The Fallacy of Passive Management
Managing for Firesafe Forest Reserves

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The hard lesson that we should take away from the last decade of fire management in drier forests is that a choice to do nothing is a choice of action, not always with a desirable outcome.

Forest ecosystems are dynamic —they change when humans disturb them, and they change when humans eliminate distur-bance. For much of the 20th century, exploitation was the guiding philosophy behind forest management. Now, as we headinto the 21st century and move toward forest preservation and restoration in many places, there is a temptation to "let nature take its course" and to allow forests to recover and develop naturally. Yet, such a passive approach to management is not a sustainable forest strategy in ecosystems that have a substantial history of natural disturbance, including forests on almost every continent. A major forest ecology principle in these areas is that the only constant is change. Preservation, as such, is the management of change.

Consider, for example, the celebrated case of the northern spotted owl (*Strix occidentalis*). In 1994, The U.S. Forest Service was looking for a way to provide habitat for owls and other old-growth dependent species in the dry forests of the eastern Cascade Range of Washington State. They proposed setting aside as reserves large blocks of forest for which there would be only minimal management intervention. I was asked if such a passive approach was likely to work over a century-long planning horizon. My response was, "no."

I argued that each reserve would be at risk, and fires would perhaps take 100,000 acres at a time. Over a century, if this occurred only once every five years, up to half of these proposed reserves would be burned over—2 million acres out of about 3-4 million forested acres in that region. None would recover any old-growth character in that time.

Pointing to a place on the map with high lightning frequency, I indicated that it would be a likely place for one of the next large fires. Three weeks later, in that same vicinity, the 200,000-acre Wenatchee Fire destroyed most old-growth and late-successional structures in the area. Passive management was a dismal failure.

I don't have a crystal ball. I was simply forecasting a likely event—one that will be repeated in the future. The hard lesson that we should take away from the last decade of fire management in drier forests, particularly in the North American west, is that a choice to do nothing is a choice of action, not always one with a desirable outcome.

Fire as an Agent of Change

Forest ecosystems evolved with a common denominator—disturbance. No preservation plan will succeed unless it recognizes disturbance as an ecosystem process and incorporates an effective strategy to manage naturaldisturbance. Here I focus on one of the most ubiquitous forest disturbances, fire; but the principles apply to wind, insects, disease, alien species, and other disturbances.

For fire, the first step is understanding historical fire regimes and how they have changed over a century or more in the U.S. and Canada, and perhaps longer elsewhere, such as the dry forests of the Mediterranean. The next step is determining which areas are at the greatest risk for catastrophic wildfire and setting management priorities accordingly. In some places, passive management may be appropriate, but in many areas active intervention is required to preserve ecosystems in a "natural" state.

We once defined disturbances in simple terms—either they were present or absent. Yet, we now know that disturbances are more complex. They take place along a multidimensional continuum defined by such factors as frequency, magnitude, extent, season, synergistic effects with other disturbances, and historical variability. In the case of fire, we can classify forest types into one of three major fire regimes: low-severity/nonlethal, mixed-severity /moderate, or high-severity /lethal. Such a classification tells us three critical pieces of information:

1. Historically, the role fire played in a given ecosystem—i.e., the historical fire regime.

2. The conditions that we have inherited from our predecessors who nobly—if naively—suppressed fire in landscapes where it was historically frequent as well as where it was not.

3. The challenges and opportunities we face in determining how best to manage future fires within as well as outside reserves.

Low-Severity (Nonlethal) Fire Regimes.

If you walked into a ponderosa pine (*Pinus ponderosa*) forest in the western U.S. at the turn of the 20th century, you would find an open, park-like stand, with trees appearing as widely-spaced pillars above a green carpet of multi-hued flowers and grasses. All were well adapted to survive the frequent low flames that visited these forests every decade.

This was a typical low-severity, nonlethal fire regime. Individually, frequent low-intensity fires had a relatively benign effect; but collectively they shaped species composition, structure, and function of the forest.

In these forests, fire was the "friendly flame," consuming debris and killing small trees that established themselves between fire events. Many fire history studies have shown average fire return intervals of 5-15 years in these forests. Fuel loads were so light that it took several years after one fire for the next fire to spread into the same area. Large trees were very fire-resistant, and patch sizes (large blocks of forest that burn in a uniform fashion) were an acre or less where old groups of trees were killed by insects.

Subsequently, the snags and fallen logs were consumed by fire, and the small "hot spots" where logs burned were areas where herbaceous com-petition was at a minimum and tree regeneration had a high likelihood of success. These forests were sustainable because of the presence of low-severity disturbance.

