Restoration Ecology

New Perspectives and Opportunities for Forestry

Courtesy of NASA

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ABSTRACT

Ecological restoration and restoration ecology have emerged as an allied practice and scientific discipline in land management. Here, we discuss the relationship between restoration ecology and forestry and the potential for interdisciplinary exchange. We present two case studies illustrating the potential roles of foresters in restoration ecology: (1) a forest restoration project in Redwood National Park, California, and (2) a project to restore northern hardwood forest structure in Minnesota. We conclude that restoration ecology can add conceptual breadth, research and management tools, and employment opportunities to the field of forestry.

Keywords: conservation; ecological restoration; forest health

By the time a conservation ethic emerged in the mid-20th century, large portions of the earth's surface had been degraded through exploitation or inattention (Vitousek 1994; Frelich and Puettmann 1999). Still more damage followed from well-intentioned but misguided management practices, such as the introduction of exotic species for erosion control (e.g., kudzu), extensive fire suppression, clearing of large woody debris from streams, and the removal of native predators. Forested landscapes have not escaped impact, and legacies of past impacts can be found even in relatively protected areas, such as wilderness areas and national parks (Cole and Landres 1996). Considering these impacts, Aldo Leopold (1953, p. 197) once wrote that ecologists "live alone in a world of wounds." He had a solution: ecological restoration.

Ecological Restoration, Restoration Ecology

Although it is likely that efforts to restore damaged lands are as old as human culture, Aldo Leopold's efforts to restore vegetation and wildlife at his farm in Sand County, Wisconsin, are often cited as the birth of ecological restoration (e.g., Jordan et al. 1987). The efforts of Leopold and his successors to restore a prairie ecosystem at the University of Wisconsin arboretum are among the best examples of the spirit and approach of ecological restoration.

Ecological restoration differs from restoration ecology, just as silviculture differs from forest ecology. *Ecological restoration* is a practice that aspires to use ecological principles but does not fundamentally aim to expand our knowledge of ecosystems. *Restoration ecology,* in contrast, is the science of restoring ecosystems. These two endeavors have different goals, cultures, and relationships to the larger body of science and management.

Ecological restoration has grown exponentially in the past 30 years and is a vibrant and expanding field. Much of the early work was conducted to meet regulatory requirements for mining reclamation and wetlands development. The work was typically limited in scope and designed as mitigation for severe damage. As awareness of sensitive ecosystems like wetlands and riparian areas began to emerge, restoration of these ecosystems became popular. The focus of these projects has been site-specific goals, such as revegetation, bank stabilization, construction or emplacement of habitat structures, and establishment of wetland hydrology. More recently, forest restoration has arisen as a treatment for structural changes associated with fire suppression (Covington et al. 1997). Although most ecological restoration efforts have not had science as a fundamental goal, monitoring and complex evaluations of success have become standard for the best projects. It is notable that the Society for Ecological Restoration supports two scientific journals, *Ecological Restoration,* directed at practitioners, and *Restoration Ecology,* directed toward a scientific audience.

Restoration ecology, which has grown more slowly than ecological restoration, intersects with so many disciplinary specialties and presents such unique methodological and analytical challenges (i.e., unprecedented ecological conditions or species mixtures) that it can be considered only a nascent science at present. These same conditions, however, may provide unparalleled opportunities for testing the accuracy and practicality of ecological theory (Bradshaw 1987). Restoration ecology classes and degree programs are developing in universities nationwide, but for reasons that are not completely clear, restoration ecology has captured the imagination of students and practitioners more readily than it has appealed to established disciplinary faculty. This is gradually changing as the field becomes more integrated with established disciplines, such as forestry, wildlife biology, and range management.

A Symbiotic Relationship?

How could or should restoration ecology integrate into the forestry community? A forester might reasonably ask whether restoration ecology represents something new or is simply a rehashing of existing ideas (see Wagner et al. 2000). More specifically, one might ask how restoration ecology differs from ecologically based forestry practices like prescribed fire, mixed-species plantings, and variable retention harvesting. Where does silviculture end and restoration ecology begin? Are they different approaches on a continuum of management options, or do they represent different spheres entirely?

These are valuable questions. Wagner et al. (2000) argued that ecological restoration should prove its distinctiveness and conceptual and methodological superiority before being incorporated as a dominant management paradigm in forest management. Although that assessment may have implied an overly competitive relationship between restoration ecology and forestry, it raised worthwhile concerns.

There are many practical reasons why restoration ecology should not be viewed as a singular management approach: (1) obviously not all systems are degraded; (2) restoration may not be practical if existing obstacles (e.g., nonnative species, human habitation) cannot be removed; and (3) other objectives may be deemed superior for a given site. There is little risk that restoration ecology will supplant established forestry practices. On the contrary, we believe restoration ecology can provide new opportunities and challenges that will expand and strengthen the field of forestry.

To place restoration ecology in context, some starting points help. First, all systems have natural regenerative processes, and many can recover without human intervention. It soon becomes clear to most restoration ecologists that many natural systems have a tremendous capacity for renewal if the problem causing degradation can be removed. Therefore, restoration is necessary only where natural regenerative processes have been impaired or the site is so degraded that recovery would take a prohibitively long time.

