Society for Ecological Restoration International
POLICY POSITION STATEMENT

October 2008

Ecological Restoration as a Tool for Reversing Ecosystem Fragmentation

RATIONALE

Ecosystem fragmentation, along with many other global trends, is causing the natural world to undergo profound changes at all spatial scales, from the micro-habitat to the continental. The widespread and unprecedented human impact upon nature has adversely affected ecosystem health and resilience, biodiversity, and the provision of ecological goods and services that all species depend on (e.g. clean air, fresh water and healthy soils). The Society for Ecological Restoration (SER) International maintains that even with the tremendous pressures that humans presently exert upon our ecosystems, fragmentation is neither inevitable nor irreversible.

Whether it is through the creation of buffer zones, wildlife corridors/habitat, and stepping stone islands of biodiversity, the innovative approaches within a bioregional planning framework, and/or the formulation of grand continental-scale management strategies, reversing ecosystem fragmentation and reinstating connectivity are fundamentally about transforming our approach to land management from one of maximizing short-term resource use to one of optimizing long-term resilience and health while providing socio-economic and cultural survival benefits.

ECOSYSTEM FRAGMENTATION AND ITS EFFECTS

Ecosystem fragmentation occurs when habitats, landscapes, and ecosystems are disconnected by human or non-human determinants, including the short-term, non-sustainable exploitation of renewable or non-renewable natural capital. As a result, contiguous natural areas are broken up into smaller pieces or patches that lead to shrinkage, attrition, and isolation -- all of which can be subsumed under the term fragmentation. This creates discontinuities in ecological processes (e.g. nutrient flows, energy transfers and genetic exchanges) that impede or alter the flow of goods and services to the detriment of ecosystem health and human well-being (Aronson *et al.* 2007). In this statement, restoration planning recognizes a distinction between landscape-level ecological processes or services and the role of fragments in providing suitable habitat for particular species. In this sense, species-specific functions of habitats are not necessarily the functional equivalent of ecosystems or landscapes.

Fragmentation can best be understood as a continuum with intact or pristine ecosystems at one end, variegated or fragmented habitats in the middle, and relictual landscapes at the other end (McIntyre & Hobbs 1999, Lindenmayer & Fischer 2006). Intact ecosystems are precious not only due to their structure as forests or wetlands but also because of their functionality -- that is their ability to sustain the healthy and resilient species populations that coevolved within as well as the health and resilience of human communities that depend on them for survival. Perhaps the most important feature of an intact ecosystem is connectivity at multiple spatial scales that encourages the dynamic ecological processes upon which all biota rely.

Variegated landscapes are typically characterized by both gradual and abrupt boundaries between native and non-native vegetation, and often times the dissection and utilization of only one or two components, such as a forest that is managed for timber production, grasslands transformed for livestock grazing, or arid lands that are stripped for metals and minerals. In general, some degree of connectivity survives and these modified ecosystems can continue to exist without the full disruption or complete loss of structure, function, and composition. Fragmented landscapes are characterized by more abrupt boundaries between native and non-native vegetation and are typically found in areas developed for agriculture or production forestry, where remnants of native vegetation abut land which is usually cleared and cultivated or planted with non-native tree species.

Relictual ecosystems occur most often when humans replace complex intact ecosystems with simplified linear ones, as is the case with industrial agricultural production systems where forests are clear-cut, grasslands tilled, and wetlands drained. The transformation of a healthy forest into a monoculture for timber or the delineation of grasslands for livestock grazing often leaves only isolated historical remnants of native vegetation. Relictual landscapes also result from urban or suburban development and the ecologically degrading practices of extractive industries, like strip-mining and the harvesting of oil sands. With little or no connectivity among small patches scattered across the landscape, these ecosystems are no longer able to provide the goods and services necessary to support prior levels of biodiversity.

Even seemingly innocuous linear barriers to connectivity (e.g. fences, power lines, roads, and canals) can sometimes significantly impact biota and even reduce biodiversity by disrupting essential ecological processes. As a result, they can have cascading effects, such as secondary extinctions and facilitating the spread of invasive non-native species, which affect the developmental trajectory of ecosystems. For example, the loss of dispersal and migration opportunities in some species can result in a weaker gene pool, and thereby a less healthy and resilient population, through ruptures in metapopulation dynamics. On the other hand, badly planned or implemented corridor restoration can facilitate the spread of invasives, disease and fire (e.g. the provision of nutrient rich soils in roadside vegetation schemes that makes possible the spread of invasive plant species). Connectivity does not equal "corridors" but relates to the overall characteristics of the landscape matrix which facilitate or hinder movement of organisms. Hence, the goal of corridor restoration is to provide the opportunity for native biota to move as necessary but, at the same time, limit the potential for negative effects from invasives, diseases, etc.

