V. CRITERIA FOR DEVELOPING APPROPRIATE TREATMENTS

It is important that activities that are employed within late-successional reserves maintain all of the pieces necessary to attain late-successional stand characteristics. This section of the assessment describes the criteria and the process for developing appropriate treatments within LSRs. **Figure 3** is a flowchart which depicts the process and displays some examples of how an Interdisciplinary Team (IDT) would utilize this section of the document.

There are 5 steps to the process. The first is the identification of a condition on the landscape which would trigger a management action (**Table 7**). Second is a determination of the seral stage of development. Third and fourth steps are done in conjunction with each other. The IDT determines what the site-specific issues of an area are and then works as a team to establish the appropriate management criteria (**Table 7**) and sideboards **(Tables 8-12)** that guide implementation of the project through an integrated prescription. The outcome, the fifth step in the process, is a proposal of an appropriate management activity.

Management Triggers

There are a variety of existing or potential conditions on the landscape which would trigger a management action. Site-specific analysis is necessary to determine if an area would require some sort of vegetative manipulation to accelerate attainment of late-successional characteristics.

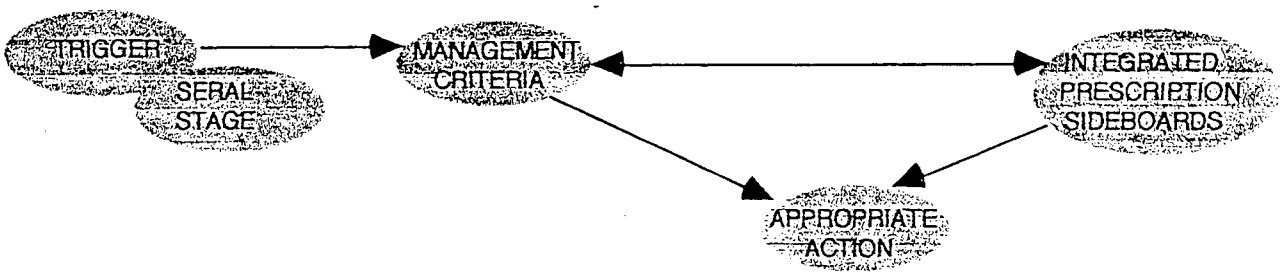
Site-specific analysis may determine that an area is on a trajectory for attainment of late-successional characteristics (refer to discussion on the range of late-successional characteristics and **Tables 8-12**). When this situation is encountered, regardless of seral stage of development, that area should be left to develop on its own.

There are certain conditions that exist on the landscape that result from past land use patterns and/or practices that would trigger a management activity within late-successional reserve land allocations. It must be remembered, however, that all activities that occur within the LSR land allocation must be beneficial to the creation of late-successional forest conditions over the long -term. (ROD C-12).

