Managing for Landscape Level Diversity Based on Observed Disturbance and Stand Development Patterns [1]

Introduction

Landscape level diversity is the result of differences among the stands on the landscape. Between stand diversity is not random. It is the product of site conditions, disturbance history, and mechanics of recolonization. Applying a single prescription or a narrow range of prescriptions to all stands across the landscape will reduce the contrast between stands. That, in turn will reduce the range of potential habitats across the landscape. We cannot identify, let alone consciously manage for, all possible habitats. What we can do is manage for a range of variation both within stands and between stands that is in context with the physical characteristic of the land and plausible disturbance patterns. This means some stands will be very complex while others are simple. The simple stands may not have the range of niches that the more complex stands have but they will have some niches that do not exist in the complex stand.

Aspect and topographic position can be used to stratify the landscape. Much of the naturally occurring variation on a landscape scale is a product of variations in temperature and moisture, as locally modified by aspect, topographic position, and slope. In turn, they strongly affect fire regime, vegetation communities and to some extent soils. Available light, as controlled by vegetation competition and serial stage also interacts with temperature and moisture to shape landscape scale diversity. Tree crown architecture, variations in stand densities, distribution of tree species vertically within stands and horizontally across the landscape found in old-growth stands is strongly influenced by vegetation competition at the time of stand initiation and fire intensity variations (both stand replacing and stand modifying fire), as influenced by topographic position and aspect.

The patterns described in this document were observed in Oregon Coast Range east of Coos Bay and entirely inside the *Tsuga heterophylla* Zone.

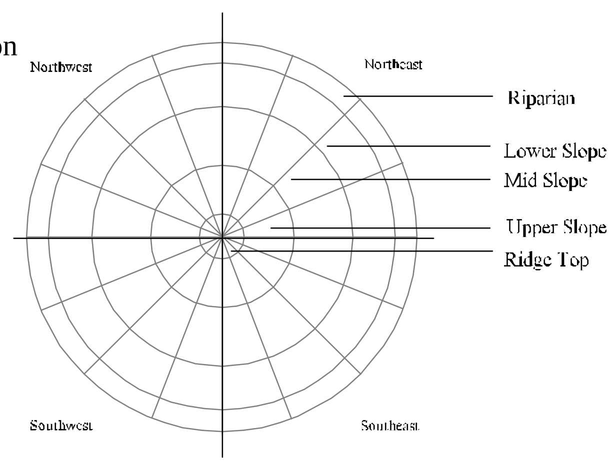

Figure 1: Polar diagram showing aspect and slope position

<u>Polar diagrams- applications and limitations</u>

The polar diagrams used in this document are in effect contour maps of cone shaped mountains with the peak at the center of the diagram and the base of the mountain/riparian zone on the perimeter. Figure 1 shows the relative location of aspects and slope positions in the polar diagrams. Some polar diagrams, in this document, illustrate a range of fire

[1] This document is an extensive update of a conceptual model for managing landscape level diversity that was first presented in the 1995 North Coquille Watershed Analysis [since replaced by the North Fork Coquille Watershed Analysis]. A slightly edited version of the original model was included as Appendix A in the LSR Assessment (USDI; USDA 1998). This document reflects the additional observations made when preparing fire histories for other sites on the Coos Bay District (Fire History Appendix).

severity patterns with respect to topographic position and aspects. Other polar diagrams illustrate the stand structural patterns that develop in response to different fire patterns.

The polar diagrams represent the affects of aspect and topographic position on fire and by extension on stand development patterns. Their simplistic nature does not take into account the affect of variations in slope nor the affects of weather on burn patterns nor unusual site conditions like high fuel concentrations due to bug kill or blowdown. We can use the affects of slope angle in conjunction with the polar diagrams to fine tune predictions of fire and vegetation patterns. However for purposes of modeling landscape patterns, fire generated weather and unusual fuel loads are best viewed as wildcards. They may be useful to explain localized anomalies, but at the larger landscape scale, their importance is not in controlling the distribution of stand patterns across the landscape but rather contributing to the fuzzy boundaries and jagged edges associated with the extremes of natural variation.

Fire Effects at the Landscape Scale

Fire intensity, fire severity, and tree mortality

Fire intensity is the function of the energy content of the fuel, the amount of fuel consumed and the rate of spread of the fire. Fire line intensity can be linked to some ecological effects like crown scorch (Agee 1993).

Fire severity indicates the proportion of the trees killed. This is a function of the fire intensity and the fire tolerance of the different tree species in the stand. A low severity fire kills few trees. A high severity fire kills all or nearly all trees. A medium severity fire is intermediate between the other two. For discussion purposes, high severity fires kill more than 80% of the trees, low severity fires kill less than 20% and medium severity fires cause mortality levels in between those values. Fire severity is also relative to area. A low severity fire that covers a large area may contain small areas of high mortality, and a high severity fire may leave small pockets with low mortality. Large moderate severity fires are commonly mosaics of smaller patches with high, moderate and low levels of mortality (Agee 1993). This is illustrated in figure 2.

