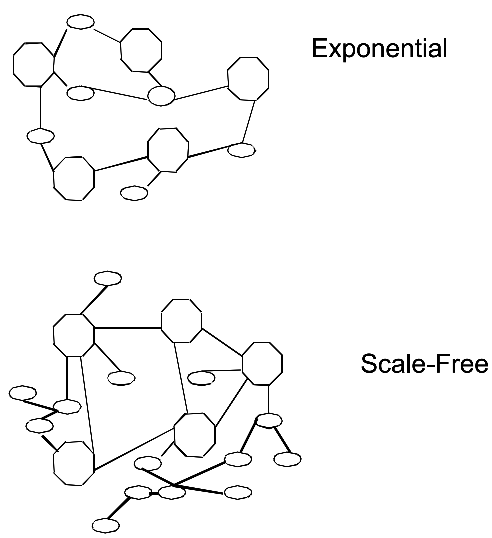

Figure 16.2. Structure of networks of large and small reserves showing a randomly-derived suite of connections forming an exponential decay for the number of links versus the scale-free network with no defined peak in the number of links. The scale-free model has been shown to be more stable and appears characteristic of many biological systems.

Ultimately, biodiversity is influenced by the structure and function of the existing landscape as well as by restoration and conservation activities (e.g., establishment of nature reserves, restauration of degraded areas), and agriculture and forestry practices (Figure 16.3). The positive contributions of restoration/conservation and agriculture/silviculture on biodiversity can be amplified by their indirect effects as mediated by their spatial arrangement within the landscape . Biodiversity can be enhanced when any of these activities at smaller scales can be placed so as to maintain or enhance connectivity among natural areas over larger scales, so as to minimize native habitat fragmentation. It is important to recognize, however, that these activities are conducted by people in landscapes inhabited by people. For any large-scale biodiversity maintenance program to be successful, it must include participation by those who are affected. Although these people are frequently called "stakeholders", in many cases they are ignored in the planning and decision-making. Critical to their participation is understanding the socio-economic factors that drive decision processes, from the local (e.g., what does a local farmer consider when deciding where to locate a milpa) to the regional scale (e.g., what might the ecotourism benefits be from selecting among alternate reserve designs). Understanding the socio-economic underpinning of restoration/conservation and agriculture/silviculture provides insight into how to manipulate incentives to optimize both biodiversity and individual and local economic well-being.

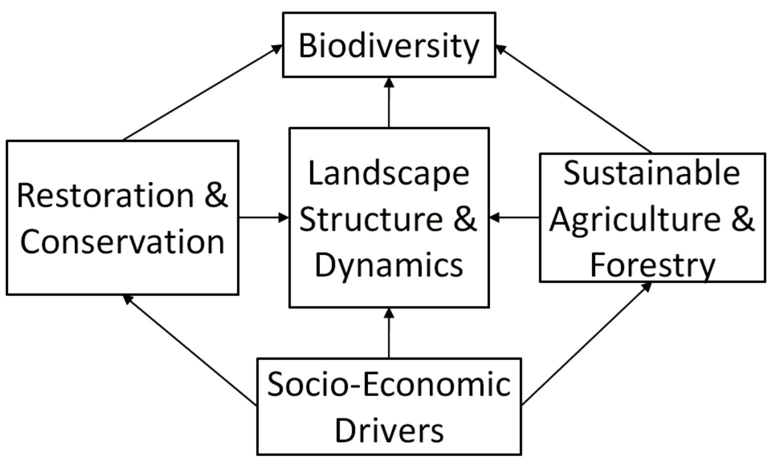

Figure 16.3. Relationships among research foci

These interrelationships imply that a research program that emphasizes only one or two components is unlikely to be fully successful. The challenge, of course, even in an integrated approach such as this is in the development of understanding of the mechanisms that drive these connections; in other words: what do the arrows connecting the boxes in Figure 16.3 actually mean?

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