Stand structural patterns as affected by fire intensity, vegetation competition and animal damage

The stand structural differences between the north and south facing slopes, shown in Figures 5 and 6, are due to differences in fire intensity, and relative growth rates of the shrubs typical for each aspect. Other factors affecting the difference between the aspects are mountain beavers, which are common in north facing draws, and the greater tendency for red alders to establish on the more moist north aspects following disturbance. Mountain beaver clipping and red alder competition limit both distribution and numbers of conifer. Vine maple and salmonberry aggressively resprout and effectively compete for growing space on north aspects. These shrubs may even survive fires uninjured in moist microsites in draws and headwalls. Together, they can exclude conifers from moist areas, which over time results in gaps in the forest canopy characteristic of north aspects.

Fire intensities are typically greater on the south aspects. The higher fire intensities expose larger more uniform expanses of mineral soil, and are more effective at killing or severely retarding stump sprouting hardwoods and shrubs. In addition, the shrubs found on the south facing slopes (evergreen huckleberry, rhododendron, salal, and Oregon grape) are less competitive plants because of their slower growth rates compared to shrubs typical of north aspects.

Characteristics of stands, on south facing slopes, where there are no indicators of underburning

The overstory is almost entirely Douglas-fir and most of those occupy the co-dominant position. The few western redcedars and hemlocks present are in the intermediate position. The stands are often single story. Some stands are two story with a Douglas-fir overstory and a myrtle understory. The few understory western hemlocks and cedars are found next to gaps in the overstory created by snap-outs, blowdown, root rot or other random mortality.

The canopy is very uniform and the stands well stocked. The uniformity and density on the south slopes cause the tree crowns there to be 65% to 80% of the crown sizes on the north aspects, based on measurements made on aerial photos. When there are large openings, they are associated with blowdown, root rot pockets, and nonforest ground. In mature stands, there are open spaces between the crowns, which are the result of the crown abrasion during high winds. That space allows enough light to reach the forest floor to support a moderate to a dense brush layer on most sites.

The branching pattern on the Douglas-fir suggests a past period of very high crown competition. The upper 30% to 40% of most Douglas-firs exhibit a normal branching pattern with the middle third often exhibiting fan-shaped epicormic branching. The fan shaped branching is stimulated on the boles of the surviving trees as light levels increase inside the stand following competition mortality of the less vigorous trees the stand. The fan shaped epicormic branches are of particular interest in that they provide nesting platforms and substrate for epiphytes.

Shrubs, which are on most sites, exclude conifer regeneration in the understory. The understory conifer that is present is usually associated with some form of soil exposing disturbance like a small slide or a root wad hole. The plant associations usually found on these sites are characterized by sclerophyllous shrubs like Oregon grape, salal, rhododendron and evergreen huckleberry. As one moves down the slope or around the hill to cooler more moist locations on the landscape, the plant associations characterized by sclerophyllous shrubs give way to associations indicative of more mesic conditions. There is also a corresponding change in the stand structure to that more typical of north facing slopes and lower topographic positions.

North facing slopes, where there is no indication of underburning have the following characteristics
The forest canopy has a rougher texture than south facing stands as seen on the aerial photos. This is due to several factors. There are more gaps in the canopy. The overstory canopy closure is in 40% to 70% range. As viewed from the ground, the openings in the canopy sit over brushy areas (typically vine maple or salmonberry). The area just back from the margins of the gaps are often occupied by redcedars, hemlock and sometimes bigleaf maple. Little conifer regeneration exist elsewhere in the stand except where disturbance has freed up growing space[1]. There is a more pronounced differentiation of the Douglas-fir into crown classes, and a greater variation in crown lengths, when compared with Douglas-fir on the south facing slopes.

Crown gaps are occasionally observed on steep sloped north facing head walls with swordfern ground cover. Observations of the Douglas-firs next to these gaps (with respect to the height of the base of the crowns, branch size, and presence of epicormic branching on the exposed lower bole facing into the gaps) suggest the gaps had supported red alders during the first 80 to 100 years following stand initiation.

