VEGETATION AND DISTURBANCE PROCESSES APPENDIX

INTRODUCTION

Vegetation patterns and the processes that control those patterns often occur on scales larger than a watershed. Consequently, the watersheds in the Umpqua Resource Area of the Coos Bay District-BLM have many similarities and few differences with respect to forest vegetation. This appendix contains discussions on forest vegetation and processes that, with some exceptions, are generally applicable to all watersheds on the Umpqua Resource Area.

The vegetation patterns are driven by temperature and moisture gradients, which are in turn controlled by elevation, distance from the ocean, temperature laps rates, topographic position, macro/ micro topography, aspect, fog effect, and cold air drainage (Hendersen, unpublished). The greatest differences in vegetation on the resource area are found in areas strongly affected by the marine influence/ fog zone (the coastal strip and major coastal valleys) and by the interior valley climate (Umpqua/ Willamette interior valleys).

Another way of to look at vegetation patterns is to see them as the product of past and ongoing disturbances and biological processes:

? Course scale disturbances that cause stand replacement: severe fire, large scale blowdown, and clearcut logging.
? Moderate severity fires are course scale disturbances that modify existing stands by killing only some trees.
? Fine scale disturbances that create gaps and patches. These are individual tree and small patch mortality caused by blowdown, low severity fire, insect, disease, snow break, and soil movement.
? Biological processes including succession, vegetation competition, suppression mortality.

At the most elemental level, all of the naturally occurring disturbances and processes affecting vegetation can be tied back to:

? Climatic conditions (rainfall, length of growing season, and temperature and humidity, which effect evapo-transpiration).
? Extreme weather (extreme drought, strong winds, and high intensity storms).
? Geology (soil characteristics including nutrient and water availability, and topography, which affects local climatic variation across the landscape).

VEGETATION COMMUNITIES

<u>Terminology</u> - A plant series is an abstract classification unit that represents an aggregate of plant associations with the same characteristic overstory tree species. A vegetation zone is a mapping unit used to represent the spatial distribution of plant series across the landscape. A vegetation zone is different from a plant series in that it is a mappable unit of land, which is represented by a single series or aggregates or mosaics of environmentally similar series in a landscape (Henderson unpublished).

<u>Forest Zone</u> - Most of the Umpqua Resource Area is in the Western Hemlock Zone (Franklin and Dyrness 1973). Special communities, on the resource area inside the Western Hemlock Zone, are grass balds (the largest on the Resource Area is on Roman Nose) talus communities, and the Port-Orford-cedar variant. Lands west of and within a few miles east of Highway 101are in the Sitka Spruce Zone. Franklin and Dyrness (1973), on their generalized vegetation map of Oregon and Washington, show the Sitka Spruce Zone extending up the Coquille Valley and including the extreme lower ends of the South, East and Middle Forks of the Coquille. Their map also shows the Sitka Spruce Zone extending into the North Fork Coquille up stream to about Laverne Park and including all of Blue Ridge and the valley bottom and valley side lands of Lee Valley, and Burton Prairie. Franklin and Dryness appear to have included those parts of the Coquille systems in the Sitka Spruce Zone based on environmental features and not on the occurrence and distribution of Sitka Spruce Series within those watersheds. The environmental features of the Sitka Spruce Zone include the mildest climate of any northwestern vegetation zone with minimal extremes in moisture and temperatures and the climate is uniformly wet and mild. Frequent summer time low clouds and fog

augment the available moisture as a consequence of fog drip (Franklin and Dyrness 1973).

Plant Series - The western hemlock series is the overwhelming dominant plant series in the Umpqua Resource area. The grand fir series occurs on valley side locations next to major valleys with warm local climates. These areas include the Umpqua River Corridor east of Scottsburg, and along the North Fork Coquille River where it passes through Burton Prairie and Lee Valley. The tanoak series also occurs in valley side locations. The northern extent of tanoak and thus the tanoak series is Hudson Ridge at the north end of Burton Prairie. Sitka spruce series is found on BLM lands on the North Spit and isolated parcels within 2 to 2.5 miles of the coast. Sitka spruce series also appears to spike inland along major river valleys. Sitka spruce is found on the extreme north end of Blue Ridge overlooking Coos River. Sitka spruce is grows next to the Umpqua River at least as far up stream as the Umpqua Wayside Park near the 9-mile marker on Highway 38. Spruce Reach Island at Deans Creek supports an old growth stand of spruce and may be the eastern most spruce stand on BLM land in the District. The Oregon white oak series is largely confined to warm valley floor locations in the Umpqua Corridor east of Scottsburg. A small disjunct population of Oregon white oaks is located in the Rock Prairie area of the North Coquille Watershed. Cadastral survey notes suggest small areas of white oak occurred in the Williams River area in the late 1800s/ early 1900s. The Port-Orford cedar series is found on stabilized sand dunes along the coast south of Sanders Lake. Port-Orford-cedar occurs in small patches and as scattered individual elsewhere in the resource area. However, those sites represent a variation of the hemlock series and not outliers of the Port-Orford-cedar series. The Douglas-fir series occurs on some of the harsher ridge top locations on the eastern portion of the Resource Area. Many of these Douglas-fir series stands are transitional to western hemlock series (unpublished - 1999 draft plant assoc. key for the Willamette and Coast Range Provinces).

Plant Associations - There is no plant association guide specifically developed to cover the Umpqua Resource Area. However, The Forest Service Area 6 Ecology Program is preparing a plant association guide the Willamette and Coast Range Provinces, which is a reasonable fit for most of the Umpqua Resource Area. That plant association guide is due out in FY2000 (per. com. Cindy McCain). The plant association guide for the Southwest Oregon Province does describe some plant associations in the Umpqua Resource Area characterized by Port-Orford-cedar, myrtle, white oak, or tanoak. In addition, the Southwest Guide and the Willamette- Coast Range guide do have some hemlock plant associations in common. The Oregon Dune NRA plant association guide should apply to the sand dunes managed by the Umpqua Resource Area and also describes associations growing on stabilized sand dunes on the coast south of Coos Bay.

The following is locally important plant species that are outside the scope of the soon to be issued Willamette and Coast Range Provinces plant association guide:

Oregon myrtle - Oregon myrtle is found over most of the Umpqua Resource Area south of the Umpqua River. Myrtle also grows on the north bank of the Umpqua and extends a short distance north of the Umpqua along tributary streams. Oregon myrtle is largely confined to the lower slope and riparian zones where it occurs on tributaries to the Umpqua River. Myrtle extends down the south bank of the Umpqua River to about Highway 38 mile-marker 12, and farther down stream on the north bank. In the Coos and Coquille watersheds, the highest concentrations of myrtle are found on south aspects below approximately 1,800 feet elevation and on flood plains. The presence of myrtle on the drought-prone south aspects and on flood plains where periodic flooding causes anaerobic conditions in the soil, suggests that myrtle can tolerate climatic and physiological drought stress. Snow and wind can cause considerable bole and branch damage. Snow break may be a factor controlling the northen limit and elevational distribution of the species. Myrtle is long-lived and can reproduce in the shade. Mature myrtle trees have a dense evergreen crown that can greatly limit light penetration to the forest floor. The myrtle leaf litter is suspected to have toxic effects on other vegetation. As a consequence of the heavy shading, and suspected litter toxicity, there is typically little vegetation under myrtle trees (Niemiec et al 1995).

Myrtle-occupied flood plains are a unique southwest Oregon/ Northern California riparian plant community. Myrtle-dominated flood plains may have a grand fir component, and occasionally Port-Orford-cedar or western red cedar are present. When Douglas-fir is found in a myrtle dominated flood plain, it is usually confined to the tops of mounds. Bigleaf maple is found on stream banks in the myrtle riparian community. When bigleaf maple is found on the flood plain in association with myrtle, but away from the stream bank, close examination of the site may reveal that the maple is located by an old silted-in channel. This suggests that bigleaf maple is incapable of regenerating in the shade of myrtle. To survive, bigleaf maple may need a gap in the canopy, like that found directly above the stream, and may need disturbance such as when a stream cuts a new channel to regenerate[1].

Myrtle also occurs as a shrub in the California chaparral. Like some other chaparral species, myrtle leaves contain flammable oils that cause it to explode into a fire ball when ignited. Myrtle's flammability and ability to vigorously re-sprout gives the species a competitive advantage. The explosively burning foliage may destroy nearby vegetation, reducing competition for moisture and growing space, while the resprouting ability enables the myrtle to rapidly capture the site following the fire. Myrtle's habit of violently torching out when ignited may enable it to compete with the taller conifers by transferring fire from the ground to the crowns of the conifer. This has management implications. Periodic underburns would keep myrtle in a short shrubby growth form. Extended fire exclusion allows the myrtle to grow taller and thereby closer to the lower portion of the overstory conifer crowns. This would enable the myrtle to serve as ladder fuel to transfer a fire from the ground to the crown, possibly facilitating a stand replacement event. In terms of ecological function in a system where fire is the dominant agent of disturbance, myrtle has more in common with understory conifers that have highly flammable needles due to resins and a high surface to volume ratio than with other hardwoods, which as a rule, tend to slow the spread of fire.