Skip ahead 50 years and the picture changes dramatically. After several decades of fire exclusion, grazing, and logging, the once open grassy stands are now choked with trees—10 to 100 times as many trees in many areas (Figure 1). Surface fuel loads are higher, and ladders of fuel now connect the ground surface to the crowns. The most fire-tolerant trees—the biggest ones with thickest bark—were selectively removed because of their high timber value. Fire severity in these forests has increased, whereas fire tolerance of the forest has decreased. As a result, the friendly flame has been transformed into an agent of destruction. Fires still occur, but the character of these fires has changed. Stand replacement fires are common in these forest types today.

Moderate/Mixed-Severity Fire Regimes

Along the gradient from low- to high-severity fire regimes are those of moderate/mixed-severity. These are a complex patchwork of the entire spectrum of fire regimes. In other words, some patches underburn with low-severity, whereas others burn down completely. In still others, fire kills small and medium trees, leaving the larger, more fire-tolerant species standing.

Wetter portions of grand fir *(Abies grandis*) and white fir (*Abies concolor*) forests, the Douglas-fir (*Pseudotsuga menziesii*) forests of the Klamath-Siskiyou region of Oregon and California, and red fir (*Abies magnifica*) forests are all classic moderate/mixed-severity fire regimes.

Though we have excluded fire in these forests, the changes are not as dramatic as in the low-severity fire regimes. We've missed fewer "rotations" of fire because the average fire return interval is 25-75 years. Nevertheless, fuel buildups have made high-severity patches more common. In addition, a subtle shift from thick-barked trees (such as ponderosa pine, *Pinaceae Pinus ponderosa*) that are more adapted to surface fires to trees more adapted to crown fires (such as subalpine fir, *Abies lasiocarpa*) is occurring at a regional scale.

High-severity (Lethal) Fire Regimes

Fire exclusion has been least noticeable in historic high-severity fire regimes found in cool and/or wet forest types such as coastal western hemlock (*Tsuga heterophylla*) or subalpine forests across western North America. These forests burn very infrequently, perhaps 1-4 times per millenium, but typically with high-intensity when the rare fire occurs. The 1988 fires of Yellowstone National Park in the western U.S. were such an event. They burned over 1.5 million acres, with several days of spectacular fire runs. On August 20, over 150,000 acres burned, driven by 50-mph winds. The intensity and spread of these fires was not a result of "unnatural fuel accumulations." This is just the way lodgepole pine/subalpine fir (*Abies lasiocarpa*) forests have always burned—intense fires leaving large patches of severely burned landscape in their wake.

While these fires can be intense enough to kill most of the forest, they create large patches that will eventually recover to mature forest. Patch sizes can be hundreds to hundreds of thousands of acres. In coastal Douglas-fir forests, some huge fires have occurred in the past. In 1902, the Yacolt fire in Washington State burned a million acres, and in 1933, the Tillamook fire in western Oregon covered over 300,000 acres. Large blocks of even-aged Douglas-fir forests grew in the wake of these fires. Around 1701, the entire eastern Olympic peninsula in Washington State burned. This event is likely linked to a magnitude nine earthquake in the area that occurred the previous year, possibly creating a sea of quake-thrown timber that dried and burned the following year.

Active Management for "Firesafe" Forests

There is no such thing as a forest free of fire. Over the past decade, we have come to realize the paradox inherent in our fire suppression efforts. The more intensely we have protected the forest from fire—as well as from insects and disease—the worse many of these problems have become. Western U.S. fire statistics show an alarming trend in wildfire severity and area burned, primarily attributable to fuel buildups in western forests. We have been sitting on a time bomb with little idea of how long the fuse is. Are we at the worst-case scenario now, or will it get worse?

Given our predicament, a realistic management goal in reserved as well as unreserved forests is to reduce potential wildfire intensities and to lower crown fire potential. This is known as managing for a "firesafe" forest.

Firesafe principles include management of three types of fuels: surface fuels, ladder fuels, and crown fuels (Table 1). Surface fuels include the dead and down debris sitting on the forest floor. Ladder fuels are tall shrubs and small trees that connect the surface fuels to the crowns of larger trees. Crown fuels are those in the overstory.

In order of priority, treatment should focus on surface fuel, ladder fuel, and then crown fuel. Reducing these fuels will limit the potential intensity of fires, provide a higher chance of controlling wildfires, and allow more of the forest to survive when it does burn. The goal should be to restore the fire resiliency of the historic forest by bringing back the fuel structure of historic low-severity fire regimes.

Passive management cannot restore these conditions; active management is necessary. The treatment can be done by fire alone, by mechanical means (logging), or by both. The means of treatment is less important than the end: a forest where surface fire behavior is reduced and/or ladder fuels are removed such that torching potential is reduced, and, as a third priority, crown density is reduced.