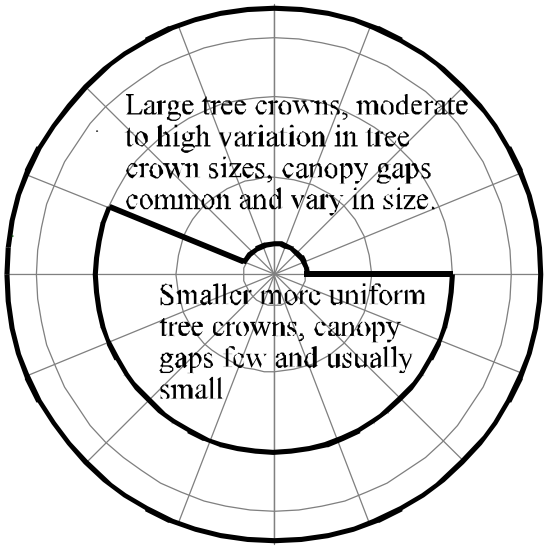


Figure 7 Relative positions of stand types that establish following a stand replacement fire where there have been no subsequent stand modifying low to moderate severity disturbance.

Redcedar and hemlock are more common on the north than on the south aspect. Like on the south aspect, they are typically found in the intermediate crown position, and most often next to gaps between Douglas-fir crowns.

The riparian zone is included with the north facing/ lower slope stand type, however features characteristic of riparian zone stands merit discussion. The riparian zone has:

- the highest level of vegetation competition
- is the most likely area on the landscape to support mountain beavers
- is the least frequently burned area on the landscape and when fire does enter this area it typically burns with less intensity
- however, landsliding/ debris torrents traveling into and through the riparian zone result in this part of the landscape having the highest disturbance frequency.

These factors cause the riparian stands to differ from the rest of the landscape in the following ways:

- High shrub competition, particularly in riparian areas with salmonberry, vine maple and red alder, limits conifer regeneration resulting in low conifer stocking levels and large gaps in the overstory canopy.
- Similarly, high shrub competition where there are salmonberry, vine maple and other aggressive shrub species all but prevents establishment of understory conifers in the absence of disturbances and limits regeneration success when there is a disturbance.

[1] Where old-growth stands are found with abundant well distributed understory regeneration, close examination will show evidence for a wide spread soil exposing disturbance like an underburn or salvage logging.

- Conifers that do grow above the competing vegetation and are outside of the debris torrent/ landslide tracks can grow to be very large due to the low competition for light.
- Red alders are maintained as a component in the landscape inside the debris torrent/ landslide tracks
- Bigleaf maple are favored where the high moisture levels at the toe of the slope and deep well drained soils in the landslide deposition areas provide optimum habitat for the species.

Low and Moderate Severity Fire and How They Modify Stand Structural Patterns on the Landscape

Stands regenerated following a fire, which killed all previously existing trees on the site, are even-age and predominantly Douglas-fir. If these stands experience subsequent low to moderate severity fires then there may be one or more additional age classes. In multi-cohort[2] stands, Douglas-fir is usually the only species representing the oldest age class. Hemlocks and cedars, with their thin bark and shallow roots, are less fire tolerant than the Douglas-fir and only survive very cool fires or in the unburned patches left by those fires that burn in a mosaic pattern. On those sites where the subsequent fire killed most of the older age class of trees, the younger age class is dominated by Douglas-fir. Where the second fire kills only a few of the older trees, the resulting partial shade favored establishment of an even-age understory hemlock stand (Hofmann, 1924). As a result, understory stands that regenerated following low to moderate severity fires not only occupy a different canopy strata and are younger than the overstory trees, they also are composed of different tree species.

Figure 8: This is a moderate severity burn area inside the 1938 Smith River Burn. This photograph was taken in 1951 and shows a recovering shrub layer and understory trees regenerating. The location is section 1, T.21S.,R.9W., W.M.

There are other types of disturbances that can also open the overstory canopy thereby increasing the light levels. These include blowdown and insect and disease caused mortality. Where there is advance tree regeneration that can respond to the increased light levels, then the openings will be occupied by trees. Not all advance regeneration is vigorous enough to stand the shock of sudden exposure to increased light levels and air movement. Where there is only brush in the opening created by mortality in the overstory, that brush will increase in vigor and mass often excluding new regeneration from seed.

[2] A cohort is a group of trees regenerating after a single disturbance. A multi-cohort stand is a stand that arose after two or more disturbances. All but the first disturbance would be less than stand replacing in severity (Oliver; Larson, 1990).

