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FINDINGS

INSIDE

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"Science affects the way we think together."
Lewis Thomas

MESSY WORLD: MANAGING DYNAMIC LANDSCAPES

The dynamic landscape approach was developed and refined through interactions among scientists, managers, and citizens through several field tours, workshops, and other forums.

"I am bound by my own definition of criticism: a disinterested endeavour to learn and propagate the best that is known and thought in the world."

Matthew Arnold, *1822-1888*

What makes a good landscape? Perhaps something tidy and uniform? Worked over and recycled? Maybe messy and chaotic? It depends, of course, on your viewpoint, on who owns the land, and on the owner's objectives.

Under the Northwest Forest Plan (the plan that resulted from President Clinton's conference in Portland, OR, in Spring 1993), public land management decisions are based largely on getting specific products out of a given segment of forest, products such as spotted owl habitat, or wood fiber. The plan attempts to achieve this combination of desired products without significant damage to social or biological systems. But does that mean the resulting landscape will be "good," will function well?

"In areas managed for timber, or matrix lands, implementing the Northwest Forest Plan will eventually result in a divided landscape, with all old forest along the streams,

IN SUMMARY

What lessons does historical disturbance hold for the management of future landscapes? Fred Swanson, a researcher at the Pacific Northwest Research Station and John Cissel, research liaison for the Willamette NF, are members of a team of scientists and land managers who are examining the way we think about and manage landscapes.

The team found that past ecosystem processes are an important reference point for guiding the design of timber sales, fire prescriptions, cutting rotations, and aquatic conservation strategies. Complex disturbance regimes result in highly complex forest structure and composition. Using natural disturbance processes as a reference point is useful, but because the range of management considerations is broader than a few years ago, landscape management will continue to be a challenge.

and the areas between fairly intensively harvested on an average 80-year rotation," says John Cissel. "The mature age class will nearly disappear from the landscape, leaving no replacement for old Douglas-fir forests when they are depleted by mortality."

"What we have to search for is the underlying basis for judging a landscape good or bad—what meets the needs of and protects the ecosystem," says Fred Swanson. "Is it the agricultural approach to the forest that we've seen through the last hundred years? Is it conservation biology, with its focus on individual species? Or is it disturbance with a view to what the world used to look like when fire and wind and disease ran relatively unchecked through the centuries?"

Cissel and Swanson are key members of a team of scientists and land managers attempting to regroove the way we think about and manage whole landscapes. Swanson is a research geologist with the PNW Station and a project leader with the H.J. Andrews Experimental Forest, and Cissel is research liaison between the Andrews and the Willamette National Forest, and co-coordinator of the Central Cascades Adaptive Management Area (AMA).

KEY FINDINGS

- Fire regimes in the central western Cascade Range of Oregon historically have been highly variable in frequency, severity, and spatial pattern. Relations of fire regime to topography at various scales are significant, though not strong.
- This complex disturbance regime contributes to highly complex natural forest structure and composition. Complexity is multiplied by management activities, introduction of exotic structures and species, and climate change.
- Old-growth forest characteristics such as large snags and live trees, and downed woody debris, were sustained on many sites for long periods and through many disturbances, thus providing habitat continuity over time.

BREAKING THE HABIT

The 10- to 40-acre clearcut, burned over, and dispersed across the landscape, had been standard on Federal lands for so long, Swanson recalls, that everyone was in the habit of thinking one way.

"Then in the late '80s, the spotted owl and old-growth work raised ideas about forest fragmentation, and the specter of undesirable consequences. It was a jolt that got us thinking in a new direction."

Two general schools of thought about landscape planning pervade Northwest Federal lands today. One is the idea that "we know what we want and we know how to get it"—the approach seeking specific desired products and taking known ecosystem processes into account.

But Pacific Northwest landscapes have been accustomed through millennia to rude interruptions by natural processes of disturbance. Fire has been particularly dominant, but windstorm, insect infestation, floods, landslides, and disease outbreaks have all played their roles in shaping forests and the landscapes they inhabit.

