SILVICULTURE FOR RESTORATION OF DEGRADED TEMPERATE AND BOREAL FORESTS

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Introduction

Throughout the temperate and boreal zones, human intervention has influenced landscapes and forests for millennia. The degree of human disturbance has only been constrained by the technology and resources available to different cultures and by time since initial habitation. Humans have influenced forests by regulating populations of browsers, clearing for agriculture, keeping domestic livestock, cutting trees for fuel, building material, and fibre, introducing new species, using fire and suppressing fire. Today's forests are the result of all these disturbances, along with climatic change and species migration into postglacial landscapes. The ability of humans to affect forest ecosystems increased dramatically after the Industrial Revolution. Management has been extended to native forests over larger areas; at the same time, the switch from biomass to fossil fuels changed traditional forest management. Combustion emissions affect forests directly and through climate change.

Restoration is important for many interest groups in all countries, and in most countries occurs on both publicly- and privately-owned land. Nevertheless, the motivations for attempting restoration are diverse, reflecting the complexity of ecosystems, their current state and past land-use, and the human context of culture, economics, and governance. Restoration is undertaken within the policy framework of increasing sustainability by enlarging the area of specific ecosystems, enhancing biodiversity, or repairing ecosystem functions. The most common specific objectives for restored forests include timber, wildlife habitat for game species, or aesthetics. Increasingly other objectives are considered, including carbon sequestration, biological diversity, non-game mammals and birds, endangered animals and plants, protection of water quality and aquatic resources, and recreation.

Forest Restoration

Although widespread, there is little agreement on what constitutes forest. Broadly defined, it encompasses efforts to counteract negative effects of conversion to other land use (reconstruction, reclamation, replacement) and disturbance and stress on existing forests (rehabilitation, reclamation). In temperate and boreal forests, the focus is on restoring native forests and landscapes (Stanturf and Madsen 2004). Much of the literature focuses on restoring historic forests, although many restoration ecologists recognize that attempting to recreate historic forests is doomed to fail because the conditions under which they developed cannot be replicated (Hobbs 2004; Davis and Slobodkin 2004). A pragmatic approach to active restoration is to restore a desired species composition, stand structure, and natural functions within an acceptable time interval. Objectives are important and may depend on spatial or temporal scale. While sustainability values of biodiversity conservation and maintenance of ecological services increasingly are important objectives, private landowners who participate in restoration seek other values such as financial return. Long-term stability of restored forests will be assured if the full range of objectives is met.

Where remnants of the putative natural forest remain, or can be reconstructed from the historical record, the question of what is natural is hotly debated. Nevertheless, even these forests have been altered. It would be easy to conclude that there is no scientific basis for restoring natural forests because humans and climate change have so drastically changed the whole biosphere. Indeed, some restorationists conclude that choice of endpoint is inherently political, not scientific. Nevertheless, such choices are necessary in a restoration program and the rationale for the choice must be conveyed to the public. The task for restorationists is to interpret the scattered scientifically based knowledge of forest history, stand development, and natural processes, and combine it with practical experience to

design objectives that improve sustainability. Understanding the dynamism of forest stands is critical to identifying appropriate operations for restoration. Changing concepts of forest ecology and how they have been applied to management and conservation include the shift from viewing forest ecosystems as closed, steady-state systems with predictable development patterns to the present view of open systems that operate opportunistically, with multiple developmental pathways following disturbance. To be successful, restoration efforts must adopt this dynamic view of forests. To be effective, restorationists will have to educate the non-technical restoration enthusiasts as well as the general public in this new paradigm.

