Towards an ecological restoration network: reversing land degradation in Latin America

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Latin America (including Mexico and Central and South America) hosts a substantial proportion of global biodiversity, but suffers from increasing rates of deforestation, land degradation, and dryland expansion. Low-cost modification of local management practices integrating ecological restoration could play a major role in abating ecosystem degradation and biodiversity loss. A regional ecological restoration network would identify the major challenges, both practical and intellectual, and generate protocols for assisting land managers and stakeholders through shared databases and experience. Such a network would enhance the critical mass of practitioners working under similar, though diverse social, cultural, and ecological contexts.

Una proporción sustancial de la biodiversidad mundial se encuentra en América Latina (la cual incluye a México, Centro y Sudamérica); sin embargo, esta región sufre de tasas crecientes de deforestación, degradación del suelo y expansión de las zonas áridas. Algunas prácticas locales de manejo, con modificaciones de bajo costo que integren la restauración ecológica, podrían jugar un papel muy importante en el abatimiento de la degradación de los ecosistemas y en la reducción de la biodiversidad. Una red de restauración ecológica regional identificaría los principales retos, tanto prácticos como intelectuales, y generaría los protocolos para auxiliar a los administradores y los dueños de terreno a través de experiencias y bases de datos compartidas. Esta red incrementaría la masa crítica de investigadores que trabajan en contextos sociales, históricos y ecológicos similares.

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Opportunities for ecological restoration and rehabilitation of degraded ecosystems in the Americas are likely to multiply in the coming decades. Ecological restoration experiments will become increasingly valuable and necessary under several projected scenarios: abandonment of production systems associated with rural–urban migration and economic globalization, gradual improvement of environmental standards for land management in many Latin American countries, and an increasing willingness on the part of managers of large-scale industrial projects to invest in mitigation or reduction of environmental impacts and rehabilitation of damaged ecosystems. What are the main theoretical and practical challenges and opportunities that lie ahead? Are ecologists in the Americas ready to take advantage of these prospects and engage in restoration practices through close collaboration with professionals from a wide range of social and environmental fields (Figure 1)? These questions stimulated the workshop that formed the foundation for this article. During the workshop, we addressed the challenges and opportunities for advancing the science and practice of restoration in the Latin Americas, reviewed existing knowledge networks in the field of restoration ecology, and identified future research and collaboration needs. This article summarizes the major conclusions.

Workshop: Towards an ecological restoration network for the Americas

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What are the major challenges?

Current socioeconomic conditions and historical land-use patterns in Latin America present an important challenge to restoration ecologists, with direct implications for both the theory and practice of the discipline. First, the economic situations of most Latin American countries necessitate placing strict limits on the costs of planning and executing restoration projects. These costs can be greatly reduced through knowledge and application of theory on alternate stable states, a subject that has gained

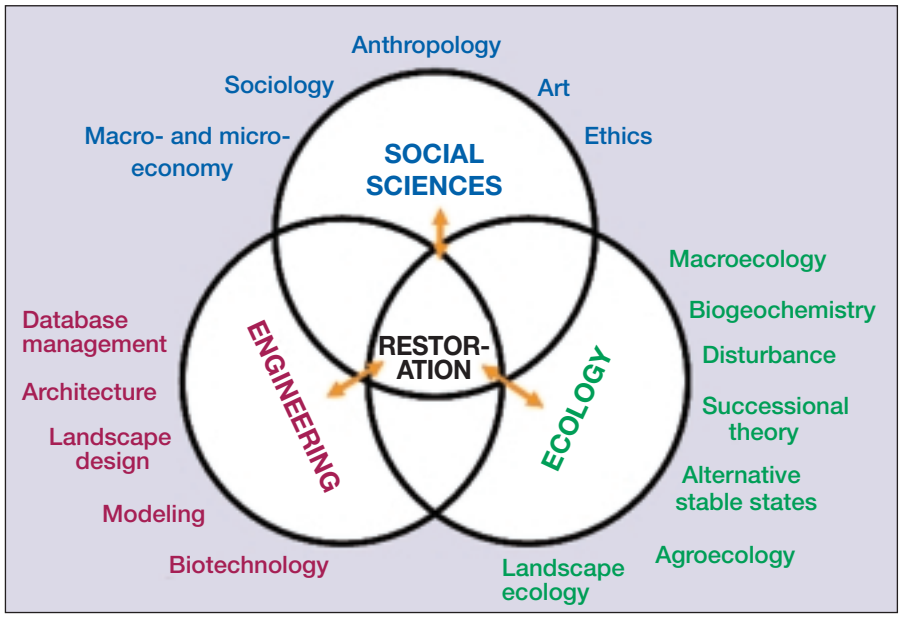


Figure 1. *Main disciplines associated with the theory and practice of restoration ecology. Ecological restoration projects must involve proactive dialogue with local people, social scientists, engineers, and other professionals. Restoration ecology provides opportunities to link environmental science, technology, and engineering within a socially relevant context.*