So the second approach is the one currently absorbing Swanson and Cissel: What if we could approximate aspects of these historical, disturbed landscapes through management practices? Or at least see what lessons they hold for managing future landscapes.

"This point of view reflects the fact that we cannot even name all of the species in the landscape, much less rationally plan for their habitat needs and ecosystem functions," says Cissel. "A premise of this approach is that native species have adapted to the disturbance events and resulting range of habitat patterns of the past thousands of years."

A long history of ecological studies already indicates the strong association between disturbance processes and species survival. For example, the northern spotted owl depends on old-growth forest often shaped by recurring disturbances; human intervention via dam construction and landslides has contributed to declines of salmon populations; and many kinds of seed need fire to germinate successfully. Ecological processes, such as hydrologic and nutrient cycles, also are adapted to disturbance.

The assumption behind dynamic landscape management is that if an environment deviates too far from historical conditions, the probability of survival of a particular species is reduced. In other words, there is a range of natural conditions to which species have adapted.

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DEFINING TERMS AND TIMEFRAMES

Natural variability refers to the composition, structure, and dynamics of ecosystems before the influence of European settlers. It draws on many fields of knowledge, especially disturbance ecology, landscape ecology, and watershed science. Natural variability concepts can be characterized and applied at scales ranging from individual forest stands to landscapes or watersheds covering thousands to millions of acres.

Where natural disturbance regimes have been suppressed and habitats altered, species decline and undesirable ecosystem changes have been observed. Examples include eastern Oregon's decline in forest health, fuel buildup after fire suppression, forest regeneration failures, and species listings such as the spotted owl, marbled murrelet, and many stocks of salmon.

"The use of natural variability as a reference point in ecosystem management is not an attempt to turn managed landscapes into wilderness areas or return them to any single preexisting condition," Swanson says. Rather, the intent is to meet ecological objectives by bringing the range of existing conditions in a landscape within the natural range.

MANAGEMENT IMPLICATIONS

- Disturbance-based management cannot be designed as a sharp-line blueprint. Past ecosystem processes and states can be used only as reference points for guiding design of timber sales, fire prescriptions, cutting rotations, and aquatic conservation strategies. Consideration for watershed processes, threatened species, and human uses also need to be integrated into a landscape strategy.
- Historical landscapes had a mix of vegetation structure and age classes across the landscape. Disturbance-based management offers an approach that could achieve such a mix, while potentially meeting ecological and social objectives.
- Adaptive management principles are crucial to the success of disturbance-based management. Frequent evaluation, public participation, monitoring, and management adjustments need to be in place alongside open and collaborative science-management relationships.
- Increased patch sizes, broad distribution of patch types and more mature forest, and less abrupt transitions between young and old patches are potential outcomes of a disturbance-based management approach. Decreased area in riparian reserves may offset the reduction of timber harvest rates and intensities because of longer rotations and higher green tree retention levels. Timber value may be increased because of larger logs.
- Attainment of aquatic ecosystem objectives depends, in part, on the frequency and intensity of upslope practices.

UNEARTHING THE UNDERLYING REGIME

So how do planners go about reconstructing an underlying fire regime?

Some forest types have simple fire regimes, like the light fires every 15 to 20 years characteristic of ponderosa pine, according to Swanson. Central Cascade fire regimes, on the other hand, are messy and highly variable in frequency, severity, and size. "The big problem with fire history is that the record embodies erasure," he says. "The messiness of the system itself, of recordkeeping, and of human intervention leaves us with a wide open question about what exactly a particular disturbance regime incorporated."

Nonetheless, it is possible to reconstruct at least a broad outline of how fire has shaped the landscape—the timing, severity, and geographic patterns of fire. Two projects on the Willamette National Forest in western Oregon have tackled this complex task, then designed dynamic landscape management around the results.