The most complex landscapes on the Umpqua Resource Area support stands initiated during the 1534-1622 fire episodes. These stands were modified by moderate severity fire(s) during the 1735-1780 fire episode and further modified by low to moderate severity fires dating from the 1845-1855 and/or the 1885-1942 fire episodes. Figure 9 is an aerial photograph of a complex landscape resulting from multiple fires. These landscapes are characterized by the following features:

- The southwest facing ridges often support stands that are a single age and single story. These are the most recently burned areas on the landscape, and appear to be more frequently burned than the rest of the landscape. Consequently, these are the youngest wild stands on the landscape.

- The south to west facing slopes, and the upper ridge locations on other aspects support two or three cohorts divided into two distinct canopy stratum. The upper stratum is occupied by older Douglas-fir. The most common overstory age class is younger than 300 years old. The lower stratum is occupied by younger even-aged hemlock with an occasional Douglas-fir.

- North facing slopes, and the lower slopes usually support three cohorts and sometimes a fourth cohort. The upper stratum is occupied by older Douglas-fir. (1535-1630 and/or 1735-1790 birth dates.) The lower stratum is occupied by younger even-aged hemlock with an occasional Douglas-fir.

Generally landscapes dominated by stands that established as the result of the 1735-1780 fire episode and later subject to low to moderate severity fires are less complex:

- The south to west facing slopes, and the upper ridge locations on other aspects support two cohorts divided into two distinct canopy stratum. The upper stratum is occupied by older Douglas-fir dating to 1735-1790. The lower stratum is occupied by younger even-aged hemlock with an occasional Douglas-fir regenerated either during the 1845-1855 or the 1885-1942 fire episodes. On some sites, the understory is dominated by stump sprouting shade tolerant hardwoods. There are a few small patches of young trees on south facing ridge tops that date to local fires after 1900.

- North facing slopes, and the lower slopes usually support a single story stands that show little evidence of underburns.

Application to Management

<u>How Managing for Late-Successional Characteristics Differs from Managing for Economic Objectives</u>
Conventional forest management practice is in many respects modeled on the south facing upper / midslope stand type that established following a stand replacement event. This is because the well-stocked (but not overstocked) uniform single cohort stands produce high timber yields within an economically advantageous time frame. Consequently, a common goal in conventional forest management is to culture all managed stands on all aspects and slope positions in the landscape so they take on the desirable characteristics of the south facing upper/ midslope stand type. This accomplished through prompt stand regeneration with treatments to lessen the affects of animal damage and vegetation competition on seedling survival and stand uniformity.

Stands managed for a timber objective are usually cultured to attain maximum merchantable stand volume/ acre at the expense of maximum individual tree growth (Smith 1962). In contrast, recent

research indicates that the Coast Range stands that survived to become the old-growth stands on the landscape today began as understocked stands. The lower stocking levels in those stands allowed more rapid individual tree growth. The typical tree that survived to become an old-growth tree was about 20-inches in diameter by age 50-years (Tappeiner *et al.* 1997). Douglas-fir stands managed for timber objectives typically average 20-inch dbh at stand age 80 to 100-years. We do not know why stands that were well-stocked 200+ years ago are not represented among the old-growth stands we see today. However, we do know that densely grown stands are at a greater risk of blowdown and insect attack than more open grown stands. We also know that trees grown in well-stocked and over-stocked stands have high crown continuity and therefore greater fuel continuity which puts the stand at a greater risk of a sustained crown fire when there are extreme burn conditions.

The classic multi-canopy, multi-species old-growth forest with large overstory Douglas-fir trees with large snag and down wood is a disturbance dependent system. Understory regeneration necessary to obtain multi-aged, multi-canopy, stand structure is dependent on disturbance. Disturbance sets back the herb and shrub layers and by that provide the necessary growing space to allow understory initiation and growth (Oliver; Larson 1990).

Figure 9: This aerial photograph was taken in 1950 of Skeeter Camp Ridge in sections 23, 24, 25 & 26, T.27S.,R.10W., W.M. Coarse textured stands with large-crowned Douglas-firs occupy the north facing slopes. The overstory stands on the south slopes are populated with small-crowned Douglas-firs. The stands on the south facing slope that have a smooth texture are where low severity fire(s) burned. The south face stands, with more open canopy, are where moderate severity fire(s) burned. The fire responsible for the open canopy condition in some south facing stands was a high severity burn on the ridge top and the upper south to southwest slopes that resulted in stand replacement.

Example Prescriptions for Attaining Landscape Scale Diversity

The following prescriptions are examples of how an ID team may approach attainment of landscape level diversity in a density management project. These are not the only approaches. Site conditions may dictate different approaches and ID teams identify different means to attain landscape level diversity.