The ecological amplitude for myrtle is defined by

- A tolerance for seasonal drought/ physiological drought
- A tolerance for, or a possible dependence on fire
- The northern and upper elevation limits may be set by snow/ ice damage. Cold and frost may also be a factor, however myrtle is abundant along Middle Creek, which is a known cold air drain.
- Optimum growing conditions for myrtle appear to coincide with the conditions governing the northen limit of tanoak.
- The range appears to coincide with Mediterranean climatic conditions - mild wet winters and hot dry summers. However, very hot summers may limit the growth of myrtle to a small tree or shrub form in the south of its range, whereas summer time morning fog may facilitate optimum growth.

Port-Orford-cedar - A published range map places the northern extent of the Port-Orford-cedar (POC), on inland sites, a little ways south of the north boundary of Coos County (Fowells 1965). The northern extent of POC in the sand dunes is about Saunders Lake in section 35, T23S.,R13W. Naturally occurring POC have not been found on the Elliot State Forest. In land, the boundary is likely south of the divide between the Umpqua and Coos River. At the north end of its range, POC typically is found on upper slopes, ridge tops, south facing benches, or in association with rock outcrops. However, second growth POC are growing next to Tioga Creek and Burnt Creek in sections 31 and 32, T.26S.,R9W. In this part of the POC range, the species appears to be maintained as a forest component by moderate severity fires, which set back vegetation competition in the herb and shrub layer and create a partial shade conditions in the overstory. Port-Orford-cedar occurrence increases to the south in the Myrtlewood Resource Area. Farther south, Port-Orford-cedar becomes an important riparian species.

The South Fork Coos Watershed is on the extreme northeastern end of the natural range of Port-Orford-cedar (POC). Timber cruise data from the 1960s through 1994 show 14 BLM timber sale units in the South Fork Coos Watershed contained POC. The highest concentration of POC on BLM land in the South Fork Coos Watershed was in section 34, T.25S., R.9W. where 5 timber sale units, containing 276 POC trees, were sold. A proposed but dropped unit in section 10, T.26S., R.9W. contained 68 POC. In the rest of the timber sale units, POC numbers were no higher than 22 and commonly much less. The only known mature POC trees on BLM land in this Watershed are in section 10, T.26S., R.9W. Those POC trees are inside the LSR and the road accessing that area is blocked. Heydon (1897a) recorded "white cedar" [POC] in his lands survey notes for T.26S.,R8W., along section lines within about a mile of the junction of Cedar Creek and Arrow Creek [2].

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[1] This observation suggests down cutting by the stream and subsequent long term confinement of a stream to a single channel will result in an eventual decline of bigleaf maple as a component in the myrtle dominated riparian zone.

[2] "White cedar" noted on the following lines common to: 8 & 9, 7 & 8, 6 &7, and 5 & 6. The following is from the summary for the line common to 6 and 7: "Timber - excellent fir hemlock white and red cedar. Considerable of the white cedar in secs. 6 and 7 is burned and dead."

In the North Fork Coquille Watershed, POC was most common in and south of the Big Bend Middle Creek area (section 5, T.28S.,R11W.). The Vaughns Creek-Mungers Road (sections 5, 7 & 8, T.27S.,R10W.) area supported a large disjunct POC population. Timber cruise data from 1963 to 1994 and POC Root Rot survey data show 20 BLM sections in the Watershed contained POC. A cursory look at timber patent records from the 1920s and 1930s suggest Port-Orford-cedar was present and possibly more common in the original stands around the Fairview Area than in the second-growth stands in that area today. The Watershed no longer contains any known mature or old-growth POC trees on BLM land.

Tanoak - The northern extent of tanoak's range appears to be Hudson Ridge in the North Coquille Watershed. Tanoak is a common species on the south facing valley-side slopes next to the North Fork Coquille River but is not present to the north, east or west of the North Fork Coquille valley-side slopes. Frost/ cold temperatures and summer drought limit the range of tanoak (Atzet *et al* 1996).:

- The lower elevation limit of tan oak is limited by cold air pooling in valleys
- The upper elevation limit is associated with the increased incidence of frost with increased elevation
- The eastern limit of the tanoak's range is limited by summer drought. Tanoak grows where marine air influence and valley fog augment moisture summer moisture availability through fog drip, high humidity and night time condensation.

Tanoak in the North Fork Coquille Watershed takes a shrub or small tree form. The species does not grow to the size nor have the vigor exhibited by tanoak in Curry County or the south end of Coos County. Consequently tanoak can form an understory in mature stands, and can be a significant component in regeneration units. However, tanoak rarely develops into pure stands in the North Fork Coquille Watershed except in association with rock outcrops. Tanoak is often found on sites where ceanothus would be expected to germinate following a burn.

Incense cedar - On the south end of the Umpqua Resource Area, scattered incense cedars grew near the crest of the Coast Range on ridges in sections 25 & 26 T.27S., R.9W. The species becomes common east of the crest on Roseburg District land. On the north end of the resource area, incense cedar is generally found east of the middle of range 8 east. Incense cedar has been found in sections 19 & 29, T.21S.,R.7W. Paradise and Tom Folley Creeks, and on top of Mehl Ridge.

Oregon White Oak - On the Umpqua Resource Area, Oregon white oak is largely confined to warm valley floor locations in the Umpqua Corridor east of Scottsburg. A small disjunct area with the Oregon white oak is located in the Rock Prairie area of the North Coquille Watershed. Cadastral survey notes suggest small areas of white oak occurred in the Williams River area.

Sugar Pine - Heydon (1897b) found sufficient sugar pines in the southeast end of the South Fork Coos Watershed on the lines between sections 34 and 35; 26 and 35, T.27S., R6W., to merit comment in the survey notes. There are no other known occurrences of sugar pine in the Umpqua Resource Area.

Plants at the extreme of their ranges - The southern most devils club plants were observed in southeast corner of the North Coquille Subwatershed (section 27, T.26S.,R10W.) Devils club has not been observed in the Tioga Creek Subwatershed to the east of the North Coquille site. A small disjunct population of canyon live oak grows on the ridge top in section 23, T.27S.,R10W. just to the south of the Umpqua Resource Area.

Vegetation Management in North Fork Coquille Watershed Valley Side Stands - Fire on valley side south to southwest facing slopes in the Fairview Subwatershed and the West half Middle Creek Subwatershed stimulates blue blossom ceanothus germination. Blue blossom ceanothus, if not controlled, will form dense uniform brush fields following fire and can grow to 25 feet tall in 12 years[3]. These ceanothus brush fields are so thick, they can only be entered by humans with great difficulty, and the ceanothus can exclude all other green plants species from the site. The sites likely to be occupied by cenathous support plant associations characterized by sclerophyllous shrubs, and poison oak. Tanoak is typically present and grand fir is often present.

[3] Measurements taken in section 27, T.27S., R.11W., Will. Mer.

The occurrence of grand fir, poison oak, and ceanothus together in the valley side stands sites suggests those sites one time had a high fire frequency. Poison oak is an indicator of frequent fire (Bill Emmingham, per. commun.) Grand fir is observed to invade areas where there was frequent fire prior to effective fire suppression activities (Cole 1977). Ceanothus is a fire-dependent species whose seeds require heat scarification to germinate.

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PROCESSES

Succession Patterns

Two good discussions on succession patterns for the Douglas-fir/ western hemlock forest, relevant to lands in the Umpqua Resource Area, are found in Franklin and Dyrness (1973, pp. 82-88), and in Hemstrom and Logan (1986, pp. 24-26, 42, 50). The following section on succession is intended to supplement and emphasize elements of the discussions by Franklin and Dyrness, and Hemstrom and Logan rather than replace them.

Disturbance Mechanisms for Initiating and Retarding Succession - The two main natural disturbances that cause stand replacement are fire and blowdown.

Overstory initiation - Stand replacement fires favor Douglas-fir and red alder. Blowdown, on the other hand, favors shade-tolerant advance regeneration, like western hemlock, and/or brush species that are already established in the understory on the site. Disturbance intensity, disturbance frequency, seed source availability, and local environmental conditions also affect the ultimate corse of succession and stand development (Hemstrom and Logan 1986). Another factor is the ability of the trees and brush species, on the site, to sucker or stump sprout after the aerial portion of the plant has been killed by a disturbance.

Understory initiation - Fires of sufficient severity to open the forest canopy, but not so severe as to be considered a stand replacement event, may favor the establishment of shade tolerant trees, such as hemlock, over shade-intolerant species (Hofmann 1924). Examples of even-aged understory hemlock stands are found in the Middle Creek, Tioga Creek, and North Coquille areas. Many of these understory stands regenerated following underburns in the 1850's, 1890's, 1918, 1923, 1930s and 1940s. These even-aged understory stands go through stand successional stages just like stands that regenerate following a stand replacement event (Oliver & Lawson 1990). Many understory hemlock stands, dating from the 1920s to the 1940s, are now in the stem exclusion stage. Those understory stands intercept most of the sunlight before it reaches the forest floor, which severely limits shrub and herb layer development on those sites.

Herbaceous Phase - The forest successional pattern on the Umpqua Resource Area differs in one minor detail from the successional pattern given by Franklin and Dyrness (1973) in that pink fire weed (*Epilobium augustifolium*), which is so common following burns in the Cascades and Olympic Mountains, is conspicuously absent from burned areas on this resource area. A *Senecio* sp. is the most common herbaceous plant on many the resource area's newly burned units and sometimes completely blankets the burned over land with yellow flowers.

