APPENDIX D: LANDSCAPE PATTERN AND VEGETATIVE DIVERSITY

Authors: Rich Fairbanks, Jane Kertis and Wes Messinger
11/1/00

Management actions, or lack of action, may change the structure, composition and pattern that contribute to vegetative and wildlife diversity. For example, stands with a regime of high fire frequency and low fire intensity are adapted to fire as an ecological function. Fire exclusion is changing the structure, composition and fire resilience of these stands. Activities proposed in the strategy could temporarily alter ecosystem components such as plant and animal species composition, stand layers, snag levels, large woody material, and landscape diversity.

Landscape pattern and vegetative diversity have been influenced by the frequency, severity and size of fires over time. We organized this section by fire regime because each regime contains a different range of vegetation composition and structure, as well as landscape pattern.

FIRE REGIME 1: LOW SEVERITY/HIGH FREQUENCY

Past Condition

Low intensity, high frequency fires once dominated the valley and adjacent foothills (see Fire Zones and Fire Regimes, **Appendix C).** Before modern fire control, prairie, oak woodland (defined as stands with less than 30% tree cover) and open forests dominated the valley and foothills (see Map 1, Historical Vegetation Types (circa 1850) of the Willamette Valley and Cascade Foothills). Fires were frequent and generally of low intensity. Botanist David Douglas recorded the results of this low intensity/high frequency fire regime, as he described the Southern Willamette valley in the 1820s:

> "Country undulating, soil rich, light, with beautiful solitary oaks and pines interspersed through it…" (Agee, 1993a).

Upland stands in the Valley and foothill zone were dominated by Oregon white oak, Douglas fir and ponderosa pine.

Stringers of riparian hardwoods and "gallery forests" dominated a broad swath of land adjacent to rivers and streams. Large, contiguous prairies were a feature of the valley floor, often abutted by large areas of oak savanna and oak woodland (Map 1, Historical Vegetation Types (circa 1850) of the Willamette Valley and Cascade Foothills). Foothills were probably a relatively open forest of oak, Douglas fir, madrone and other fire resistant and fire enduring species.

Frequent fires tended to favor larger trees and trees of fire resistant species. Oregon white oak frequently occurred as large individuals and groups in prairies. Ponderosa pine tended to occur singly among oaks or on dry gravel and sand bars. Ponderosa pine also occurred on seasonally

flooded sites and heavy clay soils. Stands tended to have a mix of ages, with very old individuals common.

Within riparian areas dead wood may have been relatively common. In prairie, woodland and upland forest, one can speculate that high fire frequency consumed most snags and down wood on a regular basis.

Current Condition

Much of the land within this regime has been converted to farming and urban development. Federal lands show considerable encroachment of Douglas fir, grand fir and various hardwood species into oak woodland and mixed forest. Canopy closure and basal area have increased; mean tree diameter has decreased.

Dense even-aged stands dominated by Douglas fir are ubiquitous on federal lands within this regime. Most of these stands are in an early to mid seral condition (Table 1). In some cases, these stands became established on woodland and savanna formerly dominated by oak. There are substantial populations of non-native tree and shrub species, including Himalayan blackberry (*Rubus discolor*) and Scotch broom (*Cytisus scoparius*).

Old trees are currently rare. Snags and coarse woody debris are uncommon.

Desired Future Condition

- Prairie, oak woodland and oak forest will be maintained and restored on a portion of Federal lands in this zone.
- Oak is maintained and restored on appropriate sites. Ponderosa pine is established on appropriate sites. Treatments to maintain these species also attempt to reduce populations of non-native species.
- Create conditions where older age classes can develop, where appropriate.
- Snags and coarse woody debris are uncommon.

Table D-1. Federal land seral stage distribution (percent of each fire regime area)

Seral Stage	Fire Regime				
	1	2	3	4	5
Early	45%	33%	33%	31%	18%
Mid	36%	21%	25%	23%	18%
Late	19%	46%	42%	46%	64%

*See Appendix O, Seral Stage Process Paper for documentation on methodology

FIRE REGIME 2: VARIABLE SEVERITY/HIGH FREQUENCY

Past Condition

This regime once dominated the South Cascades and portions of the Valley and foothills (see Map 4, Fire Zones and Fire Regimes). It formerly occurred on approximately forty percent (40%) of the federal lands in the South Cascades Zone (Table D-2.). Before modern fire control, fires were relatively frequent and usually of low intensity.