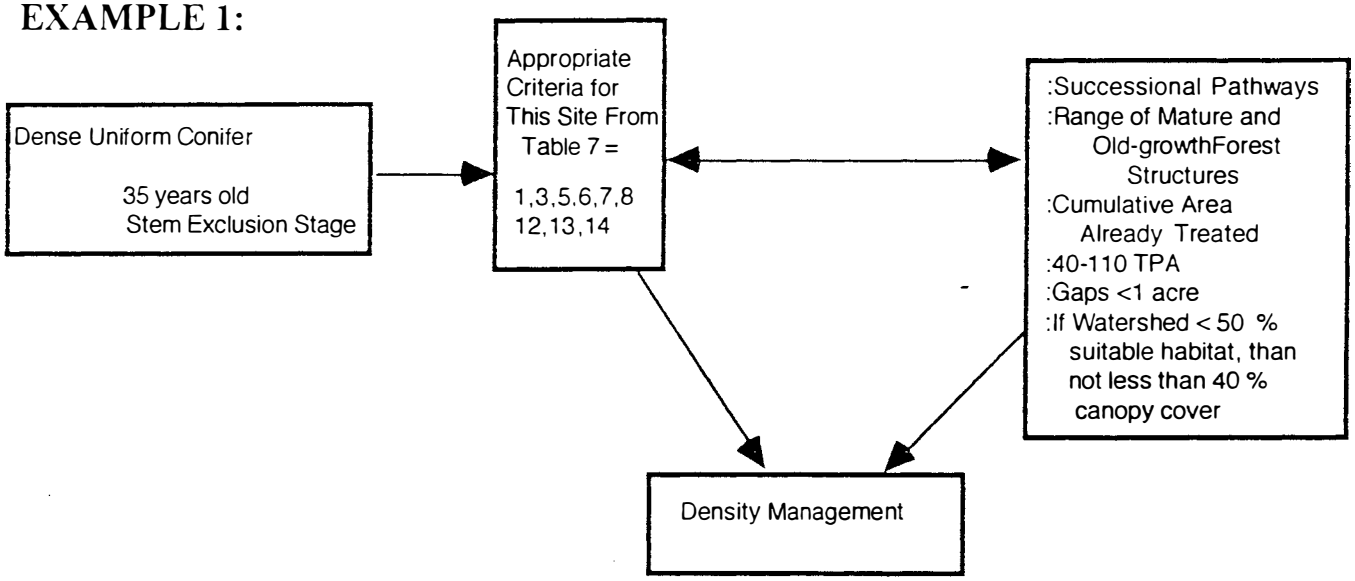
Studies have shown that accelerated development of many of the structural components of late-successional stands can be achieved (Oliver 1992, Marshall 1991). Wide spacing provides the site condition for open-grown trees and the development of lateral branches which result in a "wolfy limb" character to individual trees. Through time, the large wood will die, decay, and fall to the ground as a source, first as snags, then as large woody material that will either stay on site or move into a stream channel. As a result, it can be suggested that growing big trees also accelerates development of the down wood and snag

Figure 3: Flow Chart - Utilizing Information in LSRA to Develop Appropriate Management Action

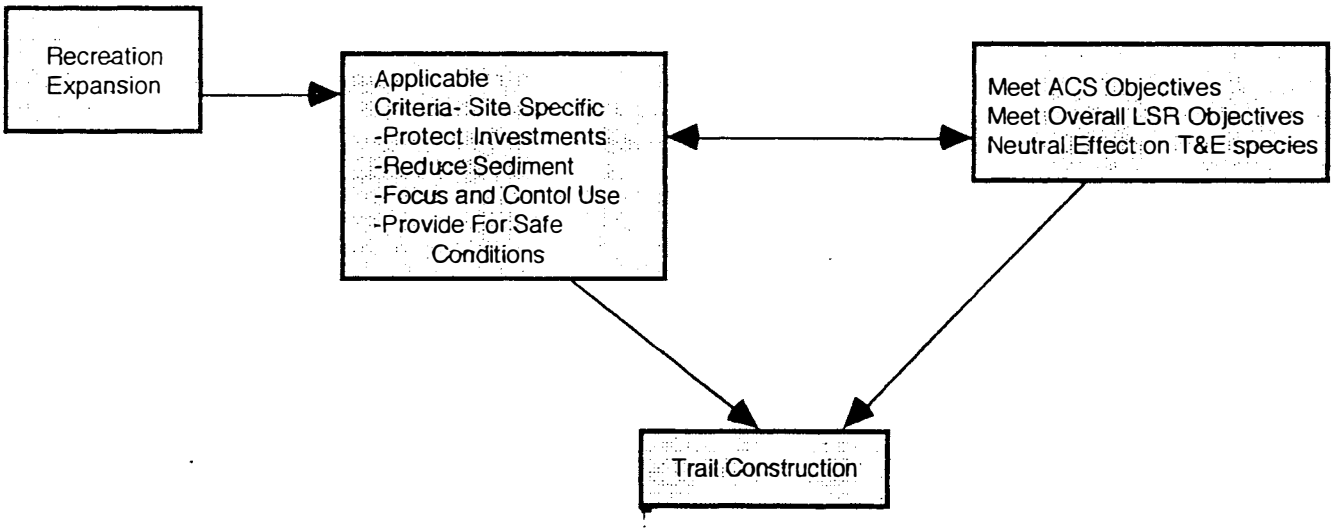
PROCESS:



EXAMPLE 1:



EXAMPLE 2:



component in size classes typical of late-successional structural character. Multiple canopy layers, canopy gaps, and the development of a patchy understory can be created. However, understanding the spatial distribution of these features at the stand and landscape scales is currently a research topic.

The effects of accelerated development of structural characteristics on ecosystem processes (i.e., tree growth and maturation, death and decay, disturbances), and functions (i.e., nutrient and hydrologic cycling, buffering of microclimates, storing carbon) is not known. Some processes and functions cannot be accelerated, such as time since disturbance. Thus, there should be enough variability in treatments and enough unmanaged land to serve as refugia for any unknown elements, functions, and processes.

Dense uniform conifer stands in managed plantations (25-50 yrs) will be the primary focus for manipulating vegetation to provide the structural conditions associated with late-successional characteristics. Although dense, uniform stands have been a part of the landscape, the amount and distribution of these stands now occurring in these LSRs is inconsistent with the range of natural conditions. Trees which have been uniformly spaced from planting and precommercial thinning will interact differently when developing through the inter-tree competition phase or stem-exclusion phase than natural stands seeding in after a stand replacement disturbance. Trees have less chance to express dominance when they have all been put on an even footing in terms of growing space and selection through precommercial thinning. Therefore, when these stands reach density levels in which individual trees are competing with each other for growing space, it will take longer for individuals to express dominance. As trees go through this stagnation stage, stems will become tall and slender as height growth continues but diameter growth drastically slows in response to loss of crown. These trees will become more dependent on neighboring trees for support. Eventually, as some trees dominate and others fall behind, the dominant trees will develop more crown and diameter growth and therefore more individual stability. Still, as trees go through this period, they are more likely to blow down or, if drought conditions persist, be more susceptible to insects and disease.

The uniformity of trees within a stand determines the rate of differentiation and self-thinning. Although plantations are generally more uniform, portions of the stands are as non-uniform as many natural stands, and some portions of natural stands developed as uniformly as the plantations. So it's a continuum, with a wide range of development which has taken place in natural stands. The plantations are skewed towards the more uniform end of the spectrum. Thinning dense, uniform stands such as these to a wider spacing would provide the remaining trees more of an opportunity to differentiate without stagnating.

Active management, such as thinning and underplanting, would accelerate attainment of at least some late-successional stand conditions (large trees, multiple layers, for example). Many of these conditions begin to develop within 30 - 75 years. Without thinning and underplanting, the managed stands would eventually develop late-successional characteristics. However, attainment of many of stand characteristics, such as large snags and logs, may take centuries.

Stands less than 80 yrs old currently occupy about 211,898 acres (**Table 6**) of land within the LSR allocation across the landscape. Approximately 86,000 acres are in 25 to 50-yr old managed stands, while younger plantations (0 and 24 yrs old) make up approximately 114,000 acres. Many of these stands may require some sort of density management within the next 30 years. There is scientific research to support that it is appropriate to change these stands from the current trajectory that they are now taking with activities that manipulate the density and spacing of trees (Oliver and Larson, 1990; Marshall, 1991) in order to achieve more natural stand characteristics. In addition, another 37,000 acres are in 51 to 80 year old stands (i.e., fire-regenerated stands, early railroad logging). While the majority of the stands in this older age group are natural or on a trajectory which meets LSR objectives, a few of these stands may also benefit from some vegetation manipulation.