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4 Measurements taken in section 27, T.27S., R.11W., Will. Mer.

Swordfern will dominate the herbaceous phase on sites that were neither burned nor scarified, where swordfern was common before the disturbance. These swordfern-dominated sites could spend an extended period in the herbaceous phase if there are active mountain beaver colonies also present.

Management Used to Extend the Herbaceous Phase - From 1986 to 1994 and in 1997, many newly burned clearcuts were seeded with nonnative grasses and legumes. This was done for two reasons. First, the resulting forage was used by deer and elk. Second, the seeded grasses and legumes appeared to suppress some brush species, most notable, salmonberry for up to five years. This also prevented the establishment of red alder. On closer examination, the forage did not suppress the brush so much as attract herbivores, which browsed on the brush sprouts while they were feeding on the grass, thereby providing brush control. The native shrub species regained control of the units in the fifth or sixth year, but by then the shrubs were no longer a threat to the establishment of the conifer seedlings. The silviculture people recognized that the seeded grass was competing for moisture, thereby reducing conifer growth. They were willing to trade some growth loss to avoid light competition from shrubs and alders. Light competition is the most common cause of seedling mortality for the resource area.

Shrub Phase - Casual observations on shrub development following disturbance in the watershed agrees with observations by Hemstrom and Logan (1986) for the Hemlock Zone portions of the Waldport and the Mapleton Ranger Districts. They observed the herb and shrub species that dominated the mature and old-growth stands will reestablish dominance by the third year. By that time most shrubs would be at least as abundant as they were in the pre-harvest stand. They found that five years after disturbance, salmonberry and thimbleberry were more abundant than they were before disturbance. They also observed that salal and vine maple increased following harvest. Bracken fern was observed to be the most common early seral stage species in salal-dominated associations.

Of all the shrub species found in the Umpqua Resource Area, salmonberry, vine maple, and blue blossom ceanothus are the ones most likely to cause conifer seedling mortality. Salmonberry is found in the lower moist north facing slopes, head walls, and in riparian zones. Close to oceanic influence, salmonberry can grow to be 12 feet tall and occupy the entire slope from the creek to the ridge. Vine maple is found where water is abundant at least part of the year and the soils well drained. Vine maple's requirement for well-drained soil can be met by the gravelly soils found on steep slopes. The abundant water is provided by a combination of seasonally high rainfall and by a soil profile that hold the water close to the soil surface and/or by lower slope positions where ground water is concentrated by gravity. The water moving through the soil is confined close to the soil surface by the shallow underlying bedrock, and therefore is readily available for plant use.

The Stem Exclusion Phase and Tree Mortality - Conventional plantations have very regular spacing. With uniform spacing, fewer trees in a stand have a significant growing space advantage over neighboring trees resulting in greater uniformity among the trees. In wild stands, the individual tree's risk of mortality increases with the proximity and size of neighboring trees (Peet and Christensen, 1987). In comparison to wild stands where big trees get bigger by suppressing and killing the smaller trees, there is a lower rate of suppression mortality in conventional plantations. The crown depth, and therefore photosynthate producing surface decreases, at more or less the same rate for all trees in a plantation as the growing space is occupied. This uniformly distributed growth, and lower mortality rate results in a more efficient use of the site and higher yields in plantations compared with natural stands of the same age on similar sites. It does not supply the size diversity, variations in crown depth, nor the variation in health and vigor of trees associated with wild stands[5]. In wild stands, mortality due to competition, and in fact most post-establishment mortality, occurs during the time between crown closure and the point when the gaps created by tree mortality can no longer be reoccupied by lateral growth of adjacent trees (Peet and Christensen, 1987). Snags produced through competition mortality in young stands are from the lower crown classes and/or areas of dense stocking. Both factors result in snag recruitment from among the smaller diameter, short crown depth trees. These small snags progress quickly through the stages of snag decomposition and provide habitat for those arthropods

[5] This discussion applies much more to plantations of the 1980s and early 1990s where: site prep was uniform across the treatment area and effective at reducing microsite variation, nearly all crop trees were planted, maintenance treatments were timely and all contract stipulations during all stand treatments were strictly enforced. Some older plantations can have high within stand variation where: site prep was less uniform, crop trees are a mix of planted trees and naturals, maintenance was not timely, and where the precommercial contract stipulations (or the contract inspector) allowed the contractor to leave "whips" and tall seedlings untreated.

that can make use of small diameter rather ephemeral material. Some snags recruited towards the end of the stem exclusion phase may be large enough to serve as roosting and nesting habitat for the small to medium size cavity dwellers. Large snags are recruited by factors other than suppression mortality. During the self thinning phase, clumpyness will decrease and the stand will acquire a relatively uniform spacing pattern (though not as uniform as a plantation laid out in a grid pattern). After the self thinning phase, most mortality will be due to factors other than growing space, like windthrow, lightening, disease, and fire (Peet and Christensen, 1987).

Vegetation Response to Fine Scale Disturbance - Openings in the overstory canopy, or gap formation, provides new growing space for the plants already on the site. If the understory is fully occupied by shrubs and/or hardwoods when the mortality occurs in the overstory, those shrubs and hardwoods will increase in vigor in response to the newly available growing space. Conifers will occupy new gaps under one of four conditions:

? where advance conifer regeneration is already established on the site and is vigorous enough to respond to the new growing space
? when the gap occurs in a stand that is in the stem exclusion stage. In those stands, the overstory canopy has intercepted most of the sunlight depriving understory plants the light necessary for survival. In this case the gap is free of herb, shrub and hardwood competition and is thus suitable for new plants regenerating from seed.
? where the gap creating disturbance is of sufficient severity that it also kills the existing herb, shrubs and hardwoods, freeing growing space.
? The understory occupants lack the vigor to respond to the new growing space

Small gaps, and the edge of large gaps are affected by partial shade that in turn favors the survival and grow of shade tolerant trees like hemlock and red cedar over Douglas-fir.

Gaps created by landsliding are a special case. Besides the disturbance freeing growing space by removing the previous occupants, the soil component of the growing space is also altered. Landslides expose subsoils that are poor in nutrients and organic matter, favoring red alder over other tree species. This is due to alders' ability to grow on soils with restricted internal drainage, fix nitrogen, and rapid juvenile growth rate (Johnson *et al* 1926; Fowells 1965).

Red Alder in The Managed Landscape - Disturbances that compact soils or expose subsoils, which are poor in nutrients and organic matter, favor red alder over other tree species. This is due to alders' ability to grow on soils with restricted internal drainage, fix nitrogen, and rapid juvenile growth rate (Johnson et al 1926, cited in Fowells 1965). In the unmanaged forest, alders were most likely found on unstable soils and on flood plains where slope failures, stream cutting action, and floods periodically exposed bare mineral soils to which alder is well adapted. Alder can be found in the managed forest where there are road cuts and fills, skid trails, and scarified soils. Those sites have exposed soils to which alder is well adapted to colonize.

Development of Red Alder Stands - Red alders approach their maximum height about age 40-years and their peak net volume about age 90-years and will begin a rapid decline shortly there after. Few live alders will remain by stand age 130-years (Newton; Cole1994). As the alder component of the stand breaks-up, more light reaches the forest floor allowing the shrub layer to increase in vigor (Oliver; Larson 1990). If there are conifers in the alder stands, they were established either before the alders or the conifers established in sizeable gaps between alders (Newton et al 1968). However in the absence of a disturbance, additional conifers are unlikely to become established under a fully stocked alder stand.

Understory vegetation will respond to changes in the overstory condition. As the alders increase in size, a greater proportion of the trees' photosynthate will go to meet respiration needs leaving less for lateral and vertical growth. Consequently, the alders will at some point be unable to grow laterally fast enough to reoccupy gaps created by random mortality and wind caused crown abrasion. These gaps allow increased light to reach the forest floor. This allows the established shade tolerant understory vegetation to become more vigorous and thus increasing their hold on the understory growing space[6].

Within the hemlock zone (Franklin; Dyrness 1973), the conifer species with the greatest potential to survive alder competition is western red cedar followed by western hemlock. Douglas-fir survives in fewer numbers and usual only in areas with low alder stocking or where Douglas-fir established on the site ahead of the red alder (Stubblefield; Oliver 1978, Newton; Cole1994). Conifer response to the understory conditions depends on the degree of light competition and the conifer species's tolerance for shade. The suppressed shade intolerant conifers are the most likely to die. Some suppressed shade tolerant conifers will also die. Others will lose epinastic control[7]. If later released, nearly all Douglas-firs that have lost epinastic control will either die of shock or not respond to the increased light levels. Depending on the severity of suppression, hemlocks that have lost epinastic control may recover vertical growth if released. Western red cedars generally do not regain a vertical growth form once they lose epinastic control but instead they channel their resources into growing long lateral branches (Oliver, Larson 1990). Conifers that make it to the intermediate crown position are unlikely to emerge through the alder canopy before the age of 40-years. This is due to a combination of reduced conifer growth due to competition, alder's superior juvenile growth rate, and repeated damage to the conifer leaders caused by the stiff lateral alder branches whipping about in storm winds (Wierman; Oliver 1979; Kelty 1986). Conifers in the intermediate crown position, particularly shade intolerant species, are still at risk of suppression mortality. Many of these conifers will have unfavorable diameter to height ratios putting them at risk of blowdown or lodging if suddenly released from competition. After age 40-years, the alder height growth becomes static whereas the conifers still have considerable growth potential (Newton; Cole 1987). Consequently those few conifers, which survived competition within the alder stands, that occupy crown positions near the top of the canopy are the most likely to emerge above the alder canopy after stand age 40-years and become free to grow.

