APPENDIX C: FIRE ZONES AND FIRE REGIMES

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Fire has influenced vegetation at many spatial scales over the past several centuries. In the INFMS area, historic fires were a variety of sizes from small, few-acre patches to very large burns occupying thousands of acres (Teensma, 1987; Morrison and Swanson, 1990; Weisburg, 1998; Van Norman 1998). At a broad scale, fires influenced vegetation pattern by affecting the distribution of stand types and seral stages across the landscape. At a specific site, the composition and structure of individual plants were also influenced by the intensity and frequency of fires.

We stratified the project landscape based on these two spatial scales. At the broad landscape level, large blocks of land with similar patterns of climate (temperature, precipitation and lightning patterns), general topography and vegetation types were identified as **fire zones**. The finer scale influence of fire severity and frequency on vegetation composition and structure was captured in the **fire regimes.**

FIRE ZONES

Distribution patterns in climate (temperature, precipitation and lightning), landforms (topography), and vegetation types (plant association groups) operate at broad, landscape scales. We used these components to divide the overall INFMS area into geographic regions with similar climate, topography and vegetation. The unique patterns and relationships of climate, topography and fuels, and fire history studies were then used to model fire regime distribution in each zone (see Fire zone and fire regime, Appendix C).

Five Fire Zones were delineated in the INFMS area (see Map 4, Fire Regimes).

Zone 1. High Cascades

Climate	• Approximately 70-100 inches mean annual precipitation • Lightning activity pattern concentrated along the Cascade crest, with scattered activity throughout zone.
Landforms	• Elevation range roughly 1,000-10,000 feet • Mixed and High Cascades Physiographic Provinces. • High elevation plateaus, lava flows, variable landtypes (see Mid-Willamette LSR Assessment, 1998).
Vegetation	• 40% of area in mountain hemlock series. • Approximately 30% in western hemlock series. • 30 % in Pacific silver fir series. • Very little, scattered Douglas-fir/grand fir series (Map 2, Plant Association Groups).

Zone 2. Low Cascades

Climate	• Approximately 60-100 inches mean annual precipitation • Lightning activity uncommon, scattered starts across zone.
Landforms	• Elevation range roughly 500-6,000 feet • West Cascades Physiographic Province. • Older landforms and variable landtypes (see Mid-Willamette LSR Assessment, 1998).
Vegetation	• Approximately 75% of area in western hemlock series. • Approximately 10% in Douglas-fir series. • 10 % in Pacific silver fir series. • Very little, scattered mountain hemlock series (Map 2, Plant Association Groups).

Zone 3. South Cascades

Climate	• Approximately 50-70 inches mean annual precipitation • Regular pattern of lightning starts across zone.
Landforms	• Elevation range roughly 1,000-6,500 feet • Mixed Cascades Physiographic Province. • Variable landtypes (see USDA, USDI Mid-Willamette LSR Assessment, 1998).
Vegetation	• Approximately 40% of area in Douglas-fir series. • Approximately 40% in western hemlock series. • 20 % in Pacific silver fir series. • Very little, scattered mountain hemlock series (Map 2, Plant Association Groups).

Zone 4. Valley/Foothills

Climate	• Approximately 40-60 inches mean annual precipitation • Very scattered, very few lightning starts across zone.
Landforms	• Elevation range roughly 200-2,500 feet • Valley floor and short slopes of foothills.
Vegetation	• Approximately 75% of area in Douglas-fir series. • Approximately 25% in western hemlock series. • No Pacific silver fir or mountain hemlock series (Map 2, Plant Association Groups).

Zone 5. Coast Range

Climate	• Approximately 80-150 inches mean annual precipitation • No lightning starts across zone.
Landforms	• Elevation range roughly 0-3,000 feet • Short slopes, foothills and coast.
Vegetation	• Approximately 25% of area in Douglas-fir series. • Approximately 75% in western hemlock series. • < 1% of Sitka spruce series. • No Pacific silver fir or mountain hemlock series (Map 2, Plant Association Groups).

FIRE REGIMES

Fire frequency, severity and size determine the impact of fire on the environment.

Fire has influenced the composition, structure and pattern of vegetation for millenia (Agee, 1993). Three components of fire that determine how that influence will be expressed in the environment are: fire frequency, fire severity and fire size.

Fire ***frequency*** is the number of times a fire occurs on a landscape over time. Frequency affects the kinds of plants that grow in an area, and their size and form.

The ***severity*** of fire influences what vegetation is killed and how the resultant area will look and develop over time. Severity can range from mortality only in the herb and shrub layer (as a result of a slow, creeping ground fire, for example) to total mortality of a stand (from a fire that moved into the tops of trees, commonly known as a crown fire).

