1240

FORUM

The Ecological Roots of New Approaches to Forestry

by Fred Swanson and Dean Berg

During the 1940s through the 1980s, forest management and research in the Pacific Northwest focused largely on harvesting natural stands and establishing Douglas fir plantations. This was accomplished with relative efficiency by clearcutting, burning woody residues, establishing dense stands of a single tree species, hastening crown closure, suppressing competing vegetation, and other practices. From an economic perspective, such intensive silvicultural practices provided a relatively high short-term return on investment. Biologically, these practices seemed at least superficially consistent with prevailing concepts of natural disturbance and successional processes. It was commonly argued, for example, that clearcutting mimics natural disturbance by wildfire—but is not as wasteful because the wood is harvested and used.

But, forestry is in the midst of a major transformation. As Hal Salwasser of the U.S. Forest Service New Perspectives Program has pointed out, we are involved in an evolution across three stages of natural resource management: from regulation of uses, to sustained yield management, to sustainable ecosystem management. Research within and at the interfaces between wildlife biology, fisheries, ecosystem ecology, and forestry has played a pivotal role in this transformation. In the broadest sense, we are moving from treating forest management as a series of discreet operations to viewing forests as ecological systems. One of the central components of this emerging emphasis on integrative management is leaving residual forest structures (e.g., trees, snags, down logs,) as biological legacies to be carried over from one stand to the next.

Although some of the techniques involved in managing biological legacies may be relatively new, the underlying concepts have evolved over more than a decade. Concern for maintaining habitat and species in federal forestland managed for timber production is reflected in federal laws, public comments and litigation over forest plans, and the continuing efforts of many land managers to be good stewards of the land. Specifically, the concept of retaining structural and compositional diversity in managed stands to meet the objectives of multiple use management is grounded in: 1) improved understanding of disturbance processes in natural and managed forests, 2) a growing understanding of ecosystem functions, and 3) experience with managed forests, including the successes and failures of efforts to implement intensive forestry practices. A major theme in leaving behind biological and physical legacies is maintaining future options—it is easier to leave standing dead trees and large, rotting logs on land and in streams than to generate them from an initially clean clearcut. Although operational testing of many of these alternative prescriptions is in the early stages, it is imperative to work from results of ecosystem research and past forestry experience in designing new prescriptions.

Disturbance Processes

Important changes in our understanding of natural systems have emerged from analysis of the structure and function of natural forest and stream ecosystems and their responses to disturbances. Studies in the Pacific Northwest and elsewhere have revealed the dramatic importance of organisms surviving even extremely severe disturbance. This was particularly clear after the 1980 eruption of Mount St. Helens. Our first impression was that previous ecosystems had been completely eradicated. However, within days and weeks, surviving organisms of a great variety of life forms began the process of restoring terrestrial and aquatic systems. Survivors persisted below ground, in rotten logs, under snowpacks, and in lakes, streams, and springs—some protected under ice and snow cover.

Similarly, studies of wildfire history in Oregon revealed that this dominant disturbance process in the region is more complex than previously recognized. Recent studies in the central Cascades Range of Oregon, based on detailed dendrochronologic analysis of fire scar and total tree age records exposed in stumps, revealed that wildfire was more frequent and involved a greater extent of low- and moderate-severity burning than expected. Large, catastrophic fires were very heterogeneous, composed of patches of diverse sizes and burn severity. This complex wildfire regime left abundant standing and down dead woody debris as well as highly variable densities of live trees.

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These studies of disturbance highlight the great importance of living organisms and physical structures which survive from one regime to the next. Examples of these "legacies" include: standing and down logs, soil structure, high soil calcium contents associated with cedar trees, reproductive organs such as seeds and sprouts, and various vertebrate species (e.g., birds and mammals) as well as the numerous invertebrates in the soil. Especially important are the hyphae and species of the mycorrhizal fungi which are essential to the re-establishment of many woody plants. These surviving elements of the predisturbance system can strongly affect the rate and course of ecosystem recovery. Consequently, the design of various ecosystem manipulations and predictions of system response must deal with nutrients, organisms, and structures both retained on and removed from a site as a result of disturbance or management.