The alder stands, in their present condition, produce some woody debris, which is recruited by competition mortality from among the smaller diameter trees (intermediate and suppressed crown classes) (Peet; Christensen 1987). Alder diameters would increase with time providing larger woody debris. However, alder's value for instream structure or terrestrial down wood habitat is short term. The reasons are alder is not decay resistance, and alder wood is comparatively weak allowing it to more readily break under the force of high stream flows compared with Douglas-fir (Niemiec et al 1995). One study found red alder, when pulled over into a stream, began losing structural integrity after three years (Keim et al 2000).

After 130-years, and assuming no disturbance of sufficient intensity to free growing space, those alder stands without a conifer component but with a salmonberry shrub layer can become brushfields (Emmingham; Hibbs 1997, Hemstrom; Logan 1986, Newton; Cole1994). The observed competitiveness of vinemaple suggests that alder stands with a vinemaple understory could also have a brushfield successional endpoint in the absence of disturbance. Trees cannot establish in a salmonberry brush field without a disturbance that frees growing space (Emmingham; Hibbs 1997; Hemstrom; Logan 1986). Salmonberry bush fields are "climax communities" that are unable to contribute wood to the streams. These sites, which had previously supported a late-successional/ old-growth forest are currently not on a trajectory to develop into old-growth.

Stands where a conifer component has successfully emerged above the red alders would have added structural complexity associated with two story stands. However, unlike the two-story conifer/ bigleaf maple or Douglas-fir/ hemlock stands, a two-story stand composed of a conifer overstory and an alder understory is short-lived. After 130-years, alder stands with a conifer component will transition into a single story low-density conifer stand with very large individual trees (Stubblefield; Oliver 1978, Newton; Cole 1987). In the absence of disturbance, a well-established shrub layer under the low-density conifer stand can preclude recruitment of understory trees thus delaying attainment of the structural complexity associated with late-successional forests. An underburn (either

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6 Oliver and Larson (1990) introduce the concept and describe the components of growing space in their chapter on plant interactions and limitations to growth. Oliver and Larson also describe the reaction of understory vegetation to overstory changes discussed in their chapter on the understory reinitiation stage.

7 The tree top loses apical dominance and vertical growth greatly slowed. Lateral growth continues giving the tree a flat-topped or umbrella form. The flat-topped form is a survival strategy for capturing light under extreme shady conditions (Oliver, Larson 1990).

natural or prescribed fire) could set back the shrub layer facilitating understory tree recruitment. However, that carries a risk of loss of the overstory trees. Under these stand development conditions, few fire tolerant Douglas-firs would have survived to become overstory trees because of their shade intolerance. The conifers that have sufficient shade tolerance to allow them to survive and potentially move into the overstory are fire intolerant hemlocks and red cedars (sources summarized by Minore 1979). These sites will develop some attributes associated with late-successional forest but will lack others and would be at higher risk of loss to fire.

Riparian zone surveys along north and central Oregon coast streams, which were neither subjected to logging nor farming found the near-stream (averaging more than 30-feet) plant community was nearly treeless 52% of the time. Hardwoods were dominant 28% of the time. All the stream-side stands were subject to a stand replacement fires 150-years earlier and therefore had gone through 150-years of successional change. The treeless areas may have initially been dominated by red alders, which had died of old-age. Alternately, beavers may have denuded these areas or these areas may have failed to support successful tree regeneration (Emmingham; Hibbs 1997). While the study described above indicated the successional pathways for those sites during the pervious 150-years, paleoecological studies, based on a 11,000-year pollen record for the same area indicated large shifts in forest species composition in earlier times. For example, red alder was much more common 500 to 1,000-years ago than today. Going further back in time shows frequent and large shifts in the abundance of conifers and alder. Emmingham and Hibbs go on to argue that temporal and spatial variations in the relative abundance of tree species "makes notions of naturalness difficult to define and goals of restoration of the naturalness quite difficult to pin down to specific management activities."

<u>Stand development following the conversion of an alder stand to conifer</u> - An alder conversion is a series of treatments designed to replace an alder stand with a conifer stand. Under the Forest Plan, alder conversion will be done to those alder stands growing on sites where conifer stands had been previously harvested. If the converted alder stand had other hardwood species in addition to the alder, then the replacement conifer stand will also have a component of hardwoods (other that alder) and depending on the hardwood stocking levels the stand could develop into a mixed stand. Depending on subsequent management and/or disturbance, these new conifer and mixed stands would be set on a development trajectory to develop into old-growth.

If the alder stand had a component of overtopped conifers, which can release, then those conifers would go through a period of shock until their shade needles are replaced by sun needles. Many of these conifers would be at risk of lodging or blowdown until they can take advantage of the increased growing space and develop favorable diameter to height ratios and expanded root systems. Conifers not capable of releasing would either die of shock or fail to regain epinastic control. Conifers that do release would contribute to the structural diversity of the new stand.

The removal of the alder component would increase the growing space for the vegetation left on the site, and for new plants that are subsequently seeded or planted on the site. Site preparation following alder cutting would increase the number of plantable spots. Site preparation would also temporally reduce herb and shrub cover and by that reduce interspecies competition enough to allow successful conifer regeneration and establishment. In combination, these treatments increase the sunlight reaching the forest floor resulting in higher photosynthesis rates for the residual and new plants. Following alder cutting and site preparation, the herb and shrub layer plants that escaped disturbance, and species on the site before treatment that can regenerate from stump sprouts, root suckers, rhizomes, root crowns, or other asexual means will rapidly recolonize the site. Pioneer plants, with light wind disseminated seeds, would germinate throughout the treated area. However, only those seedlings that sprouted on open ground away from the highly competitive resprouting plants have a reasonable chance of adding to the species composition of the new stand. Logging debris provides a pulse of fine and coarse woody material to the forest floor. In the near term, this debris adds to the fuel loads, pins down some residual plants facilitating propagation of those species that can asexually regenerate through layering, reduces plantability, provides small mammal habitat, and moderates the microclimate near the ground. In the longer term, the decomposed logging debris adds organic matter to the soil and releases nutrients for recycling. The increased sunlight warms the soil increasing microbial activity. This results in increased decomposition rates and nutrient cycling and increased root growth and efficiency of nutrient and water uptake by vascular plants.

The cumulative effect of doing alder conversions across the landscape would be an increased in the area and continuity of conifer cover, and by that restoration of forest type patterns more typical of the landscape just prior to intensive management for wood products. Alder conversions would, in time, increase the habitat suitable for late-successional/ old-growth associated species and would reduce the area of habitat for species associated with alder dominated disturbed sites. Naturally occurring streambank erosion, alluvial deposition, slope failures and debris torrents will provide disturbances that maintain populations of red alders on the landscape that are within the natural range of variability.

The conversion process curtails the short term contributions of small nondurable alder wood to the forest floor and nearby streams, and forgoes attainment of a pulse of large nondurable alder snags and debris that would have been produced when the alder stand breaks up about age 90 to 130-years. This could be mitigated by leaving some larger diameter alder logs on the site and in nearby streams at the time of conversion. Large diameter tree-length pieces would be more effective as key pieces to trap smaller pieces and by that reduce the transport of woody debris from the treated sites. With successful conversion to a conifer or mixed stand, the site would begin to produce small diameter conifer wood following canopy closure at age 10 to 15 years. With active management or timely moderate disturbances, the new stand would produce large diameter durable snags and woody debris in about 50 to 70-years. With passive management and in the absence of moderate severity disturbance, longer time periods would be needed to obtain a regular supply of large down wood and snags. The conifer stand would supply large durable snags and woody debris until the Douglas-fir component is exhausted 500 to 1,000-yrs in the future.

Slope Position/Soil Moisture Relationships and the Effect on Plant Communities

Lower moderate slopes - The combination of water draining down through the soil profile into this area from above plus direct precipitation causes these areas to be moist. Topographic shading and sheltering from the wind may also reduce evapo-transpiration demands on this slope position. Erosion processes like soil creep, and splash erosion constantly move soil down the slope, which adds to the rooting depth on the lower slope at the expense of the mid upper slope positions. Plants best adapted to these sites prefer moist well-drained soils and will tolerate some seasonal drought. The accumulation of colluvium on the toe of the slope will result in deeper soils there. Plants on the toe of the slope will find similar growth conditions to those found on benches and terraces on the lower slopes resulting in similar plant assemblages and structures.

Lower slope bench - The transition from moderate or steep slopes to a bench slows water movement through the soil. Since the land does slope down hill from the outside of the bench, excess water does drain away. Soils on this slope position are often deep which gives them considerable capacity to store water compared with sloping ground. Optimum growth for many plants occurs on these sites, and disturbances like fire or blowdown are rare. When there is a disturbance, competition to capture growing space is strong.

On undisturbed topographically protected north facing sites, a lower slope bench may be dominated by western red cedar, western hemlock, and bigleaf maple. These species grow best on moist well drain soils and tolerate shading enough to grow up through some competition. Scattered large old Douglas-firs, dating from a distant past catastrophic event may be present. The scarceness or absence of Douglas-fir on many lower terraces is the result of how rare stand replacement fires are on these moist protected sites.