The ***size*** of fires affects the spatial scale of changes detectable on the landscape.

These factors of historic average fire frequency, severity and size are often used to describe a fire regime (Heinselman, 1981; Kilgore, 1981; Agee, 1993; Brown, 1995). Knowledge of the types and distribution of historic fire regimes in our area can help us understand the ***role of fire*** in shaping vegetation pattern and stand/plant community development over time, and the effects of fire suppression and other activities on current stand and landscape dynamics.

Five historic fire regimes were described and mapped in the INFMS area (Table C-1, Map 4, Fire regimes, Appendix C for process). Fire is variable in time and space. Climatic conditions were largely responsible for patterns of fire frequency, severity and size in the past (Agee, 1993). Daily fluctuations in weather, and site level fuels arrangements drive fire severity and size for each local fire event. Fire regimes are thus named first for the dominant (most common) kind of **fire severity** expressed historically and then for the **average frequency** of that kind of fire.

Table C-1. Fire Regimes in the INFMS Area

Fire Regime	Severity	Frequency (Mean Fire Return Interval)
1	Low	High (< 35 years)
2	Variable	High (<50 years)
3	Variable	Moderate (50-100 years)
4	Variable	Low (> 100 years)
5	High (stand replacement)	Very Low (>200 years)

Table C-2. Fire Regime Distribution (acres) across Fire Zones.

Fire Zone	Fire Regime					
	1. Low Severity / High Frequency	**2. Variable Severity / High Frequency**	**3. Variable Severity / Moderate Frequency**	**4. Variable Severity / Low Frequency**	**5. High Severity / Low Frequency**	**Total Zone**
1. High Cascades		22,000	127,000	351,000	425,000	925,000
2. Low Cascades		23,000	133,000	392,000	77,000	625,000
3. South Cascades		133,000	73,000	136,000		342,000
4.Valley/Foothills	45,000	16,000				61,000
5 Coast Range			32,000	93,000		125,000
Total Fire Regime	45,000	194,000	365,000	972,000	502,000	2,078,00
Percent of Total Federal Acres	2%	9%	18%	47%	24%	

Fire Regime 1: Low Severity/High Frequency

Low severity fires occur very frequently in this regime (averaging less than 35 years) in areas where fuel loadings are low and ignitions (either lightning or human caused) are common. Fire size is variable, from small (tens of acres) fires in some ridge top meadows to large (thousands to tens of thousands acres) fires in the foothills and Willamette Valley (Davies, 1980; Boyd, 1999). Evidence from fire history studies is limited, as fires were of short duration and left little evidence of fire scars or regeneration of new individuals (Agee, 1993).

Low severity fires increased growth and vigor of grasses, herbs and shrubs, kept stand density and fuel loading low, pruned residual trees, and favored those species adapted to frequent fires (*e.g.*, sprouting species such as poison oak, chinquapin, hazel, and rhizomatous grasses).

Many fires in the Willamette Valley occurred in the late summer and fall months. Native Americans did set fires intentionally for hunting and food gathering, collecting purposes (Agee, 1993; Boyd, 1999).

Large, severe fires may have occurred infrequently (greater than 100 year intervals) in this regime, driven largely by climatic conditions. There is little documentation of this in fire history information, however.

This regime is uncommon in the INFMS area, occupying two percent (2%) of federal lands (Table C-2). It occurs in the Douglas-fir/grand fir series in the Valley/Foothills Zone (see Map 4, Fire Regimes).

Vegetation Pattern and seral distribution

The historic 1850 vegetation map of the Willamette Valley and foothills displays recent fires and the distribution of vegetation types in this fire regime (see Map 1, GLO Vegetation from 1800s, and Table C-3). Fire size was in the hundreds to thousands of acres. Prairie, late seral oak and Douglas-fir/oak (with ponderosa pine) dominated the valley and lower foothills in patches ranging from hundreds to thousands of acres. The upper portion of these types and the higher foothills dominated by large patches of Douglas-fir forest are on federal lands.

Table C-3. Historic (circa 1850) Vegetation Distribution in Willamette Valley and Foothills.

Vegetation Type	Federal Acres	Percent	Total Acres	Percent
Burned	26500	10	52500	3
Ash	520		61000	4
Prairie	2500	1	333900	22
Oak	1150	<1	146000	10
Douglas-fir/oak	3470	1	74000	5
Douglas-fir	228700	88	850000	56

Fire Regime 2: Variable Severity/High Frequency

Fires of variable severity occur frequently in this regime, averaging less than 50 years. Fire size is also variable, from hundreds to thousands of acres (Van Norman, 1998; Agee, 1993). Preliminary results from a pilot fire history study on the low to mid elevations of the west slopes of Warner Mountain (South Cascades Zone) indicate mean fire return intervals from 19 – 48 years, with an average of 27 years. Fire severity was variable, with fire scars and regeneration present for most fires (Kertis, unpublished data). The Coburg Hills in the Low Cascades Zone experienced a mean fire return interval of 44 years, with some sites averaging 10-40 year intervals (Weisberg, unpublished manuscript). Van Norman (1998) found a variable fire regime of this type in portions of the Little River Watershed to the south of the INFMS area.

