Disturbance Ecology in the Northern Rockies: One Perspective

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Abstract—Since early 1900s forestry, ecology and related professions have been aware that *external* disturbances had important effects on the development of vegetation. However, the *integral* part they play in ecosystem development and sustainability across time and space was largely underappreciated. Failure to provide appropriate disturbances can place stable and productive species and ecosystems at great risk. Seral western white pine and ponderosa pine are prime examples. Solutions to several critical problems are available and must be more widely implemented, with the support of all parties…soon. It is already too late to prevent significant losses.

Disturbances Typical of the Inland Northwest

Although fire has been the dominant physical force affecting the evolution and development of most interior western forests (Arno 1980), many other forces are also active and may be even more important locally, depending on windows of opportunity. For example, given proper stand developmental history, localized drought, snow, ice, winds, tip-overs, etc., can all incite major changes, including responses from native insects and pathogens. The current problem with the Douglas-fir beetle (*Dendroctonus pseudotsugae* Hopk.) is a good case in point (Carree 1998). Frequent importations of exotic vegetation, insects or pathogens probably were not rare to the region in the past but are obviously even less so in the face of increasing human activities. White pine blister rust (*Cronartium ribicola* J. C. Fisch.) is a classic example of an import causing far-reaching changes (Harvey and others 1994; Monnig and Byler 1992). Changing climate is not unique to this region (Mehringer 1985), but is likely to become more important to future forest management (Franklin and others 1991). Two examples are: (1) the relatively recent (2,000–2,500 year) appearance of western red cedar (*Thuja plicata* Donn.) and western hemlock (*Tsuga heterophlla* [Raf.] Sarg.) that accompanied an increase in temperature and moisture in the region (Mehringer 1985; Whitlock 1992), and (2) locally moving ecotones in pinyon-juniper (*Pinus edulis* Engelm. *Juniperus monosperma* [Engelm.] Sarg.) and ponderosa pine (*Pinus ponderosa* Laws.) woodlands as a result of localized drought (Allen and Breshears 1998). However, perhaps the greatest potential for bringing about change in current forests, mostly destabilizing change, will be the backlash from lack of physical disturbances during their development (Baker 1992). Thus we have the current dominance of late seral and climax species, with related health problems, in forests throughout the region (Atkins and others 1999; Harvey and others 1992; Monnig and Byler 1992). In effect, lack of physical disturbance may produce greater and longer lasting biological change than the most spectacular of physical disturbances.

Implications of Changing Disturbance Regimes

Landscape-level changes in disturbance regimes have ramifications not only from the standpoint of creating current forest conditions (Hann and others 1997; Quigley and others 1996; Lemkuhl and others 1994), but also in changing the history of their development. Since the biotic history of forests in the region is relatively short (a few thousand years) we should expect that vegetative communities are not well enough developed to be stable in the face of substantial change (Whitlock 1992). Thus, we can expect them to be reactive. The lack of, or change in, historical disturbance regimes has radically altered regional forests, leading to broadscale conversion of dominant vegetation, primarily favoring climax species (Quigley and others 1996) but without normal successional processes. So, not only are regional forests outside their historic norms (historic range of variability [Morgan and others 1994]), they got there without the "normal" successional processes that provide specific types of preceding vegetative and possibly soil developmental histories. Therefore, current vegetation can be viewed as largely "off-site," both spatially and temporally, above- and belowground (Harvey and others 1999). That condition is likely to have undesirable impacts on the future stability, productivity and sustainability of these forests.

Current Conditions and Their Connection to Disturbances

Interior forests show large-scale changes in species compositions and accompanying above- and belowground structures and nutrient distributions. For the most part, changes are characterized by a general shift from open ponderosa pine to closed pine and/or Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) stands in dry ecosystems (Covington and others 1994; Gast and others 1991). In moist forests, the change has been from tall, moderately closed pine/larch

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(*Pinus monticola* Dougl. ex. D. Don/*Larix occidentalis* Nutt.) to relatively short closed grand fir/hemlock/cedar (*Abies grandis* [Dougl. ex. D. Don.]) stands (Byler and others 1994; Harvey and others 1994; Moeur 1992; Monnig and Byler 1992). The lack of fire in dry ecosystems (Covington and others 1994) and the importation of white pine blister rust into moist ecosystems (Monnig and Byler 1992) essentially changed the workings of two of the most productive, stable and forgiving (in terms of both management and natural disturbances) ecosystems in north America. As a result, these ecosystems have changed to ones dominated by species not capable of doing so under historic conditions. The lack of physical disturbances has now opened the door to major biological disturbances! Further, blister rust now also threatens many populations of high altitude and southwestern five needle pines (Keane and Arno 1993; Hawksworth 1990)

Where Are We Headed?