Upper flood plain(5 to 50 year flood frequency)[8] - This area is characterized by a water table which is high enough to limit rooting depth, and occasional flooding. This limits the tree species, which can regenerate and mature on these sites, to those species that can tolerate seasonally wet soils and occasional flooding. Soils will develop an organic layer, and the processes that cause the differentiation of the soil profile into horizons may get started between flood events. When flood waters return, alluvial deposition usually covers those soils resulting in buried profiles. Often movement of water through the soil is constricted, which favors plants tolerant of physiologically induced drought caused by low oxygen levels in the soil. Examples include red alder, myrtle, and grand fir. Western red cedar, and bigleaf maple appears to tolerate short periods of flooding. Douglas-fir is intolerant of all but the shortest period of

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[8] Distinguishing between a lower slope bench and a 5 to 50 year flood plain may be difficult. If you are uncertain whether you are working with a bench or with a 5 to 50 year flood plain, treat the site as a flood plain if it is dominated by myrtle. If the site is covered with alder but salmonberry is responsible for less than 10% canopy closure in the shrub layer than you are likely working with a bench. However, you cannot automatically assume that an alder dominated site with a significant salmonberry component is on a flood plain. If the site is dominated by bigleaf maple, the soils are sufficiently well drained to be managed as a bench.

flooding and so may be excluded from these areas except where natural levees, small rises and hummocks give it the necessary drainage. The trees on these sites perform important hydrologic functions during floods. The trees act as racks to catch both large and small woody debris. That debris, in turn, serves as down log habitat on the flood plain after the water goes down, and as in-stream structures to catch gravel and create plunge pools. This trapping of woody debris on flood plains in the forested part of the watershed reduces the loss of wood out of the system. The tree boles and understory shrub and herb layers slow the flood waters causing it to drop part of the sediment load on the flood plain.

<u>Lower flood plain(1 to 5 year flood frequency)</u> - This area is characterized by a seasonally high water table and frequent flooding. The water table may be high year around on the smaller creeks where there is little elevation difference between the stream in the summer and the flood plain. Plants must be adapted to saturated soils to survive, and many are pioneer species that thrive where there is frequent disturbance by floods. Soils are newly deposited alluvium and are subject to being moved, mixed, and redeposited during high water. Usually plants here either require abundant moisture or are tolerant of physiologically induced drought caused by low oxygen levels in the soil. Willows and red alders can become established in the food plain but often show the scars caused by debris transported by high water, and are often bent over by the force of the flow.

The following is the comparative tolerances of trees found on the Umpqua Resource Area to excessive moisture. This information was compiled from several sources by Minore (1979):

most tolerant:	western red cedar, black cottonwood
?	red alder
	Sitka spruce, grand fir
?	western hemlock
least tolerant:	Douglas fir

Simply classifying plants as tolerant to excessive moisture does not fully explain the variation in vegetation from site to site on the flood plain. Season of flooding, depth to the watertable, and whether the groundwater is moving or stagnant all affect the final species composition on the flood plain. The following is an expanded ranking that considers different types of "excessive moisture" tolerance:

- Winter flood tolerance - Winter inundation does not significantly affect survival or growth of western hemlock, red alder, Sitka spruce, or western red cedar. Winter inundation as short as one week affects survival and growth of Douglas-fir and has disastrous consequences after four weeks (Minore 1968)

- Summer flood tolerance - Relative tolerance of tree seedlings to summer flooding (Minore 1968):

most tolerant:	western red cedar
intermediately tolerant:	red alder, Sitka spruce, western hemlock
extremely intolerant:	Douglas-fir

  Both red alder and western red cedar produce adventitious roots that seem to improve their ability to tolerate summer flooding conditions (Minore 1968).

- Tolerance to shallow water tables - Based on observations on the Olympic Peninsula, red alder, Sitka spruce, and western hemlock are adaptable to shallow water tables (when water table depth is greater than 15 centimeters) and will tolerate moderately shallow winter water tables (Minore & Smith 1971). There is variation in tolerance to shallow water tables when depth to water is less than 15 centimeters. Western hemlock is intolerant of water tables shallower than 15 centimeters. Sitka spruce can tolerate winter water tables of flowing water shallower than 15 centimeters. Western red cedar can tolerate winter water tables of stagnant water shallower than 15 centimeters. Red alder can tolerate water tables shallower than 15 centimeters.

<u>Unstable lower slope</u> - This area includes steep unstable ground extending back from the creek from a few feet to many hundreds of feet. The instability is due to a combination of slopes steeper than the angle of repose and the stream cutting at the toe of the slope. Stream cutting at the toe of the slope is most likely to occur on the outside curves of the stream course. The situation is aggravated by ground water movement along the contact between an

unfractured bed rock and the soil acting like a lubricant. The resulting slope failures that expose bare mineral soil, which favors pioneer species like red alder. The readily accessible water along the contact between the soil and bedrock favor moisture loving plants like salmonberry, and vine maple. Their root systems can form a mat binding the soil and reducing the frequency of mass failure but not preventing down slope creep. Under these circumstances, vine maple and/or salmonberry may dominant the site excluding alders and conifers. The readily available moisture also favors western red cedar and bigleaf maple however their numbers are limited by soil movement, blow down, and brush competition. These sites rarely burn due to high moisture.

DISTURBANCE

Fire

Before the coming of logging, fire was the most important disturbance process affecting landscape pattern in the watershed. Fire is both the primary stand replacing disturbance and an important shaper of the subsequent stand structure and composition. Topography strongly influences fire behavior.

The following fire history based is based on data collected in Tioga Creek Subwatershed (Tioga Appendix: Fire History in the South Fork Coos Watershed Analysis), Middle Creek and North Coquille Subwatersheds (Appendix: Fire History and Fire Pattern in the North Fork Coquille Watershed Analysis), East Fork Coquille Watershed (USDI 2000) and supplemented by observations in the West Fork Smith River to the north (USDI 1997). The process used to analyze the data is based work on Morrison and Swanson (1990). These fire histories are reconnaissance surveys. The sample size and distribution are too small to map out the fire boundaries adequately or to sample all fire occurrences successfully. Also the probability that fire history data collection will detect a fire is proportional to the sample size, plot distribution across the landscape, and the size of the fire. Therefore, small fires are likely under represented in the sample.

Fires, as indicated by scars and regeneration pulses largely occurred in clusters or episodes separated by periods of low fire activity. Those periods were the years:

- 1534 to 1590 - This complex of stand replacement fire(s) and reburns. The size of these fires is not known, however, the available data suggests the affected area was extensive.
- 1735 to 1798 - These fires were stand replacing events on the North Coquille Subwatershed. These fires were also stand replacing events for the west end of the East Fork Coquille Watershed, which suggests the 1735 to 1798 fires may have been important stand modifying , if not replacing, events in the south end of the North Fork Coquille Subwatershed. These fires caused both stand modification and stand replacement in the Middle Creek Subwatershed.
- 1845 to 1868 - These fires modified many stands by setting back the shrub layer and opening the overstory. That set the stage for establishing many of the understory hemlock stands in the watershed. These fires were stand replacing events in portions of Burnt Creek and of East Fork Coquille.
- 1912 to 1936 - These fires prepared the way for both understory hemlock regeneration on many upper slope sites, and for the establishment of several ridge top single story Douglas-fir stands. In 1936, the Fairview fire in the Fairview Subwatershed, the First Williams River Fire on Williams River-Tioga Creek divide, and the Sitkum Fire in the East Fork Coquille burned concurrent with the better known Bandon Fire.

Large stand replacement fires are associated with periods of severe regional drought (Heinselman 1983). Regional drought conditions could explain why several fires observed in the watershed occurred about the same time as fires in Lake States, and in the Klammath, Cascades, Olympic and Rocky Mountains (Agee 1991, Franklin & Hemstrom 1981; Heinselman 1983).

<u>Fire effects on CWD recruitment into streams</u> - The timing and amount of large woody debris input to streams depends on the stocking levels, and mortality patterns in the adjacent riparian stands. Streams that pass through young forest contain large woody material from the stand that existed before the last stand replacement fire and small woody debris from the current stand. The relative amount of material from the pre-fire and post-fire stands changes over time. When the pre-fire stand was old-growth, the change is gradual and may take more than a century. Where fire kills all of the old trees next to a stream and reburns consume the woody debris that those trees would have

otherwise contributed to the site, the result is a deficiency of course woody debris and a long lag period before the new trees beside streams can contribute wood to the stream. The resident time of debris recruited from the pre-burn stand depends on the size distribution and species composition of that stand. If the pre-fire stand was young and the stream contains only small diameter material, the debris carried over to the post-fire conditions will decompose faster than old-growth size material. Under these circumstances, total stream debris loading will decline appreciably during stand reestablishment (Swanson & Lienkaemper 1978). Riparian zones impacted by stand replacement fire dating to the 1845-1855 fire episode, the 1868 fire, or the first fires in the 1891-1944 episode, which were subsequently reburned, are the sites most likely to be deficient in CWD.

Wind

Wind storms frequently cause fine scale disturbances. On occasion, winds blow down tens even hundreds of acres during a single storm causing stand replacement.