Stand treatments in common to the following examples:

- Insure fire tolerant tree species are well represented as leave trees. Provide for future understory regeneration by leaving shade tolerent conifer species, in sufficient numbers, to provide a seed source.
- In stands with few hardwood trees and in stands where the hardwood component is largely confined to the understory, generally leave all hardwoods except where cutting hardwood species is necessary to meet other management objectives or to provide for an operably feasible unit.
- Cutting hardwoods may be necessary to put some stands on a trajectory to develop into old-growth. Examples are:
    - In stands where hardwoods are competing with conifers trees needed for the future stand overstory or where understory hardwoods are sufficiently abundant as to limit the regeneration of an understory conifer component.
    - cutting hardwoods may be necessary to provide growing space for longer lived tree species associated with late-successional conditions, or to provide for future recruitment of large decay resistant wood to streams, and future recruitment of large snags
    - cut alders trees and alder patches when those trees regenerated as a result of past management activities like road building or logging.
- Where possible provide sufficient growing space to obtain and average stand dbh of 20 inches between ages 50 and 60-years.

Example 1: Stand objective to develop characteristics consistent with a wild stand that regenerated following a stand replacement fire, but which has not been affected by subsequent stand modifying fire:

- Do not actively encourage or discourage understory regeneration.
- Ridge top, south to west facing mid and upper slopes only (Treatment Area 1 shown in figure 10): Thin the stand from below considering both leave tree size and spacing when marking.
- North facing mid and upper slopes and lower slopes on all aspects only (Treatment Area 2 shown in figure 10): Thin the stand from below using a diameter limit cut. Consider spacing only where a diameter limit cut would result in a gap larger than a quarter acre.

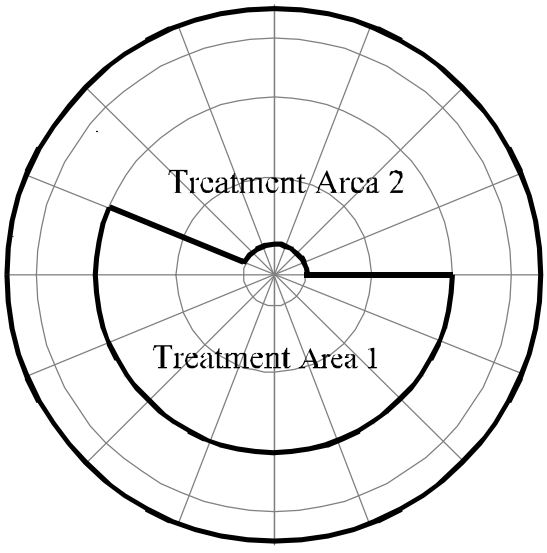


Figure 10

Suitable areas to apply this prescription:

- Areas where habitat connectivity is a priority
- Stands where a conservative thinning is prudent because of a risk of blow down

Additionally, this prescription is suitable for the first entry where a second density management entry is anticipated. In this case, the objective of the first entry is to set the overstory trees on the path to develop old-growth associated stand canopy, tree crown architecture, and stem diameters consistent with the stand's location on the landscape.

Example 2: Stand objective to develop characteristics consistent with a wild stand that regenerated following a stand replacement fire, which has been subsequently modified by a low severity fire.

Ridge top and south to west facing upper slope (Figure 11, treatment area 1):

- Thin from below considering both leave tree size and spacing when marking
- Thin to a spacing that will allow shade tolerant tree species to regenerate, establish and begin to grow.
- Set back the herb and shrub layers to provide growing space for the newly regenerated understory trees. Expose mineral soil if relying on natural seeding. Follow through with a planting contract if relying on artificial regeneration.
- The desired understory stand will consist of patches of flat-topped shade tolerate conifers capable of releasing and capturing growing space created when fine scale disturbances open gaps in the overstory stand.

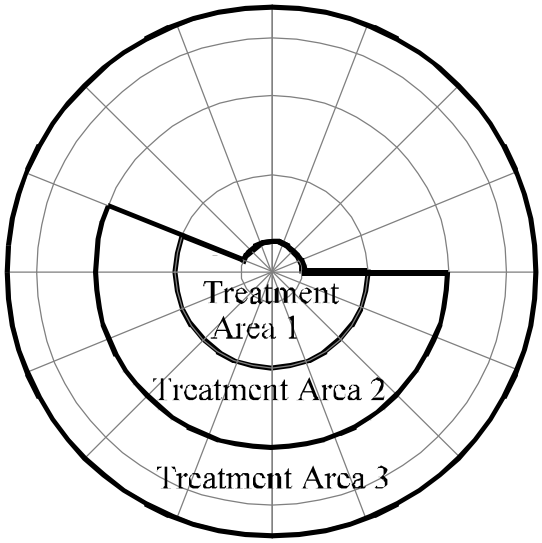


Figure 11

South to west facing mid slopes (treatment area 2 on figure 11):

- Thin from below considering both leave tree size and spacing when marking
- Do not actively encourage or discourage understory regeneration.