Commercial thinning opportunities are predominately in the "dense uniform conifer stands" in the 25-50 year old age group (**Table 6**). Throughout the LSR, federal forest management agencies are predicting that about 6500 acres per year will be scheduled for manipulation of vegetation to accelerate the attainment of late-successional conditions. Only a small portion of the 50 to 80 year old stands would be treated. Locations of these treatment areas will be based on the priorities described in Landscape cells with the "best" habitat areas being secured first then moving treatments to restore the more degraded habitats (pp. 56,57). Habitat conditions within spotted owl activity centers will be evaluated and if vegetative treatment is required to restore suitable habitat, 40% canopy closure will be maintained to provide dispersal habitat.

Table 6. LSR Acres With Potential Treatment Opportunities

LSR	AGE CLASS	ACRES BLM	ACRES SNF
RO267	0-10 YRS	9,652	1,525
RO267	11-24 YRS	16,864	11,615
RO267	25-50 YRS	23,304	7,606
RO267	51-80 YRS	9,532	3,025
RO268	0-10 YRS	7,403	14,358
RO268	11-24 YRS	12,112	39,987
RO268	25-50 YRS	15,439	39,474
RO268	51-80 YRS	10,537	14,215

Another condition on the landscape where management activities would assist in attainment of late-successional characteristics is when soil productivity is so severely degraded that the site can no longer support or maintain the plant communities that it was once capable of supporting. Soil restoration activities could be employed to restore the soil quality at the sites.

Every effort should be made to employ management practices which maintain a low risk of creating catastrophic disturbances. However, there may be times when a catastrophic disturbance, whether insects, disease, wind or fire, occurs and has led to conditions that if allowed to persist, would be detrimental to the goals and objectives of the LSR. In this situation, it is appropriate to employ some management activities. In

the case of insect outbreaks, only as a last resort should activities which apply chemical treatment be employed. All management responses to disturbance events will follow the guidelines in the ROD.

The area outlined on **Map 6** indicating Phellinus includes both mature and young stands. Treatment would occur in plantations within that area. Seral classes within that delineation are:

Grass/Forb	518 ac	Very Early (<10 yrs)	2,858 ac
Pole (11-24 yrs.)	9,892 ac	Young Conifer (25-50 yrs)	10,442 ac
Conifer (51-80 yrs)	1,584 ac	Mature Conifer (>80 yrs)	26,109 ac
Hardwood	4,872 ac		

The majority of treatment would occur in the 25-80 year age classes, as described for a preventative treatment. We estimate that about 300 acres per year may be treated. This acreage would be included in the total LSR acreage treated per annum.

In some areas, existing species mixes may be inappropriate for the site and detrimental to the attainment of late-successional characteristics. This is often the case when past disturbances, especially if human-caused, result in a species shift from what was there naturally, or has introduced noxious or non-native species onto a site which are inhibiting the regeneration of the native plant communities.

At times, there will be conditions on the landscape which are unacceptable and are in conflict with Aquatic Conservation Strategy objectives. These areas will be manipulated to bring them in line with ACS objectives over time.

There are some areas in the assessment area which are not and are not expected to be on the trajectory of attaining late-successional structural characteristics. These areas occupy a small component of the landscape (less than 1%) and are considered unique and important for the contribution they add to diversity across the landscape. These include areas in a non-forested condition for a variety of reasons which include rock outcrop areas, wetlands, and meadows. Management activities will be employed to maintain these special characteristics. Non-silvicultural activities which manipulate vegetation may be proposed within these LSR boundaries. These activities need to be neutral or beneficial to the LSR. The ROD C- 16, 17, 18 provides good direction on these types of activities. Existing facilities (i.e., campgrounds, electronic sites) are compatible with LSR objectives. Most existing and planned recreation facilities are along the coastal strip which is not within the LSR designation. Areas that exist or are planned, within LSR boundaries, occupy such a small area when looking at the whole LSR that the function of the overall LSR will be maintained. There may be some site-specific areas that are outside of ACS objectives. These will need to be reviewed at a finer scale either in Watershed Analysis or project environmental assessments. Marys Peak and the Wilderness areas are identified as areas that may possibly have conflicts with LSR objectives if increased use or major expansion of developed recreation occurs. All projects must meet ACS Objectives over the long term, meet T&E

species requirements, and avoid known T&E locations. This list is for projects that actually disturb vegetation.