Unpublished data from a site on Warner Mountain showed a mean fire return interval of only 27 years (Kertis, unpublished data). A published, peer reviewed study found a 52 to 76 year mean fire return interval for west side Douglas-fir forest where ponderosa pine is codominant (Agee, 1993). Fire intensity varied from 'under burns' with low tree mortality to complete stand replacement. The preponderance of individuals and groups of very large Douglas-fir, ponderosa pine and sugar pine point to a regime in which low intensity fires were common enough to maintain relatively light fuel loading and to prevent large scale stand replacing fires.

The most common species in this fire regime was probably Douglas fir. At low to moderate elevations ponderosa pine, sugar pine and madrone were very common associates.

Table D-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%	

Current Condition

Fires are still relatively common in the steep, dry forests of the South Cascades Zone. Several large fires have occurred over the past decade in this zone and it contains some of the highest fire risk in the analysis area (see Map 7 for high composite fire potential distribution and Process Paper in Appendix O).

Roughly fifty four percent (54%) of the Variable Intensity/High Frequency fire regime is in mid to late seral stands. These stands are primarily mixed-age stands resulting from one to several low intensity fires, with inclusions of even-aged stands resulting from stand replacing

fires. Most of the stands show evidence of increased canopy closure, increased basal area, increased populations of shade tolerant tree species, decreased mean tree diameter, increased available fuel, and increased fuel continuity (specifically, ladder fuels) since the advent of fire suppression. This dense, closed canopy structure makes stand replacing fire an increasing probability.

Although older, overstory trees are a mix of Douglas fir (and in some stands ponderosa pine and sugar pine) those species are relatively uncommon in the younger age classes. Fire suppression has prevented them from occupying all but the oldest age classes of the forest.

About thirty three percent (33%) of the Variable Intensity / High Frequency fire regime is in an early seral condition. The majority of these stands are dense, even-aged plantations in twenty to eighty acre patches.

The Variable Severity / High Frequency fire regime shows changes in fuels and vegetation due to fire suppression. Much of the land in the South Cascades Zone is remote from the wildland urban interface. The steep topography and fuel loading presents a hazard to crews engaged in wildfire suppression.

Desired Future Condition

The desired future condition is a stand structure favorable to low and moderate intensity fires. Canopy gaps (openings in the canopy of roughly 10 to 100 feet) would be a feature of some stands. Ladder fuels will be uncommon due to reduction of smaller trees, thickets of small trees and brush in treated stands.

Low intensity fire would change species composition. Such fires strongly favor establishment and growth of ponderosa pine and sugar pine (Agee, 1993). Ponderosa pine and sugar pine would be well represented on approximately 20% of the landscape within this fire regime.

Pines would be well represented in the early and mid seral age classes. Large, thick barked, fire resistant individuals of pine, Douglas fir and incense cedar would be maintained.

On rocky ridges and at the edges of openings, low intensity fires would tend to maintain oak, madrone and other sprouting hardwoods.

A program of returning low intensity fire to its role in this fire regime would reduce loading of available fuels and continuity of fuels. In time, reduced loading of available fuels may reduce the need for aggressive fire suppression, reducing risk to firefighters.

FIRE REGIME 3: VARIABLE SEVERITY/MODERATE FREQUENCY

Past Condition

This regime is most widespread in the Low Cascades Fire Zone (see Map 4, Fire Regimes and Fire Zones). The Low Cascades, comprising 625,000 acres, stretches from the north end of the analysis area to the south, and covers most of the west slope of the Cascades (Table 2.). About 21% of

this zone falls within this fire regime (Table 2). In the Coast Range, about 26% of federal lands falls within this fire regime.

This fire regime gave rise to large areas of old trees. Canopy closure was very high. Multiple canopy layers were common. Douglas fir dominated most stands with substantial representation of western red cedar and western hemlock. Snags and coarse woody debris were common.

Current Condition

Some old growth stands have changed little. Over much of this fire regime, patches of dense, even-aged plantations form a patchwork on the landscape. A high density road systems cuts through the forest; most roads are edged with young trees and brush. Snags have been removed from large areas along roads, in clearcuts, near recreation areas and in salvage-logged stands.

Desired Future Condition

Many older stands remain as described above. In plantations, fire suppression capability increases with age and as commercial thinning projects reduce ladder fuels and ground fuels in older plantations. As fires occur and stands age, snags and coarse woody debris increase in older stands.

FIRE REGIME 4: VARIABLE SEVERITY/LOW FREQUENCY

Past Condition

Approximately 63% of the Low Cascades Zone was in this fire regime before European settlement (Table D-2). This regime is characterized by mean fire return intervals of 100 to 200 years. Vegetation is commonly large old Douglas-firs with associated noble fir, western hemlock, Pacific silver fir and western red cedar. Over half the area in this fire regime was covered by stands greater than 200 years old (See Fire Zones and Fire Regimes Appendix C for discussion).