Second, forest management frequently uses techniques similar to those used in restoration, and therefore, restoration and forestry may simply be on the same continuum of management alternatives (Frelich and Puettman 1999). We suggest that the primary distinctions between restoration ecology and forestry lie in aim and scope. Restoration ecology typically places ecological goals ahead of economic goals and poses different questions and treatments than most forest management approaches. Restoration ecology also requires great conceptual breadth. In a degraded forested landscape, a restoration ecologist might be interested in restoring vegetation structure or composition, removing or repairing damaged soils, placing wood on a floodplain, or reintroducing a population of native pollinators.

Consequently, restoration ecology

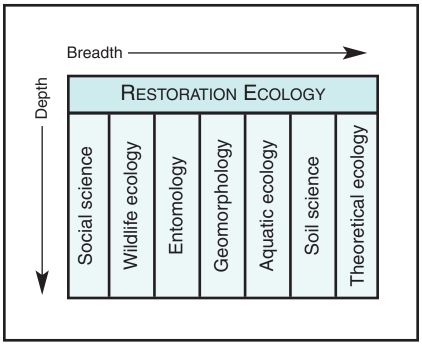


Figure 1. **The relationships between restoration ecology and established disciplines in applied science. Whereas restoration ecology requires a greater conceptual breadth than most disciplines, it requires the depth of detail acquired from the more focused fields.**

must rely on established disciplines for depth *(fig. 1).* The monitoring and assessment goals or hypotheses tested for a given restoration project might draw from silviculture, soil science, engineering, geomorphology, wildlife ecology, or entomology. However, the relationships are more than merely derivative, for restoration ecology often applies disciplinary knowledge in novel ways.

Restoration ecology may certainly benefit from active integration into the forestry community. Time and an entrepreneurial perspective have endowed forestry with an array of mensuration, silvicultural, and analytical techniques that would be expensive to recreate. Moreover, foresters are skilled, action oriented, and accustomed to solving complex problems. In short, they have the potential to be ideal team members for restoration ecology projects.

What does restoration ecology have to offer forestry in return? Foresters may well question whether the fledgling science of restoration ecology can produce results as predictably and economically as established disciplines like silviculture. Wagner et al. (2000), for instance, provided a critique of the potential risks and uncertainties involved with attempting to restore degraded forests to historical conditions. There is little doubt that restoration toward either historical or other reference conditions may be difficult or yield unforeseen results, given effects of climate change, exotic species introductions, and other obstacles. By the very nature

Photos by Leonel Arguello, Redwood National and State Parks

of the ecological problems it must tackle, however, restoration ecology has high potential to add new insights to forestry.

For example, in a study of density reduction effects on old trees in Oregon, Latham and Tappeiner (2002) demonstrated that old-growth (158- to 650-year-old) Douglas-fir (*Pseudotsuga menziesii*), sugar pine *(Pinus lambertiana)*, and ponderosa pine *(Pinus ponderosa)* can respond strongly in diameter growth. Their results call into question the long-held notion that old trees are decadent, and they have important implications both for the physiology of tree aging and for silvicultural practices in forests with old-growth trees.

Foresters may also wonder whether restoration ecology projects that generate little or no revenue will be implemented and maintained over large acreages of forestland. The many ways restoration could be financed are beyond the scope of this essay, but here we propose that integration of restoration ecology subprojects or objectives into forest management plans may both generate income and engage foresters in efforts to restore ecosystems. The Manitou Project described below is an example of such an integration.

We believe that restoration ecology has a potentially important role in employing the practical and conceptual skills of foresters and forest ecologists in new and exciting projects and partnerships. Such projects are springing up around the country. In the following section, we present two case studies that illustrate the role of foresters in restoration ecology.

Case Study 1

Restoration Forestry in Redwood National and State Parks

Redwood National and State parks contain the largest remaining contiguous stands of ancient coast redwood

Left: **(top) Overstocked stand of young Douglas-fir in Redwood National and State parks, northern California; (middle) experimentally thinned Douglas-fir stand with redwood regeneration evident; (bottom) target structure in an old-growth redwood forest nearby.**

(Sequoia sempervirens) in the world, with individual trees exceeding 100 meters in height. These stands of massive trees inspired the founding of Redwood National Park and the recognition of the coastal redwood region as a global biosphere preserve. Although the ancient trees along Redwood Creek are among the oldest trees in the Pacific Northwest, extensive sedimentation in the lower basin following winter rains in the basin headwaters suggested that even these primeval giants were vulnerable to human impacts. A history of clearcutting and road building in the upper Redwood Creek Basin was believed responsible for much of the watershed instability.

In 1978, legislation was enacted to purchase some land in the upper basin and encourage partnerships for watershed restoration throughout the basin. As a consequence, the park acquired thousands of acres of cutover redwood that had been converted to second-growth Douglas-fir. Many of the park's young second-growth forests are extremely dense (>2,000 stems per acre), single-canopy stands of Douglas-fir with low understory light, a shortage of large woody debris, and limited regeneration of tree seedlings and understory shrubs.