North facing mid and upper slopes and lower slopes on all aspects only (treatment area 3 on figure 11):

- Thin from below using a diameter limit cut. Consider spacing only where a diameter limit cut would result in a half acre or larger gap.
- Do not actively encourage or discourage understory regeneration.

Example 3: Stand objective to develop characteristics consistent with a wild stand that regenerated following a stand replacement fire, which has been subsequently modified by a low severity fire which had a moderate to high severity component.

Ridge top

- Thin the stand to 50 to 60 trees/ acre and/or cluster several quarter acre sized gaps in this area.
- Set back the herb and shrub layers to provide growing space for the newly regenerated understory trees. Expose mineral soil if relying on natural seeding. Follow through with a planting contract if relying on artificial regeneration.
- The desired understory stand will consist of patches of shade tolerate conifers and scattered individual shade intolerant conifers capable of surviving and long term growth.

South to west facing upper slope:

- Thin from below considering both leave tree size and spacing when selecting leave trees.
- Thin to a spacing that will allow shade tolerant tree species to regenerate and begin to grow but not wide enough to insure long term vigor.
- Set back the herb and shrub layers to provide growing space for the newly regenerated understory trees. Expose mineral soil if relying on natural seeding. Follow through with a planting contract if relying on artificial regeneration.
- The desired understory stand in area away from the ridge top will consist of patches of flat-topped shade tolerate conifers capable of releasing and capturing growing space created when fine scale disturbances open gaps in the overstory stand. Shade tolerant conifers would be capable of survival and long term growth in areas adjacent to the more open ridge top,

South to west facing mid slopes only:

- Thin from below considering both leave tree size and spacing when selecting leave trees
- Do not actively encourage or discourage understory regeneration.

North facing mid and upper slopes and lower slopes on all aspects only:

- Thin from below using a diameter limit cut. Consider spacing only where a diameter limit cut would result in a half acre or larger gap.
- Do not actively encourage or discourage understory regeneration.

Example 4: Stand objective to develop characteristics consistent with a wild stand that regenerated following a stand replacement fire, which has been subsequently modified by a moderate severity fire.

Ridge top, south to west facing upper slopes and southwest facing midslopes (figure 12, treatment area 1):

- Thin the stand to 50 trees/ acre or less and create several quarter acre sized gaps in this area. Concentrate the gaps at the ridge top and on the southwest aspect. The REO Review Exemption Criteria allows for 3 to 10% of a unit to be thinned to less than 50 trees/ acre and 3 to 10% of the unit to be in quarter to half acre gaps.
- Set back the herb and shrub layers to provide growing space for the newly regenerated understory trees. Expose mineral soil if relying on natural seeding. Follow through with a planting contract if relying on artificial regeneration.
- The desired understory stand will consist of shade tolerate conifers with patches of shade intolerant conifers capable of surviving and long term growth.

West facing and south facing mid slopes and southwest facing lower slopes (figure 12, treatment area 2):

- Thin the stand from below considering both leave tree size and spacing when marking
- Thin the stand to a spacing that will allow shade tolerant tree species to regenerate and begin to grow but not wide enough to insure long term vigor.
- Set back the herb and shrub layers to provide growing space for the newly regenerated