Current Condition

There has been little change in species composition, fuel loading and other conditions within older stands. Approximately 31% of Regime 4 is currently in an early seral condition (Table 2). Most of these young stands are in small patches resulting from clearcut timber harvest.

Desired Future Condition

Most older stands remain as described above. In plantations, fire suppression capability increases with age and as commercial thinning projects reduce ladder fuels and ground fuels in older plantations.

FIRE REGIME 5: HIGH SEVERITY/LOW FREQUENCY FIRE REGIME.

Past Conditions

With a return interval of greater than 200 years, this regime occurs in stands of mountain hemlock, Pacific silver fir and other montane and subalpine species. Stands are often even-aged over large areas.

The High Cascades fire zone comprises 925,000 acres, primarily at elevations above 3,000 feet. About 45% of this zone falls within the High Severity/Low Frequency fire regime (Table 2).

Current Condition

There has been little change in older stands with limited conversion to plantations. Meadows are common with some encroachment by forest. In some areas, insect and disease epidemics have created large contiguous blocks of standing dead trees.

Desired Future Condition

Stands generally have moderate to high canopy closure and shade tolerant species are abundant. Stands of old trees are common. Meadows are burned where analysis shows benefit to ecosystem function. Fuel complexes created by insects and disease are treated where they pose a threat to life and property.

NON-FORESTED COMMUNITIES

Introduction

Valley prairies, oak openings, rock gardens, meadows and wetlands are found in the project area.

Prairies, meadows and openings are important ecological and structural features of forested landscapes. They provide habitat for many vascular plants, lichens and bryophytes not found elsewhere, and are critical to the survival strategies of many animal species. Their biological and cultural importance is immense, considering the relatively small proportion of the landscape they occupy. This is a diverse group of natural features, each with a complex and unique history. Generalizations about their formation and maintenance are thus difficult; contributing factors include climatic conditions, soils, grazing history, and natural and human-caused fire. Important meadow types in the project area include valley prairies; oak openings; rock gardens and rock outcrops, a variety of deep soiled meadows, wetlands, and alpine meadows.

It is important to remember that classification and discussion of these features are simplifications. Many classifications rightfully create more subtypes than we discuss here, depending on their purpose. Hemstrom *et al.* (1987) describe 19 types of non-forest communities on the Willamette National Forest, and Halpern classified 40 different meadow types in the Three Sisters Wilderness. Dimling and McCain (1996) discuss non-forested plant communities in terms of site-specific management on

Willamette National Forest. Most actual meadow and prairie systems defy precise classification because they are complicated mosaics of various forested and non-forested communities. For example, the meadows on Horse Rock Ridge have a good deal of rock garden and rock outcrop, some deep soiled areas with *Koehlaria cristata* (prairie Junegrass) and *Festuca idahoensis* (Idaho fescue), a seasonal wetland featuring aquatics and vernal pool species, and stringers of forest. The generalizations below are intended to be useful at a landscape scale, and may hold for all or part of a given site. It is only by reference to specific locations and their unique conditions, however, that these plant communities and their histories may be understood.

Past Condition

At the time of European contact, the Willamette Valley was a complex of riparian forest, wet and dry prairie and oak savannah (see Map 1, Historical Vegetation Types (circa 1850) of the Willamette Valley and Cascade Foothills). Prairies and savannahs featured an abundance of endemic forbs and *Deschampsia caespitosa* (tufted hairgrass) where wet, or *Festuca roemeri* (a native fescue) where dry. A very high proportion of native food plants were noted in many prairies at this time. These included *Camassia, Madia, Perideridia,* (camas, tarweed, yampah). Much of the valley was dotted with large, well-spaced open grown Oregon white oak (*Quercus garryana*). This landscape may have been formed because tree growth was limited during a warm dry period about 4-8,000 years before present (Boyd, 1999). It was certainly maintained by frequent, purposeful aboriginal burns.

Oak openings of moderate size were abundant in the valley fringe, (Fire Zones 2 and4; Map 4) and common in dryer forest types and rocky areas to the elevational limit of oak. Reconstruction of the historic vegetation of these features is difficult, but they undoubtedly shared many species with dry prairies of the valley. Judging from contemporary remnants, a fringe of Oregon white oak (*Quercus garryana*) and madrone (*Arbutus menziesii*) over poison oak (*Toxicodendron diversiloba*) or snowberry (*Symphoricarpos albus*) surrounded grassy openings, perhaps with a large open-grown oak or two. Wildflowers were abundant, including some endemic species such as *Aster vialis* (wayside aster) and *Lupinus kincaidii* (Kincaid's lupine). It is highly likely that fire contributed to the maintenance of these openings, as it did to the larger savannah habitats lower in the Valley, although thin, rocky soil is a feature of many.

