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Evaluating Alternative Landscape Patterns over Time - An example from the Willamette National Forest in Oregon

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ABSTRACT: Management of forest ecosystems for high levels of biological diversity and susceptibility can take several forms. Two methods have been examined on the Willamette National Forest, Oregon. The first involves retaining the most ecologically significant stands and their interconnections for as long as possible during the planning period. The second uses natural disturbances as a template for describing a desired future condition of stands and their distribution at a landscape scale.

Forest ecosystems consist of myriad species interacting with each other and their environment in ways that we are just beginning to understand. While the most obvious species and interactions are known, many remain, and will remain for some time, beyond our ken. Yet we find ourselves trying to manage the mutual co-existence of the forest ecosystems and human uses. If we can not enumerate the species comprising natural forest ecosystems, let alone the ecosystem processes generated by their interaction, how can we hope to manage sustainable forests into the future? The most promising approach, in my view, is to understand and mimic, as best we can, the macro-scale processes that generated the forests.

Attempts to meet legal management requirements under the Endangered Species Act and other mandates have often lead to the selection of and management for a relatively small set of species which are particularly uncommon, may be disappearing from the biosphere, or have special commercial or social emphases. However, management of individual species is prohibitively expensive, fraught with untested assumptions (minimum viable populations, for example) and will not assure the continuation of processes that form a stable, productive ecosystem. Conflict often results from the efforts to provide opposing optimum habitat conditions. For example, managing for large populations of deer and elk may reduce the habitat for interior forest species to unacceptable levels or may cause deterioration of sensitive high-elevation meadows through heavy animal use.

An alternative approach, managing toward the distributions, patterns, and abundances of habitats provided by natural disturbances will not, generally, allow management for maximum populations of any single species. It will, however, provide some degree of confidence that our stewardship is allowing long-term susceptibility of forest ecosystems. Natural disturbance events (fire, wind, insects and disease and others) provided the distribution of habitats and species over time and space that gave us the forests we enjoy. Management which emulates these events, to the extent possible, would enable a continuation of the long-term pattern of interactions of species, habitats, and ecosystem processes that generated the great variety of values in natural forests. These values include timber, wildlife, water, forage, and many others.

What can we manage under a sustainable, ecosystem-oriented approach?

1) Structures (tree sizes/spacing, down wood, snags, etc.),

2) Pattern (patch size, shape, connection/adjacency),

3) The abundance and distribution of a FEW species (trees, some shrubs/herbs, some animals). These might be threatened or endangered species, for example. Species populations would generally not drive development of pattern and structure to the extent that they deviate substantially from natural conditions.

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Determination of "natural" conditions poses significant problems. Several approaches are possible, each leading to a different description of the "natural" distribution of structure and habitat. In the forests of the Pacific Northwest, for example, pioneer seral species are often long-lived enough to survive through significant shifts in climate. Old-growth Douglas-fir forests established 400 to 500 years ago reflect climatic conditions quite different from those of the present. In the ensuing 400 to 500 years, there were wet, cool periods with relatively low fire frequency, periods of early European settlement with increased fire frequency, the introduction of fire suppression in the 1900s, a dry, hot period in the 1930s, and, possibly, the onset of global warming resulting from atmospheric change. Using the pattern of habitat and structure existing in the early part of the 20twentieth century, the early pre-settlement period or the start of substantial industrial logging in the 1940s would all yield slightly different pictures of the "natural" condition. Another possibility is to reconstruct the pattern and timing of disturbances over the last several centuries and establish a range of conditions that existed over time. This latter method allows for a dynamic picture of "natural" conditions, but still does not reflect the differences between current and past climates.

Approaches

Landscape-level management of habitat pattern can take several emphases. Recent work on the Willamette National Forest and other places focuses on a "minimize-the-damage" approach. This is an effort to retain as much of the existing natural structures and patterns for as long as possible while converting the natural forest to a more typical managed forest . Out of this approach have come efforts to minimize fragmentation of the most ecologically significant old growth stands and to develop landscape level analyses of the interconnection and distribution of old-growth forests. In the end, the past pattern of timber harvest has a profound effect on the currently extant pattern of older forests and, therefore, on the possibilities for management of old-growth forests in the future.

An example from the Fall Creek drainage on the Willamette National Forest illustrates this approach. The upper portion of the Fall Creek watershed was chosen to test implementation of the Willamette National Forest Land and Resource Management Plan. The study area is 22,000 acres in size and contains a mix of management emphasis areas, including recreation, watershed, wildlife and timber. An extensive survey of stand conditions was supplemented with field data to develop detailed map layers and information on stand conditions and patterns. These data were manipulated with a geographic information system (GIS). Several alternatives were developed to test the implementation of the Forest Plan under different general landscape patterns. Two of these alternatives reflect the goal of retaining the most ecologically significant old-growth stands and their interconnections for as long as possible while converting the areas available for timber harvest to regulated forest under an 80 year rotation (minimum fragmentation). Other alternatives emphasized dispersion of harvest impacts by using a staggered-setting pattern representative of past practices (staggered setting). All alternatives were designed to produce similar levels of timber outputs and were projected for several decades into the future.

The staggered-setting approach produces a pattern of small stands in different seral conditions scattered across the landscape. This pattern disperses the impacts of timber harvest on basin-level water quality, produces maximum amounts of edge between kinds of habitats, and abundant habitat for big game and other edge-dwelling species. It also results in rapid fragmentation of large blocks of interior forest habitat. Of the stands most highly ranked for ecological significance, none remain unharvested at the end of 30 years. By 40 years, all of the most highly ranked blocks will have been mostly harvested.