Fires kept fuel loading low and created stand and landscape heterogeneity. They thinned out seedlings and saplings, as well as creating snags by killing individuals or groups of trees. Conditions conducive to the maintenance and regeneration of fire-adapted species (e.g. ponderosa pine and sugar pine) were created in parts of this regime. Because of the high frequency of fires, the low severity portion of a fire may have occupied a large percentage of the burn. Post fire conditions over much

of the burned area may have looked very much as they did before the fire, with pieces of char on the forest floor and occasional char on trees as the only evidence that a fire occurred in the area.

Large fires of high severity did occur infrequently in this regime. Weisberg (1997) found two large, severe fire periods in the Bear-Marten watershed: one in the late 1500s and early 1600s, and the other in the late 1800s and early 1900s. These time periods were important in resetting landscapes, creating pulses of coarse woody debris, and creating coarse scale heterogeneity.

This regime is uncommon in the INFMS area, occupying nine percent (9%) of federal lands. This regime occurs in the very dry Douglas-fir/grand fir plant associations in the High and Low Cascades; the Douglas-fir/grand fir series in the South Cascades; and portions of the western hemlock series in the Valley/Foothills Zone (see Table C-2, Map 4 Fire Regimes, process paper in Appendix C.).

Vegetation Pattern and seral distribution

The Spring Fire of 1996 in the Boulder Creek Wilderness Area on the Umpqua National Forest (to the south of the INFMS area) is a good example of some of the types of fires and fire effects occurring in this regime (Figure C-2).

This fire was approximately 15,000 acres in size, affecting the Douglas-fir, western hemlock, and white fir vegetation series. Although areas of low, moderate and high severities occurred in the fire area, approximately 60% of the fire area was low severity. Figure C-1 displays the spatial distribution of severity patches. Most areas of low severity occurred in large (>1000 acre) patches, with smaller patches of moderate, high and unburned areas scattered throughout the fire.