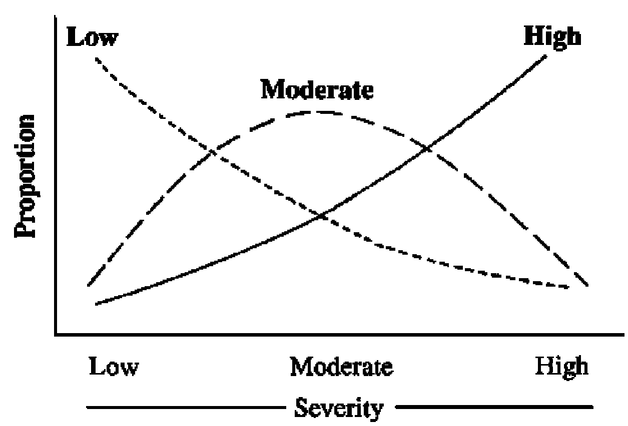

Figure 2: This figure, from Agee (1993) shows the variation in fire severity within a general fire-severity type. The general fire-severity types differ in proportion of each fire-severity level present, with moderate severity fire regime having the most complex mix of low, moderate, and high severity fires.

Table 1, at the end of this paper, includes several polar diagrams showing different levels of fire severity and tree mortality patterns. The reader should not assume these examples are discrete types. Rather, the diagrams are arbitrary points along a continuum between a light ground fire causing no mortality and a stand replacing fire causing 100% mortality. Also the lines between areas of different severity are not hard boundaries but rather are relative positions that vary along a continuum.

Changes in slope angle and the affects on fire and vegetation patterns

Slope angle affects fire patterns in two ways:

- Fires moving up a steep slope are more effective at preheating and drying fuels than fires on gentle slopes or flats. The more effective a fire is at preheating fuels, the greater the fire intensity.
- The rate water in the soil drains from the site is proportional to slope. All other factors equal, steeper slopes have less available soil water and this results in drier live fuels. Drier fuels allow higher fire intensities.

Consequently, fires on steep north facing slopes can cause higher tree morality and conversely, upper slope benches and broad flat ridge tops may exhibit lower burn severity than otherwise predicted using aspect and topographic position alone. The polar diagrams used in this paper do not take these variations in slope into account.

Landscape scale high severity fire and the resulting landscape pattern

The most severe fire, on the landscape scale, will kill all trees from ridge top to creek bottom and on all aspects. Before management, these stand replacement fires were often a complex of burns and reburns that occur during periods of extreme drought. Scattered trees may escape dying during the fire (figures 3 & 4). However over the next few decades, many of those trees that lived through the fire die slowly from stress. This stress is the result of increased exposure to the drying affects of wind, sudden exposure of the entire crown to full sunlight, direct heat injury to the crown reducing photosynthetic surface, and loss of those fine roots consumed by the fire as it burned the organic layer. The stress is further accentuated by the fact that large old trees consume most of their photosynthate through respiration leaving little for regrowth of fine roots, replacement of needles, or production of protective chemicals and pitch to ward off insect and disease attacks (Oliver; Larson, 1990). Landscape level diversity, following this extreme of an event, will correspond to the interaction of physical site characteristics like

- aspect
- topographic position
- availability of soil moisture

Figure 3: The circled area on this aerial photograph is a small high severity burn on a ridge that subsequently regenerated. A few trees survived inside the high severity burn area. The same fire was a low severity burn on the ridges radiating out from the high severity burn area. This site is in the divide between Little North Fork Coquille River and Alder Creek.

and biological factors like

- seed source and aggressiveness of light-seeded pioneer species.
- the presence and competitiveness of stump sprouting shrubs and hardwoods
- amount of rodent clipping/ big game browsing pressure resulting in or contributing to seedling mortality

The combined affects of the physical and biological factors resulting in different stand development patterns on north versus south aspects as illustrated by figure 5. Figure 5 was developed by measuring trees along transects in a 230-year old stand that had comparatively uniform north and south facing slopes. This stand has not been modified by fire since the stand first became established. Based on observations in other stands and on examining aerial photos, the stand structure shown in figure 5 is representative of hemlock zone late-successional/ old-growth stands in the Coast Range that have not been modified by disturbance beyond the affects of competition and individual tree and small gap mortality. Figure 6 is an aerial photograph showing the stands illustrated in figure 5. Figure 7 is a polar diagram showing the relative positioning of the north aspect and south aspect stands on the landscape.

Figure 4: This is a high severity burn area with small pockets of surviving trees. Some of those trees will later die from stress. The site is inside the 1951 Weatherly Creek Burn.