In this respect, reserve forests such as wilderness and parks are no different than unreserved areas. The critical factor in deciding where to invest management resources is a forest's historical fire regime. Most high-severity fire regimes are poor candidates for the application of firesafe principles. They are either at relatively low risk, due to naturally long fire return intervals, or they are forests where an alteration in fire behavior will have little effect on fire severity. Coastal Douglas-fir forests are an example of the former. With historical fire return intervals in the hundreds of years, the risk of fire is low across years and decades. Western subalpine forests are an example of the latter: none of the tree dominants are resistant to fire, as all have thin bark. Altering fire behavior may transform a crown fire to a surface fire but will have little effect on tree survival, as the thin-barked subalpine species will almost always be girdled by excessive heat at the base of the tree.

Historical low- and moderate-severity fire regimes are much better candidates for some type of firesafe treatment. They have fire-resistant trees so that an investment to alter fire behavior may restore lower fire severity. Nevertheless, there are logistic constraints, such as access, that limit the application of firesafe treatments, particularly in remote areas where many forest reserves are located.

At landscape levels, a mix of treatment intensities makes sense: no treatment on some areas, less intensive treatment (such as prescribed fire only) on other areas, and more intensive treatment involving reduction of canopy density in still other areas.

Active Management for Forest Restoration

Where passive management has been deemed ineffective, two conceptual approaches have been proposed to guide forest restoration. They have been labeled the "process approach" and the "structure approach." Both are acceptable ways to think about restoration as part of an active approach to forest preservation. The key, however, to effective management is thinking ahead.

The "process" approach relies on restoring processes such as fire to the forest ecosystem. The "structure" approach defines appropriate forest structures (patch sizes, diameter distributions, etc.) and focuses on achieving them using fire and/or mechanical means. Hybrid approaches are also possible. Whatever the mix, active management to restore forest ecosystems must be done with a view to the long-term consequences of short-term actions. Otherwise, active management will be no more successful than passive management has proved to be.

If a process approach is adopted for fire, the entire fire regime must be considered. Often, we think too narrowly about certain fire regime characteristics, such as frequency. If a historical fire frequency is, for example, an average of 15 years, we should introduce the entire distribution of fire frequencies, not just the average. The extreme frequencies (short and long) are as important as the average in terms of local biodiversity. Very short intervals, on occasion, favor sprouting understory species over those that rely on seed to recolonize the area. Longer than average intervals allow some tree species to gain a size that is sufficiently fire-resistant to subsequent low-intensity fires. A variable fire return interval ensures local diversity in the flora. Magnitude (intensity), extent, season, and synergistic properties (e.g., insects) are also important fire regime characteristics to consider. In northwestern North America, spring burning may be desired because smoke disperses more easily then, and control over fire intensity is easier in this moist time of the year. However, in this region, it is not the natural season of burning, and unintended ecological consequences may result: damage to fine roots active in the spring or disruption of ground-nesting animals. Fire is much more than a binary (present/absent) process; the whole regime must be considered.

Structural approaches also must be applied with caution. Often restoration plans call for recreating a historic or natural range of variability (percent of land area) among structural stages (grass, seedling/sapling, pole, mature, old-growth, etc.) within a landscape or watershed. Moving forest structure towards this range of natural variability becomes the management goal, but it must be carefully thought out. Here is a real example of a structurally based plan with a short-sighted approach.

A watershed in eastern Oregon dominated by ponderosa pine forest had a wide range of tree ages in the natural forest, with the oldest patches about 400 years old. The range of area that may have occurred historically within the youngest stages (grass-seedling/sapling) was roughly estimated in the plan for the national forest at 5-20 percent, with the next-largest pole stage defined to start at age 40. Large blocks clearcut in the 1970-85 period resulted in 18 percent of the landscape being in the youngest (grass-seedling/sapling) stages. In the restoration plan, managers proposed immediately cutting another 2 percent of the landscape in small group selection cuts (2-4 acres each), noting that the forest would still be within the natural range of 5-20 percent in grass-seedling/sapling structure. The authors of the plan had successfully recognized that patch sizes should be smaller, but their assumptions about area by structural stage were flawed.

If this strategy were extended over time in 40-year increments, then 40 years from now the 20 percent of the landscape currently in the grass-seedling/sapling stage would be pole-size, and another 20 percent of the old growth would be converted to the grass-seedling/sapling stage. After 200 years, managers would have cut the last 20 percent of the old-growth forest. As such, the entire forest would have five balanced age classes with 20 percent of the forest in each class (0-40 years, 40-80 years, 80-120 years, 120-160 years, and 160-200 years). No stand would be older than 200 years, and the average forest age would be 100 years.

This forest would not closely mimic the historic forest that had trees to 400 years of age and probably an average age twice that of the proposed managed forest at equilibrium. Using the high end of any range of a single age class is likely to have unintended long-term consequences. The plan could not achieve its stated goal: to bring the forest back within its historic range of variability.