Figure C-1. Spring Fire Severity Patch Distribution

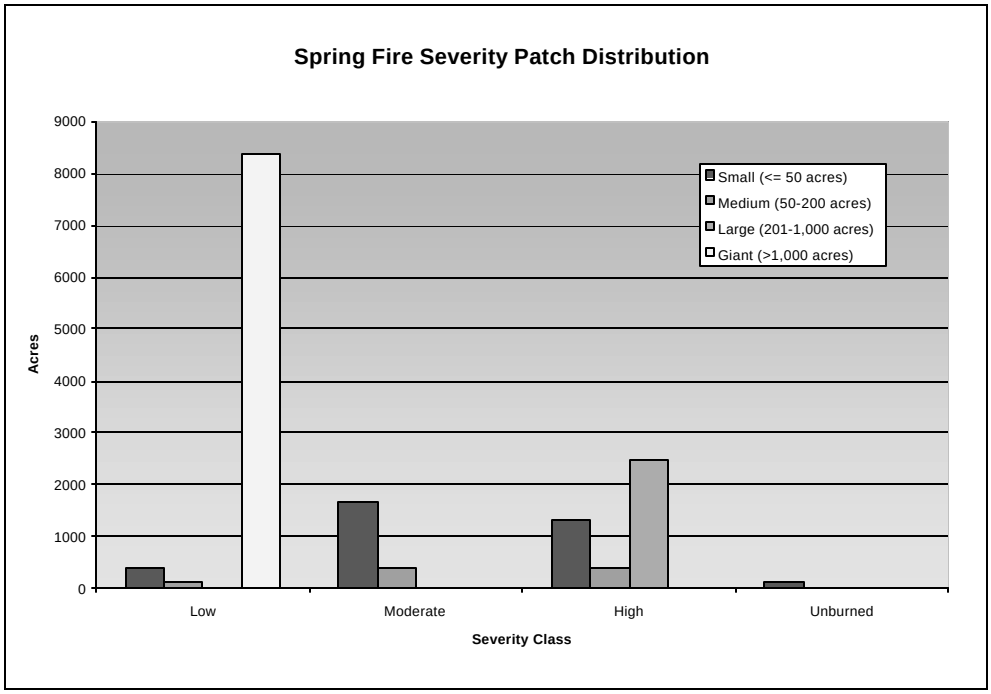
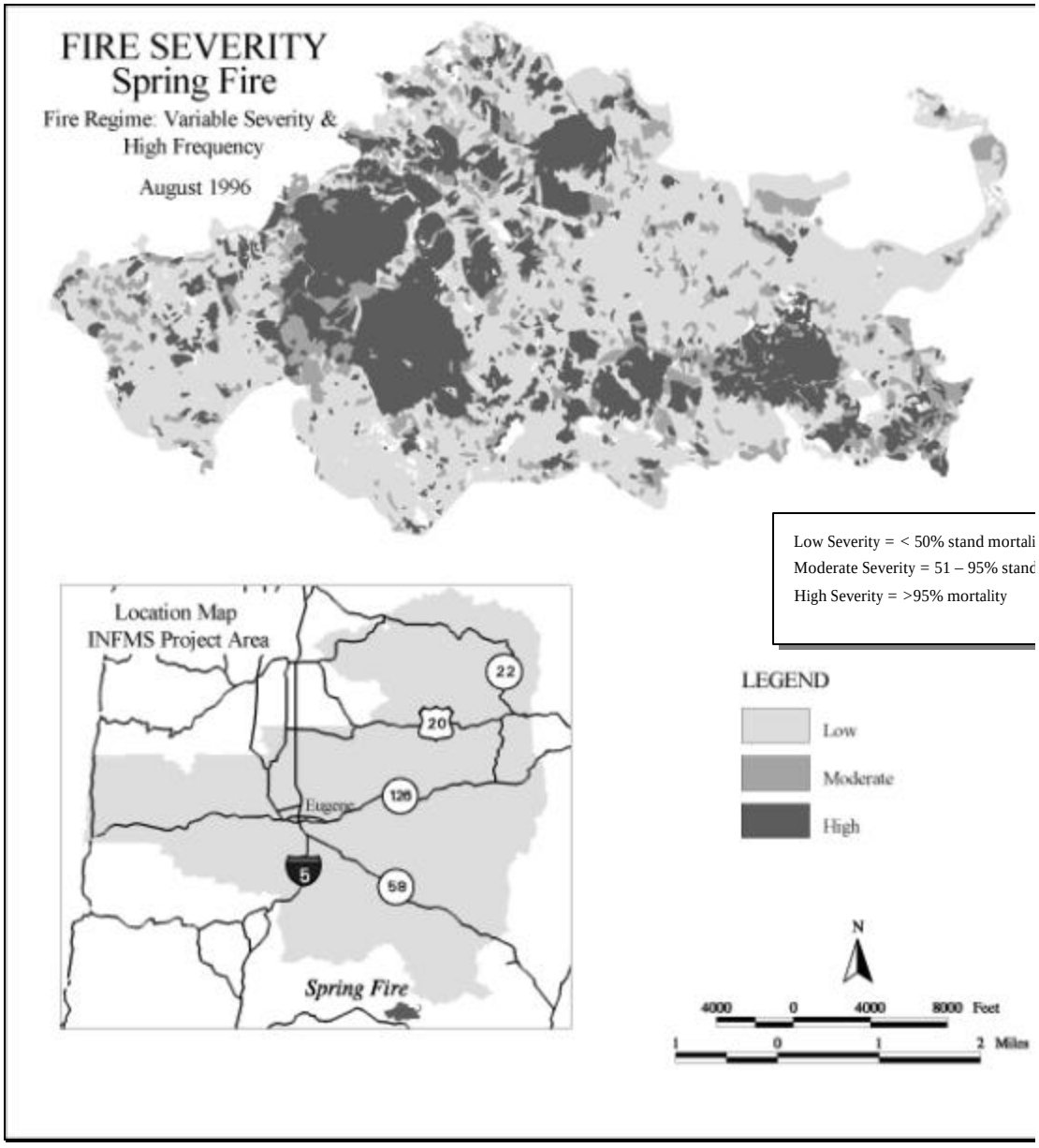
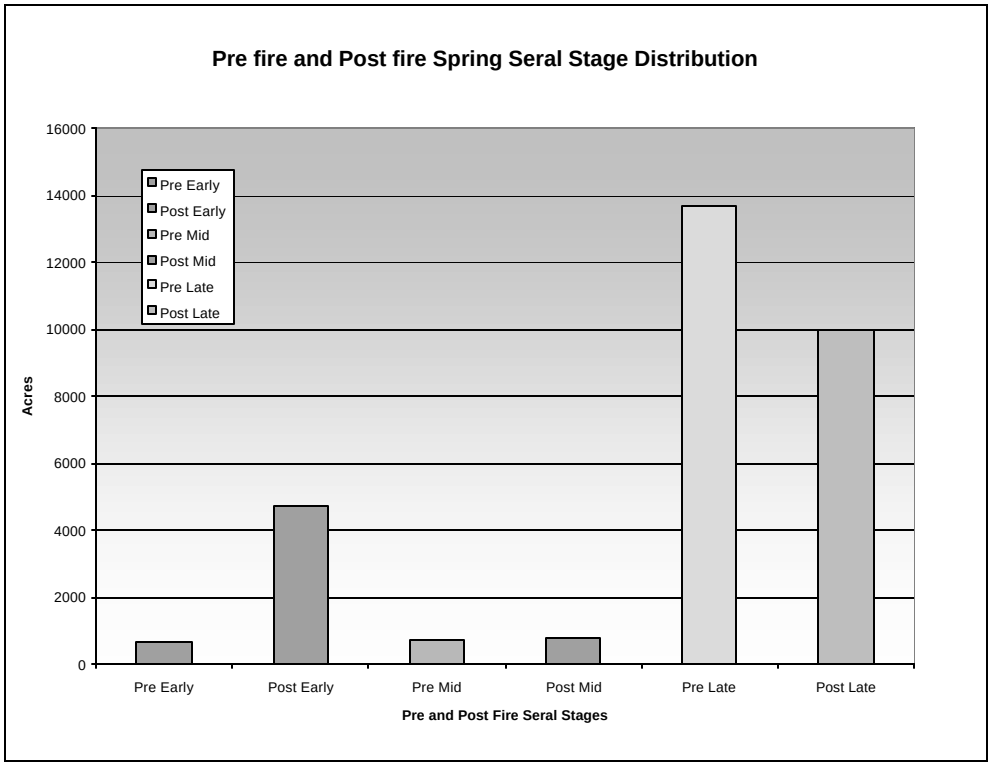