The effects of ecosystem fragmentation often linger and expand, much like a ripple in a pond. One way this can happen is when ecosystem fragmentation introduces edge effects that occur along the margins of natural areas. These edge effects include the seepage of deleterious transformations in ecological processes from the boundary deep into the interior of remnant patches causing a further erosion in biodiversity which affects different species at different depths of penetration. Furthermore, fragmentation can result in regime shifts when the loss of dominant or keystone species fundamentally alters ecosystem structure, function, and composition as has been the case with wide-ranging predators and migrating herds.

The provisioning, regulating and cultural services provided by healthy and robust ecosystems are critical to the sustainability of life on earth. Global concerns over how to achieve food and water security; ensure good air and soil quality; protect and conserve biodiversity; and produce sufficient energy to meet our growing demands demonstrate how rapidly and profoundly some human cultures have impoverished the earth and how seriously we need to address these changes and redirect our current trajectory. It is now abundantly clear that ecosystem degradation and fragmentation is the primary reason we find ourselves at this critical juncture.

ECOLOGICAL RESTORATION PLANNING AND MANAGEMENT

The science and practice of ecological restoration provides us with valuable insights into reversing ecosystem fragmentation and reestablishing habitat, landscape, and ecosystem connectivity. SER International defines ecological restoration as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" and that "an ecosystem has recovered – and is restored – when it contains sufficient biotic and abiotic resources to continue its development without further assistance or subsidy" (SER 2004).

The preeminent objective of ecological restoration is for humans to assist with the self-regeneration of healthy, self-sustaining, and resilient ecosystems that have some degree of landscape connectivity. "Connectivity relates to the ability of species and ecological resources and processes to move through landscapes, not only in the terrestrial domain, but also in aquatic systems and between the two" (Lindenmayer et al. 2008). Fundamental to this perspective is the understanding that "ecological restoration can be conducted at a wide variety of scales, but in practice all ecosystem restoration should be approached with a spatially explicit landscape perspective, in order to ensure the suitability of flows, interactions and exchanges with contiguous ecosystems" (SER 2004).

SER International advocates the integration of restoration projects, regardless of size, into regional and transnational landscape planning so as to protect biodiversity, increase connectivity, prevent further habitat loss, and foster sustainable development. To that end, restoration projects have been proven to make an important contribution to the establishment of core habitat areas, buffer zones, wildlife corridors, stepping stone habitats, biosphere reserves and similar protected areas, and in addition can improve the overall value of the surrounding landscape in terms of habitat quality or dispersal opportunities.

Ecological Restoration Planning and Management strategies include, but are not limited to: (1) the expansion and restoration of core protected habitats, within an ecosystem approach (see SER 2008), in order to maintain the diversity and resilience of native plants and animals, (2) the elimination of landscape discontinuities so as to reduce edge effects where ecologically appropriate and provide habitat, dispersal, and migration opportunities for as many species as possible, (3) the restoration of buffer or transitional zones in critical or sensitive areas such as agricultural lands and riparian ecosystems, (4) the restoration of wildlife corridors and stepping stone habitats to ensure adequate flows within the landscape matrix, and (5) the prevention of further habitat loss (Fischer & Lindenmayer 2007).

As urban expansion and suburban sprawl are expected to continue unabated, developers and local authorities are encouraged to adopt Ecological Restoration Planning and Management strategies to limit the adverse effects of ecosystem fragmentation. One example is the Sonoran Desert Conservation Plan in Pima County, Arizona which promotes large working reserves around the Tucson metropolitan area that allow for sustainable development while conserving and restoring critical landscape linkages. There are now 56 vulnerable species covered in the Pima County plan which combines wildlife conservation with wetland and riparian restoration, cultural and historical preservation, and the creation of natural corridors to link protected areas (http://www.pima.gov/CMO/SDCP/).

Ecological Restoration Planning and Management strategies, when applied to current and former forest, agricultural, and grazing lands, have the unique capability to restore small patches that can serve as important buffers or recolonizing refugia within relatively intact ecosystems or even link previously disconnected habitats. In conjunction with ecological farming techniques, restoration projects can help reinstate vital processes that have historically been excluded through the use of fertilizers, pesticides/herbicides, and other modern industrial farming practices. The relatively new agroecology movement and longstanding indigenous fallow (swidden) farming and horticulture traditions embody a more integrated, holistic and organic approach to the growing of food -- employing multi-cultures and short-cropping/long-fallow field rotations, cover crops and other organic inputs that encourage native insect and soil microorganism populations. These strategies incorporate proven methods and techniques for targeted restoration work that supports and reinforces connectivity, functionality, and resilience while diminishing the negative effects of ecosystem fragmentation.