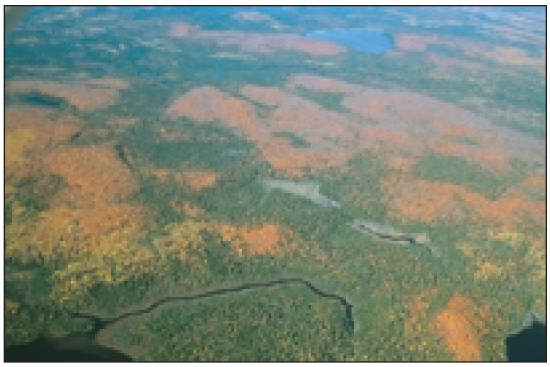
Although the park desires to restore and protect healthy, natural stands of redwoods, existing stands lack the structural and compositional diversity of native forests. The current age and size structures suggest that natural development of these attributes may take many years. Redwood National and State parks staff are drafting a bold plan to accelerate the development of late-seral redwood forest habitats and characteristics through restoration silviculture. Ecological restoration treatments will target stands where densities are exceptionally high or where redwood is poorly represented. Park staff envision variable thinning, underplanting with appropriate tree species (redwood or other native species), coarse woody debris augmentation, cavity tree creation, and exotic tree removal as possible techniques to address current imbalances in structure and composition.

Experimental thinning efforts in the park have led to substantial increases in natural redwood regeneration, suggesting these efforts may be valuable for starting the recovery of structural and compositional diversity. The parks recently hired a student forester to help develop, implement, and monitor its forest restoration plans. This restoration ecology project will complement ongoing watershed and oak savanna restoration efforts and yield greater insight into the developmental dynamics of a globally significant forest ecosystem.

Case Study 2
Using Silviculture to Restore Structure and Timber Quality in Northern Hardwood Forests

In northeastern Minnesota, northern hardwood forests of sugar maple *(Acer saccharum)* and yellow birch *(Betula alleghaniensis)* are characteristic of the north shore highlands ecological subsection. Driven by gap-phase dynamics, historically up to 85 percent of all northern hardwood forests in the subsection were uneven-aged stands more than 150 years old (Brown and White 2002). Recent analyses of forest inventory data show that many areas of northern hardwoods in the Manitou forest landscape (about 100,000 acres) are younger forests created by past harvesting. Several landowners in the area, including the Nature Conservancy, Lake County, and the Minnesota Department of Natural Resources, have formed a collaborative group to explore the potential of using silviculture to restore ecological attributes and timber quality in northern hardwoods. Many studies have addressed biodiversity implications of structural differences between old-growth and second-growth northern hardwood forests. However, the application of this information to designing silvicultural systems that are guided by the ecosystem's natural disturbance regime has not been adequately tested.

The University of Minnesota's Department of Forest Resources is working closely with the Manitou collaborative to implement silvicultural treatments designed to restore forest structural characteristics typical of mature forest. Prescriptions will be based on the target structure (e.g., gap characteristics and large woody debris) typical of older, multiaged northern hardwood forests. Before-and-after comparisons will be made in stands receiving gap-based treatments with those in which diameter-class distributions are manipulated. All treated stands will be compared with adjacent second-growth, even-aged control stands as well as with old-growth forests. Each treatment will be replicated six times. In addition to providing ecological benefits, the treatments are expected to improve the quality and value of forest products generated by this landscape over the long term.



Tom Duffus, The Nature Conservancy

In this aerial view of Manitou Forest landscape, Lake County, northeastern Minnesota, the northern hardwoods appear in orange.

The Manitou Project is funded in part under the Coastal Zone Management Act by NOAA's Office of Ocean and Coastal Resource Management in conjunction with Minnesota's Lake Superior Coastal Program.

New Opportunities and Perspectives

Those two case studies exemplify the opportunities that are open for foresters willing to apply and hone their skills in the field of restoration ecology. At Redwood National and State parks, staff actively sought the insights and skills of a forester to help them develop and implement their restoration plans. The opportunity to help reinitiate redwood stands that may be standing 30 generations from now must qualify as a heady experience for any forester. The Manitou Project is already bringing a fresh perspective by incorporating natural patterns of variability into silvicultural planning.

There are many other such opportunities waiting. Ecological restoration has been widely embraced by private and public landowners and is widely supported by taxpayer initiatives. It is under way on the full spectrum of landownerships in North America and Europe, from abandoned gravel mines to private forestland to national parks. The intellectual and operational challenges presented by such an array of ongoing activities are many and expanding. Restoration ecology can provide opportunities for intellectual leadership, as well as new conceptual and methodological challenges for foresters. It is possible that restoration ecology programs may be developed at universities with joint sponsorships by forestry departments and other established disciplines. This combination would allow forestry students to apply their considerable skills to new problems. Such initiatives and partnerships would benefit both foresters and restoration ecologists.

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