Figure C-2. Spring Fire Severity



It is assumed that seral stage distribution in this regime is dominated by late seral conditions. Fuel levels would remain low based on the frequency of fire, and stand structure and composition would keep fuel ladders spatially disjunct across the area. The Spring fire seral distribution (Figure C-3) is a good example of this. Prior to the fire, 90% of the area was in late seral condition. Immediate post fire seral distribution shows continued dominance of late seral condition (65% of area).

Figure C-3. Spring Fire Seral Distribution



Fire Regime 3: Variable Severity/Moderate Frequency

Fires occurred in this regime at an average frequency of 50 to 100 years. Fires were variable in severity; creeping and underburning in some places, killing individual trees in others, and killing groups of trees across the landscape. Fire sizes varied as well, from thousands to tens of thousands acres. Mean fire return intervals of 50 to 100 years were found in some stands in the Coburg Hills (Weisberg, unpublished manuscript), Bear-Marten (Weisberg, 1997) and Scorpion and East Humbug drainages of the Low Cascades Zone (Garza, 1995).

These fires added diversity to the landscape, providing snags, creating cohorts, thinning out smaller trees in some areas, and keeping fuel levels relatively low. Stands developing in this regime may have two to three age classes that resulted from fire activity (Weisberg, unpublished manuscript; Garza, 1995).

Periods of large, stand replacing fire activity are also part of this regime. Weisberg (1998) found the period prior to 1630 and the 1800s to contain a higher proportion of stand replacing events than other periods. These fires may have reset portions of the landscape, created large pulses of coarse wood, and increased landscape heterogeneity.

This regime occupies about 18% of federal lands in the INFMS area (Table C-2). It occurs in the High Cascades, Low Cascades, and Coast Range Zones in portions of the Douglas-fir/grand fir and western

hemlock series. It extends into the Pacific silver fir series in areas of the South Cascades Zone.

Vegetation Pattern and seral distribution

Morrison and Swanson (1990) describe the size and severity patches of this regime in the Cook-Quentin study area (approximately 5,000 acres in size). Fire severity patches mapped for fires between 1800 and 1900 reveal an almost even distribution among low severity (< 30% mortality), moderate severity (30-70% mortality), and high severity (>70% mortality) patches. Most of the high mortality patches were small in size (< 25 acres). Fires during this time covered the entire study area.

Seral stage distribution is somewhat variable in this regime. From the severity and patch class distribution of the Cook-Quentin area (Morrison and Swanson, 1990), it appears greater than half of the area could have remained or developed into late seral conditions, with much fine scale heterogeneity.

Fire Regime 4: Variable Severity/Low Frequency

Fires in this regime had variable fire effects. It was probable that a stand experienced a fire event at least once during its lifetime, with an average fire frequency of 100 to 200 years. These fires were variable in severity; creeping and underburning in some places, killing individual trees in others, and killing groups of trees across the landscape. Fires varied in size from thousands to, more commonly, tens of thousands acres. This fire regime has been documented in the Blue River Landscape Area (Cissel *et al.*, 1999), Bear-Marten (Weisberg, 1997), Augusta (Connelly and Kertis, 1992), and Scorpion and East Humbug (Garza, 1995) drainages specifically. Weisberg (1998) found this regime across much of much of the central western Oregon Cascades of the Low and High Cascades Zone.