One of my favorite cartoons has a balding, skinny guy peering out an apartment window with the caption, "With the bodybuilding contest only two hours away, Larry wondered what was keeping Vincent with the steroids." It illustrates a good lesson about advance planning: we will not be able to create desirable landscape structures overnight. Trees cannot respond that fast, and watersheds may not be resilient enough to absorb substantial restoration disturbance in a short period of time.

A major political debate over "forest health" issues, particularly in western U.S. forests, is now underway. Some advocates are pushing for widespread logging; others threaten lawsuits if the chain saw or fires are used as restoration tools. While they dissonantly debate, our drier forests continue to burn with high severity. Sustainable conditions will be delayed for centuries on these charred landscapes.

Some forests are at severe risk and others are not. Whether a forest is at risk has little to do with whether it is or is not designated a reserve of some kind or whether it is or is not roaded. Clearly, we should be sensitive to reserves and roads, but the problems and solutions are never so easily segregated and labeled.

Each forest is unique. It has different combinations of tree species, different environments, and different management histories. An effective preservation strategy must also be unique to place; the one-size-fits-all approach cannot succeed everywhere. In almost every North American forest ecosystem, the longevity of the major tree species exceeds the modern period of exploitation, so structure capable of restoration still exists in many places. There is real hope for ecosystem preservation when management goals broaden past extractive use. But these hopes will be short-lived unless a dynamic ecosystem management strategy is employed.

Table 1. Principles of "firesafe" forests

Principle: Reduces surface fuels
 Effect: Reduce potential flame length
 Advantage: Control easier; less torching*
 Disadvantage: Surface disturbanceless with fire than other techniques

Principle: Increase height to live crown
 Effect: Requires longer flame length to begin torching
 Advantage: Less torching
 Disadvantage:Opens understory; may allow surface wind to increase

Principle: Decrease crown density
 Effect: Makes tree-to-tree crown fire less probable
 Advantage: Reduces crown fire potential
 Disadvantage: Surface wind may increase and surface fuels may be drier

*transition of a surface fire to a crown fire whereby understory tress catch fire and bring flames to the crown.

BOX

Roads and Fire Management

In the debate over roads, fire, and passive management, beware of taking sides. Opinions range across the spectrum of advocacy from "roads are the source of all fire management problems," and passive management is the only solution, to "roads are the source of all fire management solutions," and active management is the only answer. Yet, neither of the following statements nor their parenthetic alternatives are true everywhere.

- Roads make the fire management job less (more) difficult.
- Roaded areas have potential for lower (higher) intensity fires.

Most areas where passive management is currently applied have few roads, whereas actively managed forests have more roads. In both cases, either the presence or absence of roads complicates fire management. In a comparison between federal lands (less roaded) and state and private lands (more roaded), national fire statistics illustrate this complexity. During the period 1984-1990, data from the western United States regions (including Arizona, California, Idaho, Montana, New Mexico, Oregon, and Washington) consistently showed more fires per unit area protected on state and private lands than on federal lands, with some variation by subregion. Generally, with more people and more access, there will be more fires—so roads can be associated with an increased need for fire control efforts.

Alternatively, when area burned is used as the comparative statistic, the less-roaded federal lands are harder struck than the state and private lands. Lightning strikes are a major source of ignition on federal lands. Unlike human-caused fires, however, lightning strikes do not usually start fires along or near roads. Because it is difficult to get to the more remote federal lands, response time is longer, and small fires become larger. This issue is complicated further by the typically more aggressive fire control tactics used by state fire control agencies (often with more resource damage due to those tactics). But in general, lack of road access is associated with a more difficult fire control job and larger areas burned on federal lands. Application of prescribed burning is also more difficult in the absence of roads.

Another argument is that fire intensity is higher/lower in roaded areas compared to unroaded areas. There are really several issues here that complicate an easy response to this statement. The first is that historical fire regimes in unroaded areas tend to be biased towards moderate to high-severity, as they are usually in higher elevation, more remote locations. With or without roads, these areas tend to burn with higher severity than do forests at lower elevations.

Lower elevation areas that are roaded more commonly have had low-severity historical fire regimes but have undergone more significant changes associated with decades of fire exclusion and selective logging that removed the largest, most fire-resistant trees. These changes had a double-whammy effect on fire: fire intensities increased over historic levels and the residual forest structure and composition was less fire-resistant. Fire severity has increased more in roaded areas than in unroaded areas as a result. Today, we often see little difference in fire severity between what were historically quite different fire regimes as forests are converging on uniformly higher levels of fire severity.

Does this mean that any future active management that includes harvesting of trees must follow the same trend? Only if the same old logging methods are used. If future logging in roaded areas follows the principles of firesafe forests, future wildfire intensity and severity would decline, particularly for low- and moderate-severity fire regimes.

Suggested Readings:

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