The Augusta Creek Study (19,000 acres, begun in 1991) and the Blue River Landscape Study (57,000 acres, begun in 1995) share the overlying goals of sustaining native habitat, species, and ecological processes within historical ranges while providing a sustained flow of wood fiber.

And both studies used detailed fire history studies retracing about 500 years of disturbance.

In intensive quantitative studies, tree ring data and some pollen analysis—from hundreds of sites across tens of thousands of acres—reveal the fire stories of a given area. From these data, fire researchers can create historical maps approximating the extent of specific fires. They also compute fire occurrence statistics including frequency, and patch size. Fire regimes may be further defined by assigning broad fire severity classes.

WRITER'S PROFILE

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DESIGNING HISTORY INTO THE FUTURE

In the two pioneering projects, "landscape areas" were designated as zones with similar ecological conditions and disturbance regimes, and vegetation management plans were developed for each zone based on an interpreted range of historical conditions. The underlying fire regime guided development of timber harvest and fire prescriptions for each landscape area.

This is where Swanson uses words such as "messy" and "sloppy." Not about the science, but about the ecological world the science is trying to describe in historical terms. That world will guide managers in developing timber harvest plans and fire prescriptions for what they hope is an appropriate future.

"We have to ask how far we can get with our deterministic thinking," he says. "We know enough to plan, for sure, but not enough to plan with high precision."

Notably, the stated concept behind the Blue River Landscape Study is, "Timber harvest and prescribed fire will be planned to approximate aspects of historical fire regimes to the degree feasible while still meeting the objectives of the Northwest Forest Plan."

Rather than the 80-year rotation ages prescribed by the Northwest Forest Plan, rotation ages will approximate the historical frequency of stand-replacing fires, at roughly 100, 180, and 260 years.

"I don't view us as having settled on the single answer to work from," Cissel notes. "While we know that in this area fire was historically the main disturbance process affecting vegetation patterns, we see it only as a good starting point for planning. For example, watershed processes, threatened species, and social goals also need to be integrated into a landscape approach. There is no one answer, and we're continually assessing and tuning up based on changing goals, new information, and operational experience."

Existing conditions, of course, are not what they used to be.

"We are not proselytizing about the specifics of these landscape management plans," Swanson says, "because so much has altered the mix, particularly in recent history. Along with climate change, there is invasion of exotic species of plants and animals, and effects of human construction such as dams and roads. All of these factors directly affect future landscape conditions, which leads, naturally to easy criticism."

HOW MUCH CAN WE EXTRAPOLATE?

To wit more information is needed on past conditions and disturbance regimes, as well as better quantitative descriptions of how these differ over large areas of complex terrain and over long periods, according to Swanson. Our current understanding is meager on this and on the effects of multiple disturbance events on vegetation and wildlife over large areas and long periods.

Further, he adds, just as current ecosystems have evolved from these past systems, we are trying to approximate, so future systems will evolve out of our present conditions and management actions.

And then there's the stream issue. In some areas, timber harvest or prescribed fire will occur near nonfish-bearing streams and on lower slopes.

"The biggest single set of issues we have had to face is around not leaving all trees along the streams and adjacent lower slopes," says Cissel. "The Northwest Forest Plan set up some expectations. People thought it was the final answer, and they thought it meant all streams would have extensive reserves. But timber production remains a key objective of the Northwest Forest Plan, and as long as that's still on the table, we're suggesting a more dynamic and historically rooted landscape approach may better meet ecological objectives."

Unlike the earlier Augusta Creek study, the Blue River project from the outset payed close attention to aquatic ecosystems, coming as it did on the heels of the Northwest Forest Plan. It also lies within the Central Cascades AMA, designated for more flexible applications of the plan, including experimental trials of disturbance-based landscape management.

TWO DIFFERENT FUTURES

What, then, might the landscapes look like under the two different approaches: the Northwest Forest Plan riparian reserve-plus-matrix system, and the Blue River-style dynamic mix across the whole landscape?

