Ecosystem Restoration: Fact Or Fancy?

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Introduction

Restoring degraded ecosystems is a major new focus of research and practice, particularly within federal agencies. Clarion calls within the last decade to restore, rejuvenate or rehabilitate degraded terrestrial and aquatic systems (e.g., Cairns 1988, 1995, National Research Council 1992) have been answered by redirection of agency effort and by proposed increases in federal funding for restoration programs. Nevertheless, the scientific basis for ecological restoration is thin and much discourse rests on emotion and myth. As Cairns has stated (1995: 7) "restoration was an aspiration and ... rehabilitation was an achievable goal."

Ecological restoration is generally accepted as the reestablishment of natural ecological processes that produce certain dynamic ecosystem properties of structure, function and processes. But restore to what? The most frequently used conceptual model for the restoration process is the shift of conditions from some current (degraded) dynamic state to some past dynamic state, generally

that presumed to have occurred prior to European settlement. We find an alternative conceptual model more helpful, that of the self-renewal—rehabilitation—restoration continuum (Maini 1992, Walker and Boyer 1993, Stanturf and Meadows 1996). In this model, the state of the forest ecosystem can range from "natural" to "degraded" and can be affected by reversible or irreversible changes. As the forest moves from a natural to a degraded state, the ability of a manager to prevent irreversible changes decreases, and the cost of intervention increases non-linearly. The need for restoration presumes a loss of ecosystem function, for example, by clearing of the forest and conversion to agriculture (Stanturf et al. 1995). A continuum model avoids the problem of precisely specifying an endpoint for restoration, and offers a context for landowners with management objectives other than preservation to contribute to ecosystem restoration.

Restoration of the myriad communities of bottomland hardwoods and the diverse communities of longleaf pine is the subject of intense interest in the southern United States. In this paper, we examine some common myths about restoration of these forest ecosystems from the perspective of a continuum model. The potential for restoration of bottomland hardwood ecosystems to the Lower Mississippi River Valley has barely been tapped. If current funding levels are maintained, close to 200,000 hectares could be restored over the next decade. The bulk of this will be on private land enrolled in the Wetlands Reserve Program (WRP), a federal incentive program (Shepard 1995). In contrast to forested wetlands, the major blocks of remaining longleaf pine ecosystems are on public lands, and restoration activities are planned or underway on many of these lands across the South. Private landowners, however, can be voluntary partners in conserving these ecosystems in a mixed ownership mosaic. Much research is in progress to sharpen our understanding of the economic as well as the ecological values of longleaf pine and bottomland hardwood ecosystems.

The Restoration Context

Bottomland Hardwood Restoration

The dominant goal of bottomland hardwood restoration programs, both on public and private land, has been to create wildlife habitat. In 1987, the U.S. Fish and Wildlife Service began an aggressive restoration program directed at wildlife refuges on public lands but also including private land. The Corps of Engineers continues to construct flood-control and drainage structures but must now mitigate wetland losses through restoration on other sites. Their mitigation programs are geared toward offsetting losses of fisheries and wildlife habitat. On private forestland, most landowners cite wildlife habitat as a major benefit of ownership. The federal Conservation Reserve Program (CRP) began in 1985

to subsidize establishing permanent cover on erosive and other fragile private land such as wetlands, in order to improve water quality. Wildlife habitat creation and water quality improvement are goals of the Wetlands Reserve Program (WRP). New programs such as the Wildlife Habitat Improvement Program (WHIP) and the Environmental Quality Incentives Program (EQIP) have similar emphases.

The strategies used to restore bottomland hardwood ecosystems cover a spectrum, ranging from extensive to intensive. An extensive strategy has been pursued on public land. It is to seek the lowest cost per acre and usually involves widely spaced plantings of heavy-seeded species of value to wildlife for hardmast. This is accomplished using bare-root seedlings or direct-seeding acorns. The idea is to establish those heavy-seeded species such as the oaks that are hardest to establish. These species provide hardmast, and the manager then relies on natural invasion through wind and water dispersal of light-seeded species. The light-seeded species are needed not only to provide diversity, but also to fill in the space between the oaks in order to occupy the site fully.

More intensive strategies are available that are more costly but provide benefits quicker. Using an intensive approach, a manager establishes a closed canopy forest sooner, and directly intervenes to shape the structure and composition of the future stand. This also provides the potential for income to the landowner. Intensive strategies involve planting more seedlings per acre, or employing more intensive site preparation or subsequent weed control than is allowed under WRP (Stanturf et al. in press). Even more intensive approaches involve establishing multispecies stands, including interplanting a fast-growing species such as cottonwood (*Populus deltoides*) as a nurse crop for Nuttall oak (*Quercus Nuttallii*) (Schweitzer et al. 1997, Stanturf and Shepard 1995, Twedt and Portwood 1997).

Longleaf Pine Restoration

Longleaf pine ecosystems once occupied more than 90 million acres in the lower Coastal Plain from Virginia to eastern Texas. Fire maintained open stands of mature longleaf pine (*Pinus palustris*) and biologically rich understories. The depletion of the longleaf ecosystem began with large-scale harvesting in the late 1880s and early 1900s that depleted seed sources for natural regeneration. The frequent fires that reduced competing vegetation and controlled brown-spot needle blight, a damaging foliar disease, was excluded from many stands by the middle of this century. This has allowed loblolly pine (*P. Taeda*) and other species more aggressive than longleaf pine to replace it across most of its range.