The abandonment of large farms and ranches in North America, Europe, and Australia offer an excellent opportunity for non-governmental organizations, private donors, and local wildlife/land managers to collaborate on important conservation and restoration goals (see Gondwana Link below). Similarly, new opportunities for industry or corporate-financed projects and other public-private partnerships are emerging as the need for landscape restoration gains prominence. In the southwestern United States, two statewide plans have been built around ecological restoration principles: the New Mexico Forest and Watershed Health Plan and the Statewide Strategy for Restoring Arizona's Forests.

Gondwana Link
Restoring Connectivity in the Australian Landscape

Gondwana Link, in southwestern Australia, is an ambitious project to reconnect and restore a 1,000 kilometer corridor (25 million hectares) of native ecosystems from the coastal forests to the edge of the central desert. In this biodiversity hotspot, a number of non-governmental organizations and private donors are working together to restore landscape resilience and the ecological processes that support the functionality of these linkages. This visionary approach also includes participation by indigenous communities and a recognition of the importance of the culture/nature relationships within so-called socio- ecological systems.

One of the more successful strategies for restoring landscape connectivity is the purchase of large farms and ranches (primarily wheat and sheep) that are no longer profitable in order to revegetate them with native species. These acquisitions offer a great opportunity for the creation of wildlife habitats. This is the case with one former ranch which, once restored, will form part of an important linkage between two of the largest protected areas in the region, the Fitzgerald River and Stirling Range National Parks. Recognizing the need to not only restore bushland but reestablish livelihoods and sustainable communities, certain commercial tree and plant species, such as sandalwood, are being cultivated.

http://www.gondwanalink.org/

RECOMMENDATIONS FOR LAND MANAGERS AND POLICYMAKERS

Ecosystem fragmentation is virtually complete in many parts of the world where patch sizes are extremely small and relictual landscapes cannot be further dissected. It is only in those regions or countries with large tracts of intact ecosystems or wilderness that fragmentation poses a serious problem or better yet a great opportunity for preserving or restoring connectivity and resilience.

Ecological Restoration Planning and Management strategies can be used at any scale but must continuously strive to be implemented at successively larger scales (SER 2004). In order to more effectively deal with ecosystem fragmentation, public and private land managers are encouraged to adopt those restoration strategies that can be integrated within a bioregional mosaic. A bioregional approach is one that integrates Ecological Restoration Planning and Management strategies with biological conservation and sustainable human development at broad spatial scales, such as watersheds, bioregions and other large contiguous geographical areas. This approach represents perhaps the most appropriate landscape-scale framework in which we can seriously begin to address the problems of ecosystem fragmentation.

It is important to understand the dynamics of bioregions, and how habitats and ecosystems are nested within the landscape in order for them to be properly restored, reintegrated, and reconnected. Some key issues that land managers and policymakers need to consider when implementing Ecological Restoration Planning and Management strategies are: (1) the establishment of long-term goals with landscape classifications, target species, and quantifiable benchmarks appropriate to the restoration objectives, (2) the management of the entire landscape matrix including both species and ecosystems at multiple spatial and temporal scales, (3) the rigorous use of adaptive management guidelines that take into account unforeseen events and areas of potential concern, (4) the use of experimentation in order to diversify the risks associated with homogenous restoration practices, and (5) the integration of aquatic and terrestrial habitats (Lindenmayer *et al.* 2008).

GIS vegetation mapping or simulation modeling alone is often insufficient for the development and implementation of restoration projects. It is critical that we endeavor to gain a better understanding of specific habitat-species relationships, dispersal-modes of specific species, and the interrelationships between matrices and patches. This may help us avoid anthropomorphic projections onto vegetation configurations that could be very different from a species perspective -- which may be altogether different with respect to suitable habitat.

Finally, and most importantly, a bioregional approach to reducing ecosystem fragmentation will require the adoption of cooperative resource management policies that involve all stakeholders in the decision-making process (e.g. indigenous peoples, local authorities, government agencies, policymakers, corporations, private landowners, etc.). A sense of community ownership and responsibility as well as the fostering of public-private partnerships are essential components of a successful bioregional approach as is regional and transnational communication, cooperation, and coordination with regard to its planning, implementation, and monitoring.

Parks Canada: Ecological Restoration in Protected Areas

SER International actively supports the adoption of standards outlined in the *Principles and Guidelines for Ecological Restoration in Canada's Protected Natural Areas*. The Parks Canada approach states that "ecological restoration contributes to the conservation objectives of protected areas management by ensuring these areas continue to safeguard biodiversity and natural capital and provide ecosystem services into the future. It strives to improve the biological diversity of degraded landscapes, increase the populations and distribution of rare and threatened species, enhance landscape connectivity, increase the availability of environmental goods and services, and contribute to the improvement of human well-being" (Parks Canada 2008). Also important is the development of restoration partnerships between Parks Canada and First Nations and Aboriginal peoples.