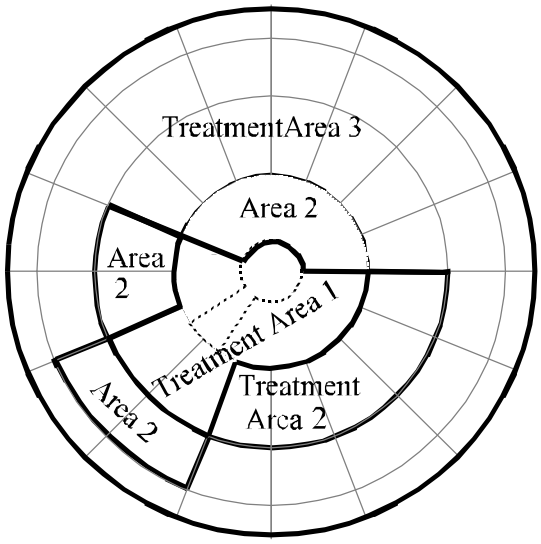


Figure 12

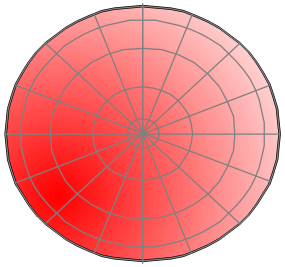
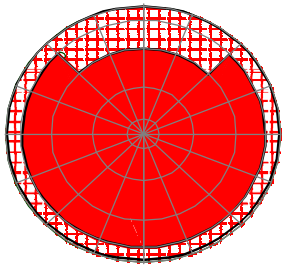
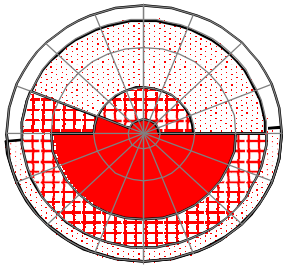
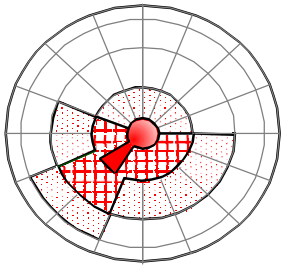
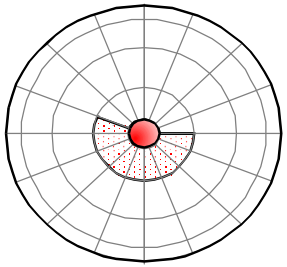
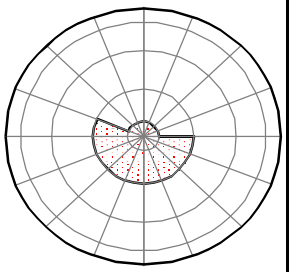
understory trees. Expose mineral soil if relying on natural seeding. Follow through with a planting contract if relying on artificial regeneration.

- The desired understory stand in area away from the ridge top will consist of patches of flat-topped shade tolerate conifers capable of releasing and capturing growing space created when fine scale disturbances open gaps in the overstory stand. Shade tolerant conifers would be capable of survival and long term growth in areas adjacent to the more open ridge top.

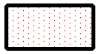
North facing mid and upper slopes and lower slopes on all aspects only (figure 12, treatment area 3):

- Thin the stand from below using a strict diameter limit cut. Consider spacing only where a diameter limit cut would result in a half acre or larger gap.
- Do not actively encourage or discourage understory regeneration.

Table 1: Fire Severity and Tree Mortality at the Landscape Scale

High severity fire: >80% mortality within the burn area.		Moderate severity fire: between 20% and 80% mortality within the burn area*.		Low severity fire: <20% mortality within the burn area	
					
Few if any surviving patches.	Surviving patches in moist topographically protected locations	Landscape and stand size moderate severity fires usually have more complex burn patterns than either low severity or high severity fires. By extension, moderate severity fires give rise to more complex stands and landscapes than do high or low severe fires. In real world landscapes, the high, moderate and low severity burn areas can be large patch to stand size where there is little topographic complexity i.e. smooth uniform slopes and few spur ridges. Where real world landscapes are topographically complex i.e. high stream dissection, numerous spur ridges, the burn patterns will be corresponding complex consisting of a mosaic of patches and gaps.		Large gap creation on the warmest driest parts of the landscape. Elsewhere the fire is an underburn setting back the herb and shrub layers. The fire may result in individual tree mortality or small gap formation in the rest of the burn area by killing fire intolerant tree species or where micro-topography and/or fuel concentrations result in locally more intense burning.	The fire is an underburn setting back the herb and shrub layers. The fire may result in individual tree mortality or small gap formation inside the burn area by killing fire intolerant tree species or where micro-topography and/or fuel concentrations result in locally more intense burning.


Unburned


Low severity burn


Moderate severity burn


High severity burn

* Assuming mortality rates of 80% in high, 50% in moderate and 20% in low severity areas, the moderate severity burn polar diagram on the left represents a burn where the weighted average mortality is 46% inside the burned area. The moderate severity burn polar diagram on the right represents a burn where the weighted average mortality is 31% inside the burned area.

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