increasing attention in the literature on restoration ecology (Suding *et al.* 2004). Understanding the physical and biological constraints on transitions between alternative ecosystem states is critical for identifying the timing and types of manipulations that are most cost effective in promoting ecosystem change. In Latin America, different cultures and forms of land use still coexist within a landscape mosaic that often includes remnants of the original habitat. Therefore, various return pathways to the reference or desired state conditions can be used without labor-intensive or costly manipulations (Figure 2). The difficult part is to learn more about the natural pathways of ecosystem recovery and to design low-cost manipulations that may enhance the process at the landscape level.

Maximizing participation of local communities in the definition of restoration targets and actions was considered essential by the workshop participants. This goal requires better public understanding of the values and approaches of ecological restoration. This can be achieved through effective and informal ecological education programs, addressing the general public, landowners, and land managers, and using simple language suitable to each local culture. Knowledge generated by a working group on indigenous peoples' restoration, recently formed within the Society for Ecological Restoration (SER), can provide valuable insights and will help to develop a successful dialogue with local communities. Active involvement of local people in restoration projects improves planning, species selection, long-term target definitions, and monitoring of experiences. The case of the Ayuquila River in Mexico provides a good example. During restoration of the riparian habitats of the river, farmers provided input on land-use protocols and restoration practices, as well as examples of habitat restoration monitored on the farms. However, new partnerships involving both academic institutions and stakeholders will be necessary for planning and monitoring restoration experiments over long periods.

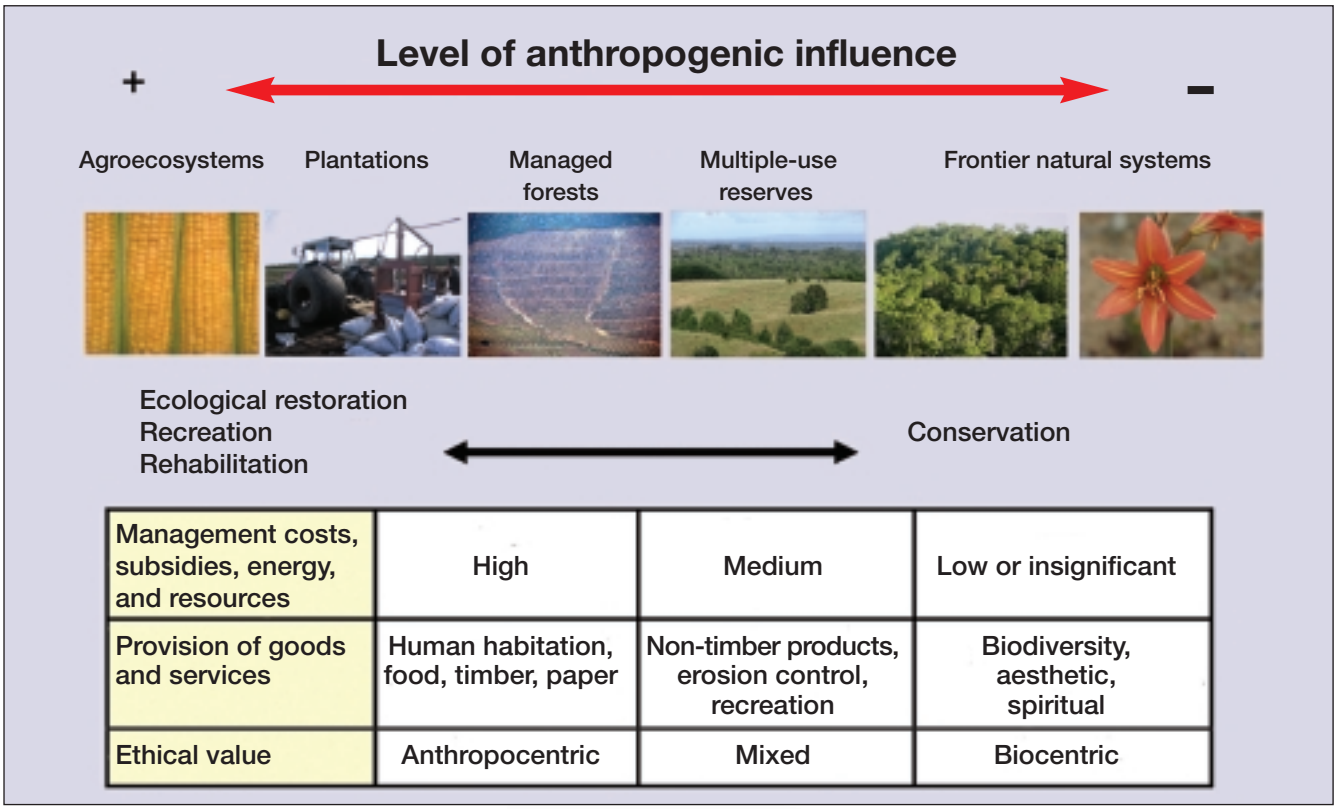
Improving standards for the design, implementation, and monitoring of long-term restoration experiments is another important hurdle. A number of examples exist of ineffectively designed and consequently unsuccessful restoration experiments, arising from limited understanding of the system being restored; these led to economic losses and local disappointment. In this context, new graduate programs at Latin American universities, such as the Restoration Ecology Master's program at Universidad Nacional Autónoma de México (UNAM) will be critical for improving the design and analysis of field experiments.