Fires often served to increase stand and landscape heterogeneity by creating large snags, thinning out understory trees, and increasing growth in shrubs and herbs. Fires also helped create at least one layer of trees (shade tolerant species such as western hemlock, western redcedar and Pacific silver fir, as well as Douglas-fir). Given the frequency of fires, it is possible a greater proportion of each burn could be high severity.

Infrequent, large scale stand replacing fires are also part of this regime. Severe fires occurred in the time periods prior to 1630s, and again in the 1800s in the central western Oregon Cascades of the Low and High Cascades Zone (Weisberg 1998). These fires created new landscapes, added pulses of down wood into the system, and created large scale heterogeneity across the area.

This is the most common regime in the INFMS area, occupying almost half (47%) of federal lands (Table C-2). It was modeled in portions of the western hemlock and Pacific silver fir series in the High Cascades, Low Cascades, South Cascades, and Coast Range Zones.

Vegetation Pattern and seral distribution

Morrison and Swanson (1990) describe the size and severity patches of this regime in the Deer Creek study area (roughly 5,000 acres in size). Fire severity patches mapped for fires between 1800 and 1900 reveal an almost even distribution among low severity (< 30% mortality), moderate severity (30-70% mortality), and high severity (>70% mortality) patches. Fires during this time covered only 59% of the study area, and created a more simple landscape pattern than the Cook-Quentin area (Fire Regime 3).

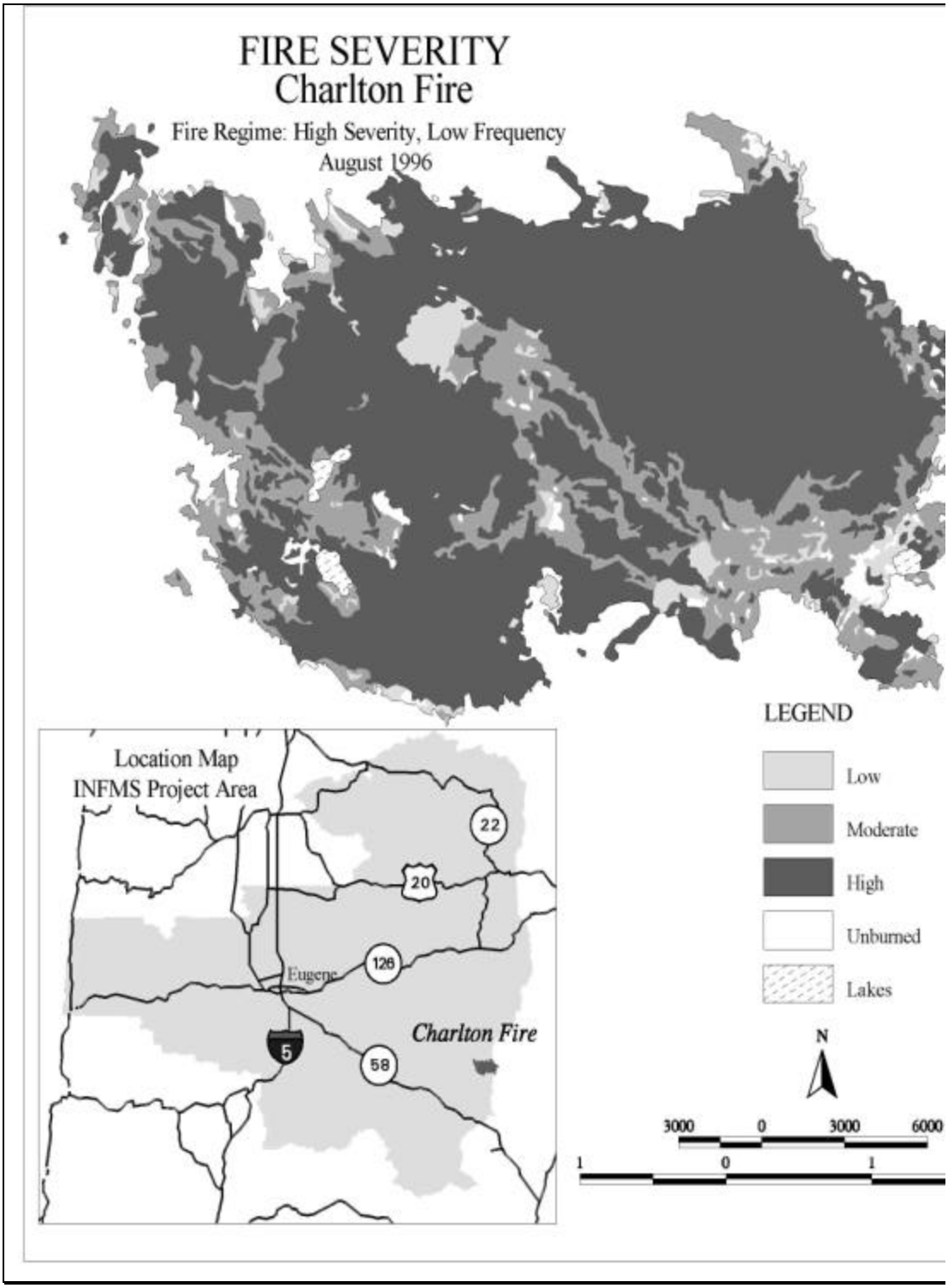
Seral stage distribution is also less variable in this regime than Fire Regime 3. From the fire extent, severity and patch class distribution of the Deer Creek area (Morrison and Swanson, 1990), it appears greater than 75% of the area could have remained or developed into late seral conditions, with much fine scale heterogeneity.