With the possible exception of stands dominated by western red cedar on especially moist sites and ponderosa pine on dry ones, productivity, value, and stability of seral species dominated ecosystems exceeded that of most other species combinations throughout the heart of the interior west. As a result of frequent actions from a variety of insects and pathogens, and related fuel accumulations, dominance by climax species will likely lead to significant losses in both productivity and longevity (Harvey and others 1999).

The shallow rooted, low and dense crowns of climax species (Minore 1979) will lead to more strongly horizonated soils with larger accumulations of litter on the surface than characteristic of forests dominated by seral species (Harvey and others 1999). This can lead to rapid immobilization of nutrients, especially nitrogen, in surface horizons. Located at the surface, nutrients are subject to the losses associated with any severe disturbance, especially fire. In the absence of disturbance, nutrient tieup can lead to vegetative stagnation, in moist, cool forests, perhaps within a single generation (Bormann 1995; Kimmens 1994).

The potential, and perhaps likely ultimate outcome of effectively eliminating appropriate disturbances will be forests dominated by species with high nutrient demands, where nutrient storage may be increased but cycling rates increasingly depressed. This will lead to a cycle of increasing stress, with associated endemic insect and pathogen activities creating a domino effect that destabilizes ecosystems (excessive mortality and more frequent fire). Thus, this leads to inappropriate sensitivity to and long-term damage from the same disturbances that once created a highly productive and stable forest ecosystem that was well adapted to intrinsic disturbances, including historical fire cycles and the activities of native insects and pathogens.

As seral species increasingly lose their ability to attain at least a codominant position, they will lose their ability to produce seed. And, without disturbance-related openings, any of the shade intolerant seedlings that are produced will quickly lose out to competition from large numbers (4–6,000 ha (10–40,000 acre)) of shade-tolerants (Graham 1990).

Perhaps most important in this species conversion process is a potential change in genetic strategy of the dominant conifers (Rehfeldt 1994). This change, from one of wide adaptability and tolerance for endemic insects and pathogens (seral species) to one of narrow adaptive capacities likely predisposed to stress (climax species), may make these forests highly susceptible to destabilization (Harvey and others 1999). In historic forests dominated by seral species, insects and pathogens probably served as stabilizing agents, removing maladapted late seral and climax species relatively early in stand development, preserving only the best of the latter and generally encouraging dominance of the long-lived serals (Harvey and others 1999; Lehmkuhl and others 1994). Such a radical change of endemic processes in dominant ecosystems is likely to have far reaching (largely undesirable) effects on the productivity, stability and management (or lack thereof) of regional forests (Atkins and others 1999; Harvey and others 1994, 1999; Monnig and Byler 1992).

A Window to the Future

Since we are continuing to lose ground with seral species, especially with western white pine and ponderosa pine, it is evident that current approaches have not been and will not likely be sufficient to restore those ecosystems. This loss has become abundantly clear as a result of widespread fire and overcrowding in dry forests and from the salvage logging of infected western white pine. Large trees infected in the 1940s and 1950s gradually succumbed to a combination of the rust and western pine beetle (*Dendroctonus ponderosae* Hopkins) during the last 20 years. The largest tree on "white pine drive" in northern Idaho was removed as a hazard to the public in 1998. In 1975, that area was still deserving of the name. Today there is hardly a white pine to be seen there and, when was the last time you visited a classic ponderosa pine-dominated forest stand in a Douglas-fir habitat type?

Without aggressive intervention, sufficient to change current trends, the outlook for many native ecosystems, particularly those featuring ponderosa pine and western white pine as the primary serals are obviously not good. Although some current efforts have had success and workable solutions for most problems inherent to both dry and moist forests are available (Covington and others 1994; Oliver and others 1994a,b; Mutch and others 1993; McDonald and Hoff 1991), they have not been applied broadly enough to substantially alter present trends. A continuing lack of appropriate disturbance is probably the greatest single threat, with the possible exception of more exotic pests, to future sustainability and productivity of interior western forests.

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