The absence of shared protocols for assessing restoration experiences across a variety of ecosystems and cultural settings currently limits the value of the large databases available to international network members. The objectives of ecological restoration have broadened to include multiple goals. These include the achievement and sharing of relevant socioeconomic benefits, the provision of ecosystem services (eg water quality, recreation values), and the improvement of wildlife habitat, rather than just the production of wood and protection of soil. New evaluation schemes must reflect these complex goals and are an important challenge for restoration ecologists. The experiences of the ReAction network in developing a common framework to assess Mediterranean restoration projects (see below) provide a foundation upon which to build the necessary set of protocols for cross-system assessment of restoration success.

Finally, restoration ecology intersects with a number of social, environmental, and technical disciplines (Figure 1), and achieving the necessary combination of expertise is important for the success of any restoration project. A network that integrates ecologists, social scientists, landscape designers, resource managers, and environmental engineers can provide the cross-disciplinary knowledge necessary to overcome the multiple ecological, social, and economic constraints associated with land restoration (Holl *et al.* 2003).

Why an ecological restoration network for Latin America?

Research in Latin America takes place in contexts that are radically different from those in Europe and some



Management costs, subsidies, energy, and resources	High	Medium	Low or insignificant
Provision of goods and services	Human habitation, food, timber, paper	Non-timber products, erosion control, recreation	Biodiversity, aesthetic, spiritual
Ethical value	Anthropocentric	Mixed	Biocentric

Figure 2. *Ecological restoration opens opportunities for flexible land-use strategies that maximize the provision and sharing of ecosystem goods and services at minimum cost, while allowing transitions between system states within a given landscape. The ecological and cultural setting of Latin America, dominated by mixed-use rural landscapes that contain fragments of the original habitat, should facilitate the use of passive restoration strategies, with limited manipulation of natural succession as a cost-effective way to achieve the desired system changes.*

parts of North America (ie the social and economic conditions, the degree of anthropogenic land transformation, common persistence of remnant habitats that can serve as sources of species and reference points in the landscape). Practitioners and researchers from the region are conspicuously absent from, or underrepresented in, the SER (see below) and other international societies. We propose that a network of Latin American restoration ecologists should: (1) promote communication among scientists and other professionals working on restoration, rehabilitation, or reforestation projects within the region; (2) convey to network members the knowledge and expertise gained in the continents' wide diversity of terrestrial and aquatic ecosystems; (3) stimulate innovative thinking and conceptual advances in restoration science to face the challenge of particular cultural and ecological scenarios within Latin America; (4) foster local capacity-building and education of the general public in restoration science; and (5) stimulate the transfer of technical knowledge to government authorities in charge of land planning. Networking to advance the theory and practice of restoration ecology has a number of advantages. A community of restoration ecologists working in Latin America could build upon the experiences of other individuals and organizations.