Fire Regime 5: High Severity/Low Frequency

This regime is characterized by very infrequent (often greater than 200 years), severe fires that involved thousands to tens of thousands acres. Fires killed much of the existing stands and served to reset the landscape, allowing new stands to develop over long time periods before the next large fire event occurred. Several small lightning fires may have occurred between large stand replacing events, creating fine scale heterogeneity by killing pockets of trees and creating snags. This regime is described for high elevation forests in the USFS Crest Wilderness Prescribed Natural Fire Plan (1996) and areas just to the east of the Cascade crest in the High Cascades Zone (Simon, 1991). It is also documented for higher elevation forests in the Low Cascades Zone (Morrison and Swanson, 1990; Garza 1995)

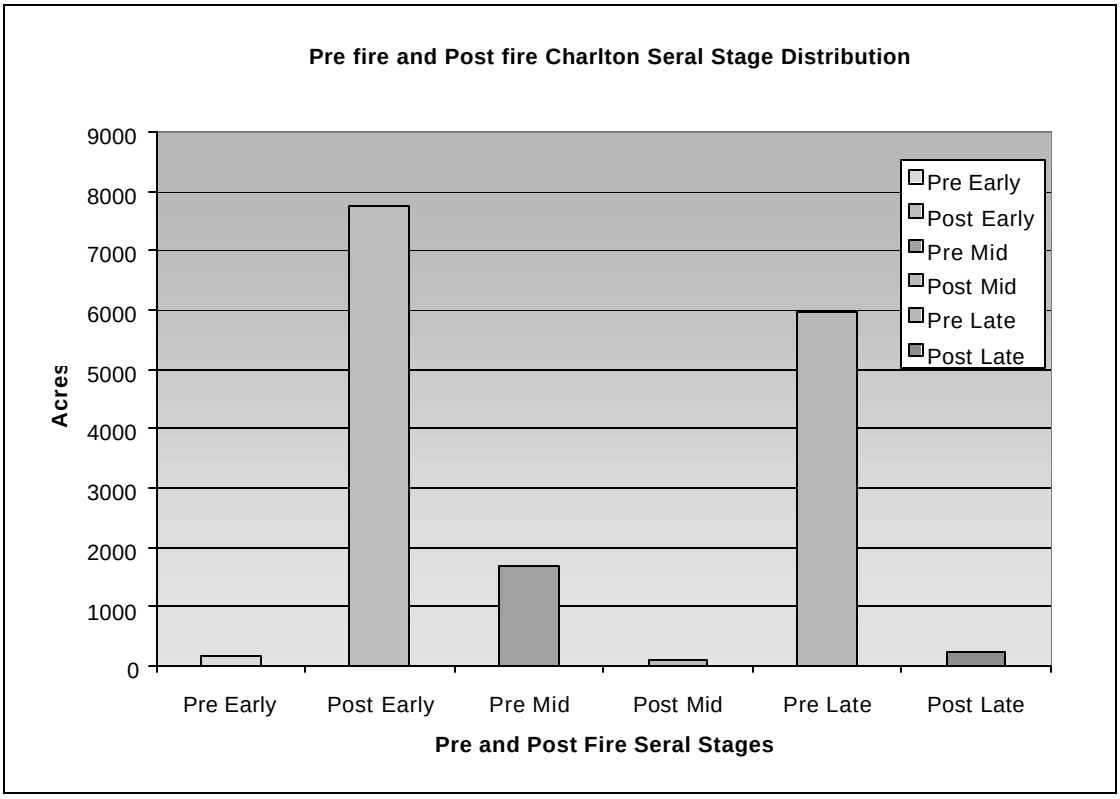
This regime occupies about a quarter of federal land in the INFMS area (Table C-2). It is found in cooler Pacific silver fir, mountain hemlock and Sitka spruce vegetation types in the High Cascades, Low Cascades and Coast Range Zones (see Map 4, Fire Regimes).