Ecological Functions

Parallel with disturbance ecology research, there has been a great deal of study focused on natural forest and stream systems during periods without catastrophic disturbance. In the Pacific Northwest, much of this work began with the International Biological Program in the 1970s and continued with the National Science Foundation sponsored Long-Term Ecological Research Program in the 1980s, as well as in a variety of other research programs. Findings from these and other studies include:

- Standing and down dead wood material is a significant element of sustaining biological diversity (as habitat for many species) and possibly forest productivity. Traditional, intensive forest practices have the net effect of greatly reducing concentrations of wood debris in forests after the residual woody debris from the previous natural stand decomposes.

- Coarse woody debris in streams increases channel complexity, thereby improving fish habitat quality and increasing retention of nutrients in stream systems. Stream cleanup practices employed in the 1970s, and splash damming in earlier periods greatly reduced levels of coarse woody debris in streams, thereby reducing habitat quality.

- Natural forest stands are very complex in early and late stages of succession—in contrast with the simpler structure and composition of stands managed intensively for wood fiber production. Traditional practices eliminate or reduce the duration of complex early and late seral forest stages, possibly eliminating ecological processes and species that are dependent upon them. Input of nitrogen to Pacific Northwest conifer forests, for example, occurs by nitrogen-fixing organisms particularly evident in early and late successional stages of forest development. The presence of these nitrogen-fixing species is greatly reduced in stands managed on short cutting cycles, and in which competing vegetation is suppressed. The net effect may be a reduction in long-term nitrogen input to these forest systems where nitrogen availability commonly limits productivity. Furthermore, suppression of biological legacies and early seral vegetation, combined with unsuccessful efforts to reestablish tree plantations on clearcut harsh sites, may disrupt the belowground ecosystem to the point that the site is converted to nonforest vegetation.

• Insectivorous birds and canopy invertebrates, such as spiders and ants, can be important predators of forest insect pests. Retention of habitat structure, such as large, live trees and multiple canopy layers, may maintain beneficial predator-prey relations in managed forest stands and landscapes.

• Tree root systems help anchor soil on hillslopes. Timber harvesting on marginally stable slopes can lead to increased incidence of landslides and debris flows in downslope and downstream areas.

We could cite many additional examples of ecosystem elements which contrast between natural forests and stands managed intensively for wood fiber production. Considered individually, perhaps none of these ecosystem functions justifies revamping traditional forestry practices. But, considered in aggregate, the need to modify forestry to maintain future options and minimize risks is clear.

Experience with Managed Forests

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Some contend that the practice of retaining green trees and snags is a return to the "high grading" logging practices used at various times in the 1930s and '40s. However, new practices have very different objectives and strategies. Retaining trees of high value provides habitat, maintains the productive capacity of the site, and sustains a supply of large, high quality logs. The biological features of the resulting stands are quite different from those that were left after high grading.

Many techniques explored in the development of intensive plantation forestry will be important in the design of more multiple use forestry practices. For example, in denser green tree retention units (10+ trees left per acre), experience with shelterwood cuts may provide a strong basis for anticipating effects on regeneration. Growth and yield potential of sites where green trees are retained may be maintained by paying close attention to stand density, and thinning to control crown competition for light. In some cases, traditional and nontraditional practices may overlap. For example, regeneration on low density retention units may be achieved by using stocking levels and genetically improved stock similar to that used for intensive plantation forestry.

Finally, when considering where we are in terms of understanding complex forest ecosystems, it is useful to consider the historical context of intensive plantation and multiple use forestry. Plantation forestry has been developed over the past three decades through the concerted efforts of industry, universities, and Forest Service research and development programs. The total research and development investment in plantation forestry probably exceeds several hundred million dollars directed at the rather singular objective of maximizing wood fiber production. Multiple use forestry is only beginning to develop and is doing so in a much more piece-meal fashion, perhaps in keeping with its more complex objectives. In both cases, there has been a great deal of learning as we go—always building on past experience.

The extent to which alternative forestry practices meet the biological objectives for which they were designed has yet to be determined in detail by research and monitoring. We have not learned everything about forests. We will always be managing with less than complete information. Hence, we need flexibility in our silvicultural systems such that we can continue to adapt based on new information. FP

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