Blowdown of timber usually occurs when there is a soaking rain followed by strong winds. Trees along stand edges facing the prevailing windstorms are more susceptible to windthrow than are edges at angles to the wind (Alexander and Buell, 1955). Corners and gaps, on the down wind side of clearcuts and canopy gaps are vulnerable to blow down because the wind speed is accelerated as it funnels into constrictions (Smith 1962). Exposed clearcut boundaries on ridge tops where the opening is on the lee side will cause winds to eddy the same as sharp ridges. Blowdown is most likely to occur on the lee side of sharp ridges and on the windward side of gentle slopes. Individual tree and small patch blowdown are widely dispersed and annual occurrences. Before 1981, ten to fifteen acre size blowdown patches typically occurred every three to five years on the Umpqua Resource Area. Less frequently, severe windstorms blew down stands covering areas of hundred acres and more. The most important windstorms in terms damage to the forest, which occurred since the establishment of a District office in Coos Bay were in 1951, 1962 and 1975. Blowdown in the last 20 years has been limited to individual tree and small patches.

Severe winter storms originating offshore regularly hit this region with heavy rains and strong winds. High wind warnings for wind speeds of 60 to 80 mph on the headlands are made in most years. These winter storms come out of the southwest quadrant. If the winds come more from the west than from the south, the winds will be strongest on the coast and decrease in strength inland. This is due to the north-south orientation of the Coast Range that slows the wind through surface roughness. The most destructive winds are the ones out of the south that blow parallel to the ridges. At the most exposed ridges in the Coast Range, it is estimated that sustained winds of 110 mph occur at intervals of 5 to 10 years (PNWRBCMC 1968).

<u>Major Storms That Resulted In Large Acreage Of Blowdown On The Coos Bay District</u> -
The 1951 Storms - Southerly to southwesterly winds of 40 to 60 mph were reported over most of the state with gusts of 75 to 80 mph reported in some locations for the November 10-11, 1951 storm. The December 4 storm reached its greatest intensity along the coast where there were unofficial reports of wind speeds between 60 and 100 mph and up to 75 mph reported in inland western Oregon (PNWRBCMC, 1968). The Coos Bay BLM office had only been established a few years before the 1951 storms. According to a retired BLM employee, the salvage effort that followed the 1951 storm made it necessary to hire additional staff and that made the shift from custodial management to timber management on the District possible.

October 12, 1962, The Columbus Day Storm - The Columbus Day Storm developed off the coast of California and struck this area October 12, 1962. It approached the coast from the southwest and then turned so that it came out of the south when the storm hit the Oregon Coast. Some official reports for sustained wind speeds and peak gusts are Astoria 44 and 96 mph, Eugene Airport 63 and 86 mph, Troutdale 66 and 106 mph, and Salem Airport 58 and 90 mph (PNWRBCMC, 1968). Winds reached 152 mph at the Air Force radar station at Hauser (The World Newspaper Dec. 12, 1995). The barometric pressure measured at the North Bend Airport was 28.42 (The World Newspaper Dec. 12, 1995).

Several timber salvage sales resulted from this storm. A partial list of those sales includes 113 acre Sale No. 66-45 on Wilson's Folly Creek in the Tioga Creek Subwatershed, and the 186 acre Sale No. 65-36 in Skeeter Camp in the East Fork Coquille Watershed. The Wilson's Folly unit is on an east facing slope in a canyon where the creek flows S20 W. The Skeeter Camp unit is on a ridge top. The Yankee Run Salvage Sale No. 63-32, 129 acres and also in the East

Fork Coquille Watershed, was similar to the pattern exhibited on Wilson's Folly Creek in that the blow down was on an east facing slope adjacent to a creek that flows in a S10°W to S30°W direction. There were many other large and small salvage units, and there is still blowdown from that storm on the ground today. A witness to the 1962 storm told of watching old growth tree crowns being spun around by the wind causing the bole to be twisted in two. The wind then lifted the tops up and carried them for some distance before the tops finally fell to the ground. The 1975 wind storm similarly twisted the tops off of trees.

November 10, 1975 Storm - The Middle Creek Subwatershed was directly affect by the 1975 storm that occurred on the night before the opening day of elk season. The 1975 storm caused a distinctive pattern of blowdown in that the damage occurred in patches along a narrow linear path starting at the mouth of the Middle Creek Canyon in section 15, T.27S., R.11W., Will. Mer. and extending to section 1, T.28S., R.9W. Will. Mer. 15 miles away. The storm also caused damage on the Roseburg District - BLM. The resulting salvage sales inside the Middle Creek Subwatershed were the 263 acre Old Man's Salvage Sale No. 77-27, the 264 acre Fishladder Salvage Sale No. 77-28 and a 35 acre unit in the Vaughns Creek Sale No. 76-27. Blowdown salvage sales were also sold in the Garbage Dump and Cherry Creek areas[9]. The actual blowdown patch sizes were smaller than the sale acreage. The normal practice at the time was to sell the blown down timber plus the standing green timber between the down material and the nearest logical fire break. Much of the blown down timber in the Fishladder and the Old Man's Salvage Sales was on north facing steep ground. The soils are so fragile on those sites that large areas are classified unsuitable for timber commodity production and would not have been included in a timber sale under normal circumstances. Middle Creek flows S70°W past the Old Man's Road and Fishladder Salvage Units. The 35 acre Vaughns Creek Sale unit is on a ridge top.

The most recent major wind storms were the November 13, 1981 (the Friday the 13th Storm) and the December 12, 1995. The Friday the 13th Storm destroyed the Hood Canal Bridge in Washington. That storm caused the 22 acre blowdown patch that was sold as the Friday the 13th Salvage Sale, Sale No. 83-51. The 1995 storms caused numerous individual and small groups of trees to blow over but did not result in large contiguous areas of blowdown.

The December 1995 storms was only one of a series of storms that hit the coast in rapid succession. The first hit Sunday night December 10 and continued into the morning of the 11th with wind as high as 70 mile per hour. Gusts up to 107 mph were recorded at Cape Blanco (The World Newspaper Dec. 11, 1995). The December 12 storm hit during the day. Winds speeds of 120 mph were observed at Sea Lion Caves, 107 mph in Newport and 80 in Portland, OR. NOAA measured steady winds of 70 to 80 mph. The North Bend Airport measured the barometric pressure of 28.72 at 8 a.m. The pressure was predicted to drop to 28.35 (The World Newspaper Dec. 12, 1995). However, the part of the storm with the lowest pressure stayed at sea and did not hit land (TV cable Weather Channel). The combination of wind speed and barometric pressure experienced December 12 was comparable to a high category 2 or low category 3 hurricane (TV cable Weather Channel).

Other Exceptionally Damaging Storms To Hit The Oregon Coast (PNWRBCMC, 1968) -

January 9, 1880: Caused a 3-mast schooner at Coos Bay to drag anchor, blow on to a beach and break in two.

January 29, 1921: Hurricane force winds reported for the entire Oregon Coast. A 113 mph wind officially recorded at the mouth of the Columbia. Unofficially Astoria recorded 130 mph winds.

December 21-23, 1955: North Bend reported sustained winds of 70 mph and gusts to 90 mph.

November 3, 1958: Sustained wind speeds of 51 mph and gusts to 71 mph reported at Portland Airport. Mount Hebo Air Force Radar Base reported 130 mph.

March 27, 1963: Unofficial reports of wind speeds greater than 100 mph on the coast. Official sustained wind and gusts were 57 mph and 63 mph for Portland. Eugene had 48 and 75 mph.

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[9] Lance Finnegan, former timber manager for the Burnt Mountain Resource Area said his entire TQ76 sale plan consisted of units with blowdown from the 1975 storm. The 1975 storm also blew down some trees inside the Cherry Creek Natural Area.

Snow Damage

Snow accumulation is usually limited to above 1,800 feet elevation. Wet snows that fall before alders lose all of their leaves result in snow break among the alders above 1,800 feet elevation. Repeated snow breakage has been observed to effectively release conifers from over topping red alders and may be a reason to why alder was a minor component in stands above 1,800 feet before there was much road construction or logging. Heavy wet snows can also damage conifers. Wet snows can cause considerable damage to recently commercial thinned stands. The commercial thinned stands most prone to snow break are wild stands that had not been precommercial thinned. Those stands are susceptible to snow break because trees in these formerly dense stands have small branches and small stem diameters relative to their heights making them vulnerable to breakage when overloaded with wet snow or ice. A thinned stand's susceptibility to snow break declines as the trees build stem and branch diameter in response to the increased growing space. Snow break was particularly bad on the District in 1969.

Snow damage may be an ongoing selection mechanism acting on the genetically controlled aspects of crown shape. Young stands on sites above 2,100 foot elevation, which have a lot of natural fill-in, have numerous trees with narrow candle-like crown form. The narrow crown form of Douglas-fir is most frequently observed on the ridge accessed by the Middle Fork Brummet Creek Road. This form is similar to that of mountain hemlock and subalpine fir. The narrow candle-like form is believed to be an adaptation for shedding snow, thereby avoiding snow break. In contrast, most all low elevation Douglas-firs have a broader crowns[10]. The form difference between low elevation Douglas-fir and Douglas-firs subject to frequent snow at higher elevations, has also been noticed in the Cascade Mountains (Arthur Mckee personal communication).

Insect and disease

These agents, often working in consort, tend to modify stands by initiating gaps or patches and only rarely cause stand replacement.