Figure C-4. Charlton Fire Severity



Low Severity = <50% mortality
Moderate Severity = 51 – 95% mort
High Severity = >95% mortality

Figure C-5. Charlton Seral Stage Distribution



Vegetation Pattern and seral distribution

The Charlton fire of 1996 (part of the Moolack complex) is a good example of the kinds of fires and fire effects that may have occurred within this regime (see Figure C-4). This fire was roughly 8,000 acres in size, affecting the mountain hemlock series. Although areas of low, moderate and high severities occurred in the fire area, approximately 75% of the fire area was high severity in giant patches.

Seral stage distribution in this regime is assumed to vary over time. In high fire years early and mid seral stages would dominate. As stands developed over time, late seral dominated. The Charlton fire area is representative of potential seral stage distribution in this fire regime. Prior to the fire, 75% of the area was in late seral condition and 20% was in mid seral (Figure C-5). Post fire seral stage distribution is drastically different, with virtually all of the 8,000 acre area in early seral.

LITERATURE CITED

Agee, J. K. 1993. Fire Ecology of Pacific Northwest Forests. Island Press.

Boyd, Robert [ed.] 1999. Indians, fire, and the land in the Pacific Northwest. Oregon State University Press, Corvallis, Oregon.

Brown, J. K. 1995. Fire regimes and their relevance to ecosystem management. *In* Proceedings of Society of American Foresters National Convention, Anchorage, AK Society of Amer. Foresters, Bethesda, MD.

Cissel, J., F.J. Swanson and P.J. Weisberg. 1999. Landscape management using historical fire regimes: Blue River, Oregon. *Ecological Applications* 9:183-198.

Connelly, K. P. and J. Kertis. 1992. Unpublished. Report on Augusta fire history. On file at USDA Forest Service, Blue River Ranger District, Willamette National Forest.

Davies, J. 1980. Douglas of the forests. University of Washington Press, Seattle.

Garza, E. S. 1995. Fire history and fire regimes of East Humbug and scorpion creeks and their relationship to the range of *Pinus lambertiana* Dougl. M.S. Thesis, Oregon State University, Corvallis, Or.

Heinselman, M. 1973. Fire in the virgin forests of the Boundary Waters Canoe Area, Minnesota. Quaternary Research.3:329-382.

Heinselman, M. L. 1981. Fire intensity and frequency as factors in the distribution and structure of northern ecosystems. *In* H.A. Mooney et al. (eds.), Fire regimes and ecosystem properties. USDA Forest Service General Technical Report WO-26.

Kertis, J. Unpublished data. Warner Mountain fire history. Ecologist, Northwest Oregon Ecology Group (Siuslaw NF)

Kilgore, B. M. 1981. Fire in ecosystem distribution and structure: western forests and scrublands. *In* H.A. Mooney et al. (eds.), Fire regimes and ecosystem properties. USDA Forest Service General Technical Report WO-26.

Morrison, P. and F. J. Swanson. 1990. Fire history and pattern in a Cascade Range landscape. USDA Forest Service General Technical Report PNW-GTR-254.

Simon, 1991. Fire history in the Jefferson Wilderness Area east of the Cascade Crest. Unpublished report on file at the Deschutes National Forest, Bend, Oregon.

Teensma, P. D. A. 1987. Fire history and fire regimes of the Central Western Cascades of Oregon. Dissertation, University of Oregon, Eugene, Or.

USDA Forest Service. 1996. Crest Wilderness Prescribed Natural Fire Program. Willamette National Forest, Eugene, Oregon.

USDA Forest Service, USDI Bureau of Land Management and USDI U.S. Fish and Wildlife Service. 1998. Mid-Willamette LSR assessment. Willamette National Forest, Eugene, Oregon.

Van Norman, K. 1998. Historical fire regime in the Little River watershed, southwestern Oregon. M.S. Thesis, Oregon State University, Corvallis, Or.

Weisberg, P. J. 1997. Fire history and fire regimes of the Bear-Marten Watershed. Unpublished report to the Eugene District BLM. On file at the Eugene District BLM

Weisberg, P. J. 1998. Fire history, fire regimes and development of forest structure in the Central Western Oregon Cascades. Dissertation, Oregon State University, Corvallis, Or.

Weisberg. P.J. Unpublished manuscript. Fire history in the foothills of the central western Oregon Cascades. On file Willamette National Forest, Eugene, Or.