The minimum fragmentation approaches, on the other hand, retain 5 of the most significant blocks at the end of 30 years in a unharvested condition and 3 partially harvested. By the end of 40 years, since the unharvested blocks are all that remains of available unregulated forest, only 1 remains unharvested, 5 are partially harvested and 2 are mostly harvested.

In sum, the minimum fragmentation approach retains the most ecologically significant blocks of old forest for several decades, but does not forestall their conversion to managed stands. Land managers in the next three decades could decide to manage those remaining blocks in different ways, giving rise to more options for old-growth management under the minimum fragmentation approach. But there are limitations to this approach. At the end of the rotation, the framework of stands over 80 years old would lie entirely within lands not available for timber harvest (scenic, recreation, special wildlife, unsuitable soils, and other allocations) and none of these form particularly large areas of interior habitat. In addition, there may be unacceptable impacts on water quality and soils as a result of concentrating harvest in some areas to allow retention of old-growth blocks for a few decades.

An alternative method of designing landscapes focuses on examining the "natural" pattern of habitats and structures across a landscape and developing management strategies to mimic them to varying degree. We call this the dynamic landscape approach because it recognizes the range of variability of patterns that occur in natural landscapes and allows for adjusting patterns as disturbances (fire, for example) occur which were not planned. The objectives are to develop a management approach that:

1) Integrates and sustains landscape level functions and processes through pattern and structure using natural disturbances as a template.

2) Works over an appropriate temporal and spatial scale.

3) Guides the development of stand-level prescriptions for the transition from the current (partially harvested) landscape pattern to a desired landscape pattern. Stand structure prescriptions would also reflect the kinds of structures found in natural stands, with the realization that timber harvest will remove some structure (green trees).

4) Analyze differences in outputs and impacts from several different approaches to the natural disturbance template.

The criteria for the specific designs of different possible landscape patterns and stand structures must be dependent on the local ecosystem conditions of disturbance history, existing stand patterns, and output objectives. The criteria identified for the Augusta Creek effort include the following:

1) Maintain the historic pattern of patch sizes, mix of successional stages, stand structures and landscape positions. Investigations of fire history in the western central Cascades of Oregon (Morrison 1984, Teensma 1987) indicate that the long-term landscape design should allow for a mix of block sizes between a few tens of acres to several hundred acres. Each block would generally fall within one overall seral condition, but would include several to many stands with varying characteristics (density and distribution of green leave trees, for example). Forty to sixty percent of an area might be in stands with most of the structure typical of old growth, for example. The remainder would be evenly distributed in younger seral conditions. Large blocks with old-growth structure would be distributed across the area to minimize the chances for a single wildfire to impact all the old-growth in the area.

2) Minimize the risk of adverse peak stream flows. The steep, highly dissected topography of the area and presence of soils subject to rapid erosion require the location of recently disturbed blocks in a way that minimizes impacts to streams and soils. This may require deviation from a purely natural pattern, but is required by minimum resource protection standards in the Forest Plan.

3) Include design constraints from other resource elements to varying levels (scenic and recreation concerns, for example).

Using an alternative which most closely approximates natural disturbance patterns as a baseline, several other alternatives would be developed to reflect additional concerns for mixes of resource values, including water quality, wildlife habitat, and timber output. The set of alternatives would be modeled for 200 or more years, using FORPLAN or some other scheduling tool, to examine outputs. Adjustments

to the design of each alternative would follow based on the results. The end result would be a set of management alternatives for a prolonged period, each based on the natural disturbance template, and each considering a mix of other factors to greater or lesser degrees.

Once the general landscape designs are formulated, a set of prescriptions for individual stands would be developed. These prescriptions would guide stands toward the desired structure and species composition. Each stand within a larger block would have at least the minimum structural characteristics for the general seral state of the entire block and additional structure as dictated by the design for the whole block. For example, a block that is generally in old-growth seral condition might be composed of stands that all have at least 8 trees per acre over 32 inches in diameter and certain levels of shade-tolerant trees, snags, and down wood. Some stands within the block might be core old-growth stands with substantially higher levels of large green trees and other structures, while other stands would have lesser amounts of structure.

The transition from current landscape patterns to the desired condition would require some thought. Many the blocks of stands in the area have had significant harvest to date. The transition of the entire block to a single desired general seral condition might require thinning young stands to particular densities, careful commercial thinnings, planting, and the use of prescribed fire.

SUMMARY

The processes and functions that occur in natural ecosystems are complex and, for the most part, unknown. By managing the structure and pattern of stands and landscapes to mimic, as best we can, natural disturbances, we come as close as we can to managing for ecosystem susceptibility.

Two approaches to managing ecosystem pattern and structure have received considerable thought an effort on the Willamette National Forest and other places. An approach to minimizing the impact of land management on remaining unharvested areas within the general forest land base can provide options for retaining blocks of intact interior forest habitat for several decades, depending on existing and planned harvest levels. It does not provide a long-term solution to ecosystem management that allows for flexibility and is strongly influenced by exiting stand condition patterns. An alternative approach, which emphases a dynamic landscape pattern that emulates natural disturbances, requires more information on natural disturbance patterns and more extensive analyses. It provides, however, a range of pattern and structure conditions and flexibility around unforeseen events (wildfire, for example). Both approaches attempt to provide habitat for all species and operating room for all natural processes by managing pattern and structure at a large landscape scale. Both are more likely to provide sustainable ecosystems and human uses than management based on individual species and resources.

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