Reconstruction

Forests are amazingly resilient and functioning forest habitat will develop whether or not we intervene, given sufficient time; for example large areas of agricultural land in the Tropics and the Commonwealth of Independent States appear to revert to forests annually (FAO 2001). Afforestation is an important component of forest reconstruction, particularly in Europe where forestland area has expanded in the 20th century, driven initially by the need of the war industry and the fear of a wood shortage. Afforestation and agricultural policy has been examined in tandem at the European level since 1968; afforestation was a way to address problems of agricultural overproduction and rural unemployment. Increasingly, afforestation is undertaken for ecological and amenity reasons. Perhaps the most important lesson learned from the European experience is that not everyone welcomes afforestation, even when programs are voluntary. In predominantly agricultural landscapes, planting trees may be seen as an assault on rural culture and traditional landscapes. Certainly there has been a backlash in many countries to the former afforestation practice of planting conifer species.

Rehabilitation

Because restoration requires on-going management, the silviculturist plays an important role in bringing to bear time-tested techniques to shape the development trajectory of a stand toward the desired condition, and to maintain the restored ecosystem. In boreal forests, the emphasis is on altering forest management to incorporate consideration of landscape-level concerns (biodiversity, disturbance regimes) as well stand structure and coarse woody debris. In temperate Europe, the main issue is conversion from single-species conifer plantations to broadleaved or mixed stands. In North America, present forests are composed of native species, however distributions and structures are not the same as they were before the influence of European settlers. In the western United States, the issue is restoration of fire disturbance regimes and reestablishing historic forest types and structures. These issues dominate thinking about forest restoration in the United States, and approach the notion of re-creation. Although logging, grazing and fire suppression have heavily impacted these forests, ample remnants of relatively undisturbed conditions remain. Alternatively, such "natural" forests can be discerned from the historical record or through stand reconstruction techniques such as dendrochronology. They are similar to approaches in boreal Europe.

Common Themes

Some similar concerns cross continental as well as national boundaries; for example, disturbance is a common theme. Besides the obvious link of disturbance to degradation and the need for restoration, restoring natural disturbance regimes is often a stated or implied goal. Fire in particular is a disturbance agent in specific ecosystem and natural fire regimes have been disrupted by decades of suppression.

What is natural is an issue; in addition to the effects of climate change on geological time scales, altered forest composition and structure due to human intervention can be found in all continents. Because of the dynamic nature of forest ecosystems, even without anthropogenic disturbances it is difficult to specify a natural forest in a given place and time. Nevertheless, a recurring theme is the return of forests to more natural conditions using nature-based silviculture to accomplish that goal. Native species are emphasized, although a case can be made to use what are clearly exotic species under some conditions. Even native species may be discriminated against if they are not site-adapted,

which is one motivation for conversion of Norway spruce in Europe or other pines to longleaf pine in the southern United States.

Defining a "natural" stand structure is even more arbitrary. Given the luxury of large areas of contiguous forest under a single or a few owners, it is possible to restore to a diversity of stand structures on the landscape in roughly the same proportions as occurred historically with little human influence; that is to say, under mostly natural disturbance regimes. These conditions appear to exist in western North America; they may also exist in boreal Europe and Central and Eastern Europe. In more populous regions, however, nature-based silviculture that emphasizes restoring complex stand structures should stress the positive aspects of structural diversity in terms of stand stability. A cautionary note is in order. Restoration is not necessarily a win-win effort, especially for private landowners, and changing landscape conditions does not appeal to everyone. Restoration will succeed over the long-term if activities are framed in an economic perspective, with distinct, measurable objectives.

References

Davis, M. A. and Slobodkin, L. B. 2004. *Restoration Ecology* 12(1): 1-2.

Food and Agriculture Organization (FAO). 2001. *Global Forest Resources Assessment 2000*, FAO Forestry Paper 140, Rome.

Hobbs, R. J. 2004. *Frontiers in Ecology* 2(1): 43-44.

Stanturf, J. A. and Madsen, P. 2002. *Plant Biosystems* 136(2): 143-.

Stanturf, J.A. and Madsen, P., editors. 2004. *Restoration of Boreal and Temperate Forests.* CRC Press, Boca Raton. In Press.