In the past, survival of planted longleaf stock was generally poor. Advances in regeneration technology have greatly increased survival (Barnett et al. 1990). The delay in stem elongation that characterizes this species (called the grass stage) keeps established seedlings at a stage where they are very susceptible to competition. Fire is the ecological tool for controlling competing vegetation and favoring longleaf pine, and must play a role in restoration. Frequent use of fire may hasten initiation of height growth and will reduce competing vegetation, thereby stimulating growth and development of the biologically diverse, fire-adapted understory so characteristic of this ecosystem.

Restoration Myths

Myth 1: Reforestation Equals Restoration

All restoration goals can be simplified into one immediate goal: to reestablish the dominant tree overstory, whether closed canopy bottomland hardwoods or open stands of longleaf pine. Although some argue that this is incomplete restoration, it is a necessary and costly first step. Despite all that we know about establishing these dominant tree species, still there are frequent failures, and we need techniques for sites where our standard prescriptions do not work. Nevertheless, we know relatively little about establishing understory species (Walker and Boyer 1993) and even less about non-vegetative components or the impact of restoration on soil quality (Schoenholtz et al. 1997).

Reforestation, however, does not equal restoration. The goal of restoration is broader than simply establishing a tree canopy of a few selected species. Functional reestablishment of the natural system is the ideal, even if we must recognize the impracticality of this goal (Kusler and Kentula 1990). Fortunately, as Cairns (1986) suggested, most functional attributes are correlated to vegetation structure and composition. Which brings us back to the question, restoration to what standard?

Restoration guidelines generally recommend identifying older, relatively undisturbed stands as the criteria for successful restoration. Reference sites for bottomland hardwoods may have hydroperiods altered by the same hydrologic alterations that contributed to the degradation of the site to be restored. Hydrologic modifications and natural succession continue to influence species composition and biological diversity, primary productivity, and the ultimate success of restoration efforts. The interaction of succession and hydroperiod under natural conditions is dynamic and complex. When one or both have been altered by human intervention, however, the present condition of a reference site may not be an appropriate goal for the future condition of a restoration site (Stanturf et al. 1995).

The continuum model avoids the difficulty of setting a single point in time as the standard by which we judge success or failure. If we accept that a range of stand conditions is within the accepted tolerances, we can allow succession and future management intervention to shape stand structure and composition along a trajectory toward an acceptable endpoint (Mitsch and Wilson 1996).

Myth 2: The Same Strategy Works on All Ownerships

Restoration of public land in the lower Mississippi Valley relies on native species planted mostly in single-species plantations of oak at wide spacing, to allow natural invasion of other species. Sites that do not flood frequently or are more than 100 meters from existing seed sources may not seed in successfully (Allen 1990). We question the appropriateness of this extensive strategy for private land on two counts. First, a more intensive approach would provide a more diverse stand and landscape quicker. Second, the extensive approach is inappropriate if the landowner wants to produce timber. The stocking that results from federal cost share programs, which are administered using the extensive strategy as practiced on public land, will not be sufficient to support a commercial pulpwood thinning even at age 20 or 30 (J.C. Goelz, USDA Forest Service, personal communication: 1996).

Even on public land, the extensive approach can be challenged. Wildlife managers believe the low-cost, extensive strategy described above will meet their objectives (Haynes et al. 1993). Managers will have few opportunities, however, for manipulating these understocked stands in the future to further enhance wildlife habitat. Even when natural invasion successfully increases stocking, it takes 20 or more years to develop a closed forest (Allen 1990). During that interval, significant opportunities will be missed to provide habitat for Neotropical migratory birds (Twedt and Portwood 1997) and other wildlife (Wesley et al. 1981).

Myth 3: Ecological and Economic Values Are Incompatible

Ecological and economic goals are not mutually exclusive. Rather a "win-win" situation is possible, especially on NIPF, where landowners are usually not interested in maximizing commodity outputs. A related myth is that NIPF owners are not interested in restoration. It may be true that many landowners cannot afford expensive restoration costs without a promise of future financial returns. Under the continuum model, objectives other than preservation are allowed, and NIPF owners can play an important role in ecological restoration.

Even if a landowner omits financial return as a secondary objective and primarily desires to benefit wildlife, the easiest way to create the desired habitat may be to thin a young stand. The sale of the thinning could help to offset the cost of improving habitat, easing the financial burden of management for wildlife. This might make the difference in some ownerships whether the stand is thinned at all, especially on public land where appropriations for management are shrinking.

We believe the more intensive strategy for restoring bottomland hardwoods will have multiple ecological and economic benefits. In addition to providing future income from pulpwood harvests, natural succession and invasion by other species will be accelerated simply by having a closed canopy forest sooner. This will be more attractive to bird and mammal vectors of heavy seeds as well as light seeds. If a closed canopy stand is established sooner, other wetland functions will be restored to levels typical of a closed forest, rather than an open field of soybeans. Future options to manipulate stand structure abound. In the cottonwood and Nuttall oak interplanting, we have the option to harvest all the cottonwood at age 10 in the summer (in order to reduce coppice regrowth, thereby completely releasing the 8-year-old oak stand); harvest in the winter and encourage another 10-year cottonwood pulpwood rotation from coppice; or partially harvest the cottonwood at age 10, retaining a few individuals for future sawlog or den trees. For most NIPF owners, the cottonwood stand will be an interim step along a path toward a naturally self-renewing bottomland hardwood forest.

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