Root diseases - Laminated root rot and black stain disease can kill patches of sapling and pole size trees. Laminated root rot is transmitted through root grafts and by root contact with infected debris. The laminated root rot causal agent can survive up to 50 years in buried debris and stumps. Black stain disease, stands out as an agent more closely associated with the managed forest than wild settings. Black stain disease kills patches of sapling and pole size conifers on inherently stressful sites impacted by compaction or loss of top soil. Black stain disease is a current management concern and is controlled by minimizing stress to plantations, and by timing plantation treatments to avoid attracting the insects that vector the disease. *Armillaria* is occasionally observed killing trees in westside forests. Within the Coos Bay District, the few confirmed cases of *Armillaria* were on tractor damaged soils.

Swiss Needle Cast - Aerial surveys for Swiss needle cast indicate this fungal disease on Douglas-fir foliage occurs in the extreme west end of the South Fork Coos Watershed (Filip 1998). At least one BLM plantation, in the Ren Smith area, appears to be infected. The following discussion on Swiss needle cast comes from information provided by Don Goheen, forest pathologist with the Southwest Oregon Forest Insect and Disease Service Center. The disease is cause by *Phaeocryptopus gaeumannii*, an ascomycetous fungus. The disease causes yellowing and premature loss of infected needles. This can result in reduced height and diameter growth but rarely directly kills its host. The loss of foliage can affect the infected Douglas-fir trees competitiveness, which can alter stand dynamics and ultimately stand structure and species composition. *P. gaeumannii* is native to North America and was long thought to be of minor importance within the Douglas-fir range. Swiss needle cast causes severe damage to Douglas-fir planted outside the tree's range though out the world. In recent years, Swiss needle cast has become particularly damaging in Douglas-fir stands within 30 miles of the coast in Northwest Oregon. Most impacts are noted in stands 10 to 30 years old. However, cases of severe infection have been reported in older stands. The disease is showing up in Douglas-fir stands planted in or near the spruce zone on the south Oregon Coast. The cause of the current out break of Swiss needle cast does not have a single simple explanation and is a subject of on going research. However, one or more of the following factors may be responsible:

- Douglas-fir has been established in dense pure plantations in the coastal fog belt where the tree had been a

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[10] Alternate explanation: the narrow crown form may be less reflective of what is necessary to survive today and be more an indication of the selection pressures controlling tree establishment and survival at the time the dominant seed source regenerated. The dominant Douglas-fir seed source on the north rim of the East Fork Coquille Watershed, where narrow crown trees are most commonly noted, is old growth that regenerated in the 1500s towards the end of the Little Ice Age.

minor component in wild stands.
- Some plantations were planted using off-site seed.
- As the disease progresses there a greater inoculum load (more spores) increasing the probability and severity of infection.
- Recent climate shifts may have created conditions more favorable for the fungus.

In areas where the disease is causing discoloration of the Douglas-fir, follow the follow interim recommendations. Deviate from this recommendations to incorporate new strategies for managing coastal fog zone sites as supporting research is published and as necessary to address site specific needs:
- Use local seed source - do not deviate more than 500-feet elevation or 1 mile latitude
- If species other than Douglas-fir are present, favor those other species when thinning. If the stand is predominantly Douglas-fir and the disease is not severe, a thinning prescription that favors the most vigorous disease tolerant individual trees may prove some benefit. However, thinning is not a tested treatment for managing Swiss needle cast in Oregon. Thinning is not recommended for severely infected pure Douglas-fir stands.
- Pruning infected Douglas-fir stands is not advised because the loss of leaf area through pruning combined with the loss of foliar mass to the disease can have a detrimental affect on tree growth.
- If site prep costs are not prohibitive, interplant young (less than 5 to 10 years old) at risk Douglas-fir with resistant native species.
- Under plant older Douglas-fir stands with shade-tolerant resistant species. Thinning the overstory Douglas-fir may be necessary to insure survival of the underplanted trees.
- Fertilization with nitrogen, or phosphorus or blended fertilizers with micronutrients does not appear to provide significant benefit therefore fertilization is not recommended for disease control purposes.
- Fungicides have been proven effective to control Swiss needle cast in Christmas tree plantations. However, fungicides are not considered an operational treatment for managing infected forest stands.

<u>Insects</u> - Insect attack is a secondary disturbance in the Coast Range forest. The following discussion on insects is based on a personal communication with Don Goheen, who is with the Southwest Oregon Forest Insect and Disease Service Center. Douglas-fir bark beetle (*Dendroctonus pseudotsugae*) and Douglas-fir engraver (*Scolytus unispinousus*) attack stressed trees and fresh blowdown. The Douglas-fir bark beetle attacks large trees and therefore is the economically more important of the two. The Douglas-fir engraver attacks are limited to the tops and branches of large trees, and to small trees. In this area, black stain disease is the primary cause of stress that predisposes small trees to Douglas-fir engraver beetle attack. Douglas-fir bark beetle attacks, in the Coast Range, are rare and are associated with large blow down events and fires. The two biggest bark beetle epidemics occurred in response to the back to back blowdown events in the winters of 1949-1950 and 1950-1951, and following the 1962 Columbus Day Storm. The large quantity of blowdown in 1949-50 and 1950-51, coupled with the lack of a road system to support aggressive salvage, resulted in the 1951-1952 beetle epidemic being the larger than the beetle outbreak that followed the Columbus Day Storm. At times other than following fire kill or blowdown, Douglas-fir bark beetles are not effective against live healthy Douglas-fir. The Burnt Mountain Unit Resource Analysis (USDI, 1978) describes normal bark beetle attacks as usually limited to clumps of a dozen or less trees widespread through the forest. It is now understood that under normal conditions those clumps are often laminated root rot centers opportunistically attacked by bark beetles . The Douglas-fir bark beetle is an opportunistic user of trees weaken by root disease and causing standing trees to die resulting in snag recruitment inside root rot pockets.

The following is the epidemiology of Douglas-fir beetle (*Dendroctonus pseudotsugae*, provided by Donald J. Goheen, Entomologist/Plant Pathologist with the USDA, USFS, Southwest Oregon Forest Insect and Disease Service Center:
- Under normal circumstances, Douglas-fir beetles do not infest and kill green healthy Douglas-firs. Rather, small endemic populations of these beetles survive in greatly weakened trees, especially trees in root disease centers.

- On occasion, Douglas-fir beetle populations may increase to epidemic proportions. Outbreaks are triggered by events that produce large numbers of weakened hosts all at one time. Fires may occasionally set off population increases, but major wind or snow events that cause many trees to topple or break much more commonly do so. Cutting trees and leaving the logs on site creates the same kind of condition as a blow-down event from the prospective of Douglas-fir beetles.

- Douglas-fir beetles will infest down Douglas-firs of 10 inch diameter or greater and will produce brood. Down trees occurring under a still-standing canopy provide optimal breeding habitat since beetles prefer and are most successful on down material that is shaded, cool, and moist.

- Douglas-fir beetles occurring in the vicinity will attack down Douglas-firs in the spring of the year after the trees come down (usually from April to June). They are able to detect stressed or downed trees over considerable distances. Douglas-fir beetles have a one-year life cycle, and the new brood will emerge from the down trees in the spring of the subsequent year. If there are enough of them, Douglas-fir beetles emerging from down logs can infest standing trees.

- Douglas-fir beetle infestation of green trees occurs when brood has emerged from a fairly substantial number of down trees. Based on past experience, the threshold appears to be at least 4 down Douglas-firs $\geq$ 10 inches diameter per acre. The more down host trees there are and the larger the size of the down trees, the greater the likelihood that emerging beetles will infest green trees and the larger the number of trees that will likely be infested.

- Number of green Douglas-firs that are infested by beetles emerging from down trees is usually a function of the number of down trees that the beetles breed in. Generally, in the year that the beetles emerge from down Douglas-firs, one standing green tree is infested for every 3 down trees. The next year, one additional host is infested for every 4 to 5 Douglas-firs that were attacked in the first year, and in the third year, one additional green tree will be infested for every 25 that were infested the year previously. Outbreaks usually subside in the fourth year. During the entire course of an outbreak, 4 standing green trees can be expected to be infested for every 10 down infested Douglas-firs.

- Most commonly, beetle-caused mortality of standing Douglas-firs will be concentrated fairly near the downed trees initially attacked by the beetles. However, Douglas-fir beetles are strong fliers, and in a certain percentage of cases (10 to 20 percent), they infest trees one to 5 miles away from where they emerge.

- During outbreaks when Douglas-fir beetles infest standing green trees, they often show a preference for the largest Douglas-firs in a stand and also often cause concentrated mortality, killing all of the trees in patches that vary in size from ¼ to 2 acres.

Balsam wooly adelges (*Adelges piceae*), also called balsam wooly aphids, caused considerable grand fir mortality in the lower parts of the North Fork Coquille and East Fork Coquille Watersheds during the 1960s. Grand fir had been a more prominent component of the low elevation valley side stands and riparian zones before the balsam wooly adelges epidemic than it is today (per. com. Lance Finnegan). Balsam wooly adelges were accidently introduced from Europe and is a highly destructive to Pacific Silver fir, subalpine fir and grand fir. The insect, when in the crawler stage, is disseminated by the wind. All individuals are female so it only takes one to form a new colony. Five predator species have been introduced and established by 1965, but at that time were not providing economic control (primary sources summarized by Funiss; Carolin 1977). Currently, true fir mortality, attributable to the balsam wooly adeges, has dropped suggesting predators and parasites are keeping the adeges populations in check. However, this insect still merits concern (pers. com. Donald Goheen). Defoliator insects have not caused significant economic damage to Coast Range forests.