Rock gardens are characterized by thin, steep, rocky soils. They are obvious on the landscape as the bald “foreheads” of cliffs and steep slopes, but may occur midslope where subsurface rock prevents tree establishment. The Willamette National Forest classifies these features into wet and dry subtypes, but most are dry by midsummer. Rock gardens feature a mosaic of bryophyte, grass and forb-dominated patches, and are often associated with substantial rock outcrops. They are among the most botanically diverse habitats in the project area, some

featuring spectacular wildflower displays. A number of species are limited to rock garden community types, including *Romanzoffia thompsonii* (Thompson's mistmaiden). These habitats are often garlanded by shrubs, including *Ceanothus* (ceanothus), *Garrya* (silktassel), *Arctostaphylos* (manzanita) with a fringe of oaks and madrones further back. It is likely that soil is the controlling factor in formation and maintenance of these features.

Rock outcrops and cliffs share many species with rock gardens, and often occur in the same habitat complex. They include an additional group of more unique species, including some rock endemics (for example *Lewisia columbiana* var. *columbiana* in the South Cascades zone). The moist, shaded areas and deciduous trees often associated with cliff bases provide a type of habitat that is limited on the landscape, particularly for lichens and bryophytes. Both rock gardens and outcrops occur throughout the analysis area.

A group of upland meadow types formed on deep soil presumably could support forest vegetation. The history of each individual meadow is unique, hindering generalization. Ridge-top meadows may be formed by lightning fire. Some aboriginal cultures regularly fire travel corridors to maintain open conditions (Lewis and Ferguson, 1999). In the project area, known aboriginal trail systems often overlap with ridge-top meadow systems and areas of very short fire return interval. It is thus possible to surmise a causal relationship between aboriginal trails and some meadows. These features occur throughout the analysis area.

Wet meadows are primarily maintained because saturated soils exclude tree establishment or increase tree mortality. Changes in hydrologic conditions and fire may both contribute to their formation. They are often associated with ephemeral or permanent ponds and lakes and are found throughout the analysis area.

Late lying snow and saturated soils are the primary cause of alpine meadows. This class of non-forested community occurs in the High Cascades zone, where a long fire return interval characterized by large, intense stand replacement fires dominates the landscape. These fires probably influenced the extent of meadows and heath land, even if they were not the primary causal agent.

Current Condition

Euro-American settlement of the project area substantially reduced the extent of unforested plant communities. Habitat quality for native plant, animal and fungus species has decreased in the remnants. It is not possible to quantify these changes, but by reference to known changes in ecological processes, trends can be inferred. Of these processes, development, road building, and the introduction of exotic plants have had the most obvious effects, although fire suppression and other activities have also played a role in certain cases.

Historical grazing reports (*e.g.*, Kulms, 1917, Ingram, 1922) suggest that some forested riparian areas in the early part of the century were far more open than they are at present. Whether this was due to post-settlement grazing patterns or was a remnant of aboriginal burning practices is not clear.

Willamette Valley prairies and savannahs are very nearly extinct. Agricultural and urban development accounts for most of the loss of habitat. A few acres still exist in public ownership and private reserves. These remnants may have experienced a change in relative abundance of native species. They have experienced invasion by non-native species and shrub and tree encroachment. Shrub encroachment was largely caused by fire exclusion (more properly by cessation of aboriginal burning regimes since contact). Agee (1993) estimates that 50% of threatened oak woodlands in the Pacific Northwest will be unrestorable due to lack of fire by the year 2010. Reintroduction of fire at specific, limited areas in the National Wildlife Refuge system, the West Eugene wetlands, Lane County Parks, and The Nature Conservancy (TNC) reserves is intended to reverse this trend.

Oak woodlands in the Pacific Northwest may become unrestorable due to lack of fire.

Species composition has changed significantly in these remnant prairies. Introduction of exotic plant species has substantially degraded habitat quality and shrubs such as the exotic *Rosa eglanteria* (rose), and native *Spiraea* (spiraea) have increased. In the uplands, exotic grasses are now dominant. Undesirable weeds such as *Rubus procerus, Cytisus scoparius* are now common. There is some evidence that the proportion of aboriginal food plants was higher in the past than in present communities, with fire suppression and the associated increase in shrub cover undoubtedly playing some role in any loss.