Landscape simulations suggest that important distinctions can be made. For example, under dynamic landscape management, the most young forests contain higher densities (15 to 50 percent) of canopy cover. The Northwest Forest Plan directs a relatively consistent 15 percent.

The extent of mature forest (80 to 200 years old) also differs significantly. "Many species associated with old forest, such as the northern spotted owl, also use mature forest," Swanson says. "We believe that the greater amount of available late-successional forest—both mature and old forest—will provide higher levels of habitat for most species associated with old forest." Crucially, mature forest is needed for replacement if natural disturbance, climate change, or other natural processes should cause high mortality of old-growth forests.

Significantly larger patch sizes created by disturbance-based planning will benefit species needing interior (nonedge) forest habitat, and broader distribution of forest patch types will help species whose dispersal is favored by late-successional habitat spread across the landscape, he says.

"The dynamic landscape approach provides greater flexibility for management in riparian and adjacent lower slopes by relying, in part, on lower cutting frequencies through long rotations, and on lower cutting intensities through greater green tree retention in

the uplands," Cissel explains. "Some disturbance in these zones is accepted as part of the range of historical conditions."

These treatments may increase light levels to streams, leading potentially to short-term, localized increases in productivity and temperatures, and allowing less than maximum large wood input.

And timber? The rates of harvest will be distinctly lower because of harvest rotations designed around longer fire intervals, instead of maximizing timber growth, according to Cissel. Although the volume will be lower, however, the value may be higher because of larger log sizes. Ongoing analysis is attempting to answer this question.

READING THE LESSONS

Neither of the examined landscape futures has historical precedents, Swanson and Cissel emphasize. Both represent management "experiments," and evaluation and monitoring will teach researchers and managers a great deal more in coming decades.

Preliminary evaluation of the Blue River project established that the alternative management approach would meet all nine objectives of the Northwest Forest Plan's Aquatic Conservation Strategy, and would also provide larger patches of less fragmented northern spotted owl habitat, according to Cissel. Continuing evaluations will be used to fine-tune management plans in coming decades.

"This kind of adaptation is not new for the Willamette National Forest," says Cissel. "We're accustomed to changing the way things are done through our research and management partnerships. We work the kinks out one at a time, and are constantly in a refining mode."

Monitoring of the alternative approach involves a mixture of projects specific to the Blue River study, and some linked to existing monitoring on the Andrews Forest, at various scales. Examples include a spotted owl demographic study, already 10 years old, that has been reoriented to compare AMA lands with late-successional reserves; within-watershed measurements of stream discharge that are ongoing on the Andrews; and measurements of stand and stream-reach effects of management on water temperature, amphibians, vascular plants, and lichens.

Public participation has been a significant part of each study. The more fluid, less formal feedback comes from field trips and visits, and "chatting on the landing," according to Swanson, with more formal opportunities generally developing around timber sales, and individual restoration projects. "Natural variability concepts provide a foundation for improving discussion among managers, scientists, and the public about the desirability and feasibility of different goals for an area, the resulting impacts and tradeoffs, and how to improve the management of dynamic ecosystems," he says.

AND IS THE ALTERNATIVE APPROACH SELLING?

Swanson notes that the concept of natural disaster as a part of ecosystem function is playing out on a larger stage, which includes the Yellowstone fires, the experimental flooding of the Grand Canyon, the renaturalization of rivers in Europe, and watershed restoration in Japan. Projects not unlike the Blue River landscape plan also are underway in Canada.

If only reference to natural disturbance processes could provide specific, quantitative direction for ecosystem management. No such luck, Swanson says. "Rather, this approach makes management planning and decisions more challenging because the range of management considerations is much broader than a few years ago, when management issues focused on the question of preservation versus intensive plantation forestry." The Northwest Forest Plan is clearly just one area where the PNW Research Station's landscape planning research can be applied.

The quest continues: how to work, in a messy world, towards landscapes that function well?

"The simple news that Nature told. . . with tender majesty."

Emily Dickinson, *1830-1886*

FOR FURTHER READING

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