At the workshop, Susana Bautista provided information on ReAction, a network which has carried out a series of restoration activities to combat desertification in the northern Mediterranean. The objective of ReAction is to build an open-access, standardized database of evaluated experiences and a directory of practitioners. ReAction allows scientists to share high-quality information through the database, as well as to establish common ground for project evaluation, technological transfer, and capacity-building. An international advisory panel of experts interacts with local organizations of researchers, environmental managers, and landowners.

George Gann provided information on the International Society for Ecological Restoration (SER), the largest such organization in the world, and discussed their experiences in strengthening ties among the 2000 members from 50 countries. Although 90% of SER members are from the US and Canada, the Society's objectives are to promote ecological restoration globally, through the organization of conferences, publications, and the education of its members and the public.

Finally, Fabiola López introduced the recently created Mexican Environmental Restoration Network (REPARA). REPARA's first priorities are to discuss the methods and conceptual framework of restoration, to define geographical priorities for restoration programs, and to ensure long-term financial support to restoration

projects. During its first year, REPARA recruited 110 members from 53 institutions and environmental NGOs throughout Mexico.

Opportunities and prospects

The ecological and cultural diversity of Latin America provides opportunities to generate novel land-use frameworks and experimental protocols for ecological restoration. Extensive portions of North, Central, and South America remain rural or undisrupted by large-scale human impacts, in contrast to extensive regions of Europe and Asia, which, for centuries, have been intensively managed or transformed for industrial food or timber production. Given the elusive nature of restoration targets, the definition of desired system states is a social as well as a scientific endeavor. In this context, Latin American cultures are still much more closely tied to the land than are most people in northern, temperate regions. Preserving the local knowledge and traditional land-use modes of rural and indigenous people provides opportunities for restorative management of degraded land and alternatives to dominant land-use patterns based on intensive forestry and agriculture.

The mosaic of agricultural and forestry systems and the scattered remnants of original habitat that still cover much of the landscape in Latin America facilitate the definition of restoration targets and allow the application of restoration strategies based primarily on enhancing natural succession (Figure 2). However, in highly degraded areas that lack isolated habitat remnants, restoration strategies may require active implementation of techniques that imitate succession. In such cases, information about physical and biological barriers to restoration is extremely important and the costs of restoration may be high. Designing rural landscapes for multiple and interchangeable land uses, including sustaining production, provision of ecosystem services, and biodiversity conservation, while maximizing future land-use options, represents a challenge for restoration scientists in Latin America (Dobson *et al.* 1997; Foley *et al.* 2005; Mattison and Norris 2005; Polasky *et al.* 2005). As long as management does not irreversibly prevent system state change, land-use strategies should minimize the costs of restoring managed land and maximize benefits from ecosystem services. Understanding the dynamics of alternative stable states in managed systems and developing extensions of this theory to socioecological systems for land-based communities in the Latin Americas is a future research priority.

Restoration ecology presents us with challenges and opportunities which can only be met by practitioners willing to collectively strengthen the theory and application of restoration science within the cultural, political, and biological contexts that exist in Latin America. Through this workshop, we hoped to motivate the Latin American scientific community to become involved in this endeavor. Restoration ecology must go beyond the traditional preservation of wild ecosystems, to actively involve local people in defining land-use options, understanding system state feedbacks within managed landscapes, and creating novel management scenarios which allow transitions to desired system states at minimum cost and with maximum sharing of benefits (Figure 2). A Latin American restoration network could provide the necessary intellectual stimulus and would contribute to the achievement of a critical mass of restoration scientists. Strengthening restoration science in Latin America would be a key factor in reversing the current regional trends of increasing habitat degradation and biodiversity loss.

References

Dobson AP, Bradshaw AD, and Baker AJM. 1997. Hopes for the future: restoration ecology and conservation biology. *Science* **277**: 515–22.

Foley JA, DeFries R, Asner GP, *et al.* 2005. Global consequences of land use. *Science* **309**: 570–74.

Holl KD, Crone EE, and Schultz CB. 2003. Landscape restoration: moving from generalities to methodologies. *BioScience* **53**: 491–502.

Mattison EHA and Norris K. 2005. Bridging the gaps between agricultural policy, land-use and biodiversity. *Trends Ecol Evol* **20**: 610–16.

Polasky S, Nelson E, Lonsdoff E, *et al.* 2005. Conserving species in a working landscape: land use with biological and economic objectives. *Ecol Appl* **15**: 1387–1401.

Suding KN, Gross KL, and Houseman GR. 2004. Alternative states and positive feedbacks in restoration ecology. *Trends Ecol Evol* **19**: 46–53.

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