A large number of rare plants, including a number of federal and state listed and candidate species, occur in the valley. These include *Lomatium bradshawii* (Bradshaw's lomatium), *Aster curtus, Erigeron decumbens* var. *decumbens*, *Horkelia congesta* var. *congesta*, and *Sidalcea nelsoniana*. While habitat loss due to development is the greatest factor in their decline, the absence of fire in prairie remnants has contributed further. Recovery of these, particularly species over a limited portion of their former range, is a primary motivating factor in the prescribed fire programs mentioned above. The oak openings of the Valley fringe have experienced less development than the prairies of the Willamette Valley proper. They are analogous to the valley habitats on a reduced scale, and can serve as replacement habitat (refugia) for the lost upland prairies and savannas of the Valley floor.

Aster vialis (wayside aster) is limited to the southern portion of the Willamette Valley and valley fringe. It now most commonly occurs in disturbed areas near roads. Other known sites are presently found on the fringes of relatively undisturbed oak openings, which may have been the aster's historic habitat. This species is a US Fish and Wildlife Service (USFWS) "species of special concern" and is listed as Threatened by the

There is a high likelihood that *Aster vialis* has lost natural habitat due to fire suppression.

State of Oregon. There is a high likelihood that this species has lost natural habitat due to fire suppression.

Since most rock gardens are formed and maintained by soil conditions, fire suppression has not had a substantial effect on their number or extent. Most degradation of these sites that has occurred since historic times is due to invasion of exotic plant species, although. The thin, steep soils are fragile, and the natural disturbance can leave these sites particularly vulnerable to invasion by exotics. Even the most pristine have a substantial component of exotic grasses.

Almost all deep soiled upland meadows have suffered some forest encroachment since settlement, as demonstrated by historic photographs. Research in the Three Sisters Wilderness attributes this change in certain meadows to macroclimatic cooling trends and changing grazing regimes (Miller and Halpern 1998). Changing fire regimes may contribute to loss of meadow acreage as well. Since each meadow has a unique history, generalization is impossible, but fire may be a useful tool in restoration. These features are probably the most amenable to management, and aside from measurable but not overwhelming encroachment and some invasion by exotics, have not changed a great deal in historic times.

Many upland meadows have suffered forest encroachment.

These upland communities are the subjects of several ongoing prescribed fire programs on the Willamette National Forest.

Of the nonforested habitats discussed here, alpine meadows may have changed the least in historic times. European impact occurred through grazing (including fires set by herders) in the late 19th and early 20th centuries, and through recreation in the late 20th. Some of these meadows are experiencing encroachment by woody species.

While the resolution of vegetation data primarily developed to track timber resources is less than ideal for this purpose, a large-scale estimate of meadow acreage in the analysis area was possible.

It suggests that about 36,000 acres are currently in naturally unforested vegetation types. These are roughly divided into 8,000 acres of wet meadows, 15,500 acres of dry meadows and 12,500 acres of unclassified meadows.

Desired Future Condition

Given that valley bottom prairies and savannahs are the most threatened habitat in the project area, their restoration and maintenance is of utmost importance. Unfortunately, little of this former habitat is in public ownership, and restoration opportunities are thus limited. Ongoing cooperative projects such as burning the Willow Creek Nature Conservancy preserve should be continued and expanded.

The extent and quality of oak openings on the valley fringe and in the drier fire regimes should be increased

The areal extent and quality of oak openings on the valley fringe and in the drier fire regimes should be increased substantially. Encroachment of woody species (both trees and shrubs) is probably the factor most amenable to treatment with prescribed fire. Improvement of *Aster vialis*

habitat is needed, as this rare oak opening species now seems most abundant in roadsides. Dominance by exotic plants may be exacerbated by fire, and treatments should reduce the population numbers of these species.

Rock garden and rock outcrop communities should not be reduced in extant or quality in the future.

Deep soiled upland meadows will be enhanced in area and quality. This includes reducing the extent of encroachment by woody species.

Alpine meadows may be the most undisturbed class of openings discussed here, but are subject to similar trends. Area and quality should be maintained or enhanced.

LITERATURE CITED

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

Agee, J. K. 1993a. Fire Ecology of Pacific Northwest Forests. Island Press, p. 355.

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

Dimling, J and C. McCain. 1996.

Hemstrom, M.A., S.E. Logan and W. Pavlat. 1987. Plant Association and Management Guide, Willamette National Forest. USDA Forest Service PNW R6-Ecol 257-B-86.

Ingram. 1922.

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

Kulms. 1917.

Lewis and Ferguson. 1999.

Miller and Halpern. 1998.