"Identifying elements that favour ecosystem connectivity such as: increase protected area size; establish buffers and easements; reduce habitat fragmentation; provide migration corridors; conserve sources of propagules and colonists; conserve refugia for sedentary species; reduce edge effects; and increase opportunities for adaptation of protected area ecosystems to large-scale disturbances such as climate change." (Parks Canada 2008) The Parks Canada approach also states that "ecological restoration is as much a process as it is a product. The actions of restoring an ecosystem bring people together, often in significant ways that lead to a renewed engagement between people and ecological processes" (Gann & Lamb 2006). These participatory and cooperative land management strategies are important components of a multi-scaled approach to halting and reversing ecosystem fragmentation.

http://www.pc.gc.ca/docs/pc/guide/resteco/guide_e.pdf

REFERENCES

Aronson, J., S. J. Milton, and J. Blignaut (Eds.) 2007. Restoring Natural Capital: Science, Business and Practice. Island Press, Washington, D.C.

Fischer, J. and D. B. Lindenmayer. 2007. Landscape modification and habitat fragmentation: a synthesis. Global Ecology and Biogeography **16**: 265-280.

Gann, G. D. and D. Lamb (Eds.) 2006. Ecological restoration: A mean of conserving biodiversity and sustaining livelihoods (version 1.1). Society for Ecological Restoration International, Tucson, Arizona, USA and IUCN, Gland, Switzerland. http://www.ser.org/content/Globalrationale.asp

Lindenmayer, D. B. and J. Fischer. 2006. Habitat Fragmentation and Landscape Change: An Ecological and Conservation Synthesis. Island Press, Washington, DC.

Lindenmayer, D., R.J. Hobbs, R. Montague-Drake, J. Alexandra, A. Bennett, M. Burgman, P. Cale, A. Calhoun, V. Cramer, P. Cullen, D. Driscoll, L. Fahrig, J. Fischer, J. Franklin, Y. Haila, M. Hunter, P. Gibbons, S. Lake, G. Luck, C. MacGregor, S. McIntyre, R. MacNally, A. Manning, J. Miller, H. Mooney, R. Noss, H. Possingham, D. Saunders, F. Schmiegelow, M. Scott, D. Simberloff, T. Sisk, G. Tabor, B. Walker, J. Wiens, J. Woinarski, and E. Zavaleta. 2008. A checklist for ecological management of landscapes for conservation. Ecology Letters **11**:78–91.

McIntyre, S. and R. J. Hobbs. 1999. A Framework for Conceptualizing Human Effects on Landscapes and Its Relevance to Management and Research Models. Conservation Biology **13**:1282-1292.

MA (Millennium Ecosystem Assessment). 2005. Ecosystems and human well-being: synthesis. Island Press, Washington D.C. and Covelo, CA.

Parks Canada and the Canadian Parks Council. 2008. Principles and Guidelines for Ecological Restoration in Canada's Protected Natural Areas. Prepared by National Parks Directorate, Parks Canada Agency. Gatineau, Quebec. http://www.pc.gc.ca/docs/pc/guide/resteco/guide_e.pdf

Society for Ecological Restoration International Science & Policy Working Group. 2004. The SER International Primer on Ecological Restoration. www.ser.org & Tucson: Society for Ecological Restoration International. http://www.ser.org/pdf/primer3.pdf

Society for Ecological Restoration International Science & Policy Working Group. 2008. Opportunities for Integrating Ecological Restoration & Biological Conservation within the Ecosystem Approach. www.ser.org & Tucson: Society for Ecological Restoration International. https://www.ser.org/pdf/SER_Briefing_Note_May_2008.pdf

SOCIETY FOR ECOLOGICAL RESTORATION INTERNATIONAL

SER International is a non-profit organization infused with the energy of involved members -- individuals and organizations actively engaged in ecologically sensitive repair and management of ecosystems. Our mission is to promote ecological restoration as a means of sustaining the diversity of life on Earth and reestablishing an ecologically healthy relationship between nature and culture. The SER International Science & Policy Working Group promotes excellence in research and contributes to the policy dialogue on ecological restoration as a conservation tool. The Working Group is composed of:

Jim Harris (Chair)
Chair in Environmental Technology
Cranfield University

Sasha Alexander (Secretary)
Project Director
Society for Ecological Restoration International

George Gann
Executive Director
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Keith Bowers
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