Landslides

Land slides usually affect only small areas at a time but the severity of that disturbance can be very high. Landslides result in the loss of the top soil and organic layer at the point of origin. In extreme cases, all soil is lost down to bedrock. Landslides bury developed soil profiles, where they come to rest, with material that is predominantly subsoil and fractured rock. The loss of the organic layer and top soil to landslides sets back plant succession, and favors pioneer species. Red alder is particularly successful in occupying slide tracks and deposits because of its small winged seed facilitates long distance disbursal, rapid juvenile growth, and ability to fix nitrogen. From the stand point of red alder's regeneration strategy, fresh road cuts and fills provide the same conditions produced by landslides. Landslides that reach creeks can deliver structural material (woody debris, and boulders), gravel, fine sediment, and fine organic matter.

Floods

Like landslides, floods affect only a small part of the landscape but it too is a significant process. Flooding can kill or damage vegetation by burying small plants under sediment and breaking plants with brittle stems. Flooding affects the species composition on the flood plain by killing plants that do not tolerate saturated soils. This frees growing space for those plants that have mechanisms to survive saturated soil conditions or can regenerate on sediment deposits.

Vegetation response to small scale disturbance

Gap creating agents include individual tree and patch blow down, low severity fire, insects, disease, drought, and soil movement. In addition to these agents, riparian vegetation is also modified by flooding, stream bank erosion, and saturated soils.

Openings in the overstory canopy, or gap formation, provides new growing space for the plants already on the site. If the understory is fully occupied by shrubs and/or hardwoods when the mortality occurs in the overstory, those shrubs and hardwoods will increase in vigor in response to the newly available growing space. Any newly regenerated conifers in a gap already occupied by established shrubs and hardwoods will be out competed and will die. Conifers will occupy new gaps under two conditions. First when there is advance conifer regeneration already established on the site that is vigorous enough to respond to the new growing space, and the other when the gap occurs in a stand that is in the stem exclusion stage. In those stands, the overstory canopy has intercepted most of the sunlight depriving understory plants the light necessary for survival. In this case the gap opens new growing space free of herb, shrub and hardwood competition suitable for plants regenerating from seed. Small gaps, and the edge of large gaps are affected by partial shade that in turn favors the survival and grow of shade tolerant trees like hemlock and red cedar over Douglas-fir.

DEFINITIONS OF OLD-GROWTH AND MANAGING FOR LATE-SUCCESSIONAL CHARACTERISTICS

Work by Franklin and others (1986) established the minimum standards for considering a stand to be old-growth Douglas-fir. These are:

- Two or more tree species with wide range of ages and tree sizes
- Eight or more Douglas-firs per acre that are greater than 32-inches dbh or greater than 200-years old
- Shade tolerant trees greater than 12 per acre that are greater than 16-inches dbh
- A deep, multilayered canopy
- Four or more snags per acre greater than 20-inches dbh and greater 15-feet tall
- Fifteen or more tons per acre of logs including 4 pieces per acre with diameters equal or greater than 24-inches and lengths greater than 50-feet.

North et al (1999) found a positive correlation between northern spotted owl use and densities of trees $\geq$31.5-inches dbh; snag volume per acre and volume in decay class I, II and III snags; foliage volume per acre and diversity of height classes. In the study area $\geq$70% of the snag volume was derived from snags larger than 20-inches dbh rather than from small numerous dead intermediate and suppressed trees. The size of snags on medium and high forage use sites averaged 34-inches dbh and 79-feet tall with a mean density of 6 snags/ acre. The medium to high use areas often had large rot-resistant snags (Douglas-fir and western redcedar) that date from a past disturbance.

Hicks and others (1999) found that spotted owls preferred older stands to young stands. However they did find spotted owls using a subset of young forest that contained “legacy” structures such as occasional large green trees, snags and down wood. While spotted owls preferred nesting in older stands, the birds used suitable young stands next to late-successional forests for roosting and hunting. Based on their observations of the types of stands used by spotted owls, Hicks and others developed strategies for managing for both the habitat needs of spotted owls and the preferred habitat of spotted owl prey:

- “Avoid disrupting down logs during logging operations and retain some large woody debris (possibly in well-

distributed piles) to help minimize disturbance of established small mammal communities.
- "Use stocking control practices that accelerate the development of large-diameter stands and understory shrub diversity, to favor higher densities of small mammals.
- "Retain green trees with defects and snags in harvest units to improve habitat for flying squirrels and other small mammals at all forest regeneration stages
- "Enhance spotted owl hunting habitat by thinning dense stands to facilitate movement through the site, and partially control vegetation to reduce density of low shrubs that may impede the ability of spotted owls to locate and acquire prey.
- "During thinning or harvest operations, clump leave trees to provide well-shaded sites for owls to roost during the day."

Ripple and others (2000) analyzed the 1949 landscape patterns on the Central Coast Range. They found
- old-forest stands composed 63.2% of the landscape (range 15.7% to 100%).
- nearly all of the prelogging forest was well stocked (≥70% crown closure).
- 49% of the prelogged landscape supported pure conifer stands (>80% conifer cover).
- 2% was pure hardwood
- 30% was conifer dominated mixed stands
- 6% hardwood dominated mixed stands
- the remaining 11% composed of pure and mixed conifer and hardwood classes each of which represented <1% of the landscape.
- 21% of all old forest stands and 58% of all young conifer stands had a significant hardwood component (>20%)
- Near 11% of the stand s were dominated by hardwoods.
- The proportion of the old-forest class was relatively constant with increasing distance from streams.
- In the prelogged landscape, the amount of nonforest and hardwoods decreased with distance from streams and the amount of seedling/sapling/pole and young conifer increased.

This last observation may reflect differences in disturbance and landscape response:
- The greater the distance from streams the lower the site moisture and thus the greater probability that a fire will carry and be of sufficient intensity to locally cause stand replacement. The generally warmer drier upper slopes are more favorable for successful conifer establishment than for alders.
- Landslides are dominant disturbance process in and immediately adjacent to draws. Alders are more competitive on the more moist sites on the lower slopes and where landslides have exposed nitrogen poor subsoil.

Tappeiner *et al.* (1997) observed old-growth trees often averaged 20-inches dbh at age 50 and 40 inches at age 100. This individual growth rate is higher than observed in plantations today. By running stand development simulations, Tappeiner *et al.* (1997) found 31 to 46 trees/ acre, at age 20-years, resulted in the better fit to observations made in old growth stands with respect to the estimates of total densities and densities of the larger diameter classes. Franklin and Hemstrom (1981) noted that old-growth stands can be in an open grown condition during their first 40-years and sufficiently open to allow successful establishment of shade intolerant trees for 100 years. This suggests that old-growth stands developed with low density, regenerated over time, and had little inter tree competition. The implications are well-stocked plantations and young well-stocked wild stands are not on the same stand development trajectory followed by the old-growth stands currently on the landscape. Setting these young stands on a trajectory to develop into old-growth would require a disturbance of sufficient intensity to

? increase growing space to allow attainment of large diameter trees that in turn can eventually become large diameter snags and down wood. Ideally the trees that would compose the future old-growth stand would be about 20-inches dbh by stand age 50-years and many would be 40-inches dbh by stand age 100-years.

? provide number and size of gaps between overstory trees to allow establishment of a younger understory stand of tolerant tree species and to facilitate development of deep multilayered canopies.

The rarity of Coast Range old-growth, with close-spaced annual rings lain down during the first 50 to 100-years, suggests either extensive repeated fires reduced the seed sources (Franklin; Hemstrom 1981) or well-stocked to overstocked conditions early in the life of a stand may not be conducive to long life and development into old-growth. While the reasons are not known, it is possible that well-stocked 20-year old stands rarely survive to become old growth because they are at greater risk of blowdown during extreme storms or their high canopy continuity facilitates spread of crown fires compared with stands that were understocked at a young age. Young Douglas-fir stands are particularly susceptible to fire during their first 75 to 100 years. Alternately, partial burns could account for the low stocking condition and age ranges observed by counting and measuring old-growth tree rings (Franklin; Hemstrom 1981).

The classical theories of plant succession assume a single successional pathway, a single endpoint, and the characteristics of the successional stages are controlled by the site. This suggests stocking levels at age 20 or 50 would have little relevance with respect to attaining the old-growth condition that a site is capable of supporting, and disturbances are viewed as setbacks delaying attainment of the preordained old-growth and eventually climax conditions. In contrast, current thinking on plant succession concludes that a large number of factors can affect succession consequently succession can be quite variable on similar sites (sources reviewed and summarized by Cook 1996). Therefore differences in conditions at early successional stages and differences in disturbance patterns can result in different succession pathways, different developmental trajectories and different successional end points on sites that are otherwise physically and climatically similar. This suggests that in the absence of disturbance (either natural occurring or management action) well-stocked young stands we see today on the landscape, which are protected by fire exclusion and land use allocation, will develop into a different old forest from the old-growth present on the landscape.

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