In **Table 7** we have delineated those site conditions which would trigger a management action. We also noted, in some cases, that such site conditions would have different objectives and thus a different response from management, depending on the seral stage of development. For example, in the very early seral stage, (i.e., less than 10 years of age), a management activity would not space trees so widely that the risk of predation by animals or competition with herbs and shrubs would be so high that the desired tree species would be lost. Instead, a management goal in the very early seral stage would be to plant and maintain enough trees on site that one could be assured that adequate stocking to meet long-term objectives would be attained. It would not be until the later seral stages that confidence in survival would be high enough that a management activity would risk thinning trees widely.

Management Criteria

Management criteria have been established (**Table 7**) to guide prescriptions for the appropriate management activities. These criteria are designed to help to "keep all the pieces" and assure attainment of late-successional characteristics. Not all criteria will be applicable with every project. The criteria vary by condition on the landscape (or "Management Trigger") and/or seral stage of development. If these criteria cannot be met with a proposed prescription, then that prescription must either be revised or the project dropped or sent to the REO for project-specific approval.

Existing Guidelines For Habitat Manipulation

The US Fish and Wildlife Service recommends that silvicultural activities be limited to stands which do not currently serve as suitable habitat for spotted owls and other T&E species. Suitable habitat for owls includes nesting, roosting and foraging habitat. Nesting habitat is defined as mature stands with sufficient structure and large snags or old-growth remnants which provide nesting opportunities. However, owls frequently use younger stands including natural stands 50 to 80 yrs old for roosting, and foraging. So, caution needs to be taken when recommendations are made to treat these stands, especially if they are located within 1.5 miles of a known owl activity center, as they are likely being used by the resident owl pair.

The ROD addresses maintaining dispersal habitat for terrestrial species through Riparian Reserves (RRs). The RR network was designed to facilitate dispersal of both terrestrial and aquatic species. The reserve system and other mitigating measures found in the ROD replaces the 50-11-40 rule. Dispersal habitat for the owl is defined as stands with an average tree diameter over 11" dbh and a minimum crown closure of 40%. Stand treatments which

reduce the crown closure to below 40% (or approximately 60 trees per acre in a 35-yr.-old stand in the Coast Range) may affect dispersal for owls. The effects of silvicultural prescriptions on dispersal habitat will be identified and evaluated at the watershed (5th field) level in consultation with USFWS and the level one consultation team for the Oregon Coast Province.

In these LSRs, the RR network covers approximately 80% of the landscape. In general, activities proposed in this assessment are planned both inside and outside of RR boundaries within LSRs. Many of the objectives for LSRs are similar to RR objectives and thus, similar treatments are appropriate.

Activities should be directed at stands that were regenerated following previous harvest activity and that show no significant development of multi-canopy tree structure.

Appendices F.1 and F.2 contain two letters of direction from the Regional Ecosystem Office (REO) which outline specific types of treatment that are already exempt from REO review. It has been sufficiently demonstrated that implementation of the activities listed is consistent with the attainment of late-successional characteristics.

Appropriate Management Activities

The activities listed in **Table 7** are a list of management options that may be appropriate for a given management trigger.

Activities not addressed may be appropriate on a site-specific basis and should be brought to the REO for approval.

The appropriate management activities listed in **Table 7** are intended to be the result of an integrated prescription which considers the management criteria, the successional pathways appropriate for a given site, and the desired future conditions of the area. Implementation of these activities will accelerate attainment of late-successional characteristics. Resource managers are presented with a range of appropriate treatments so that they are able to select the most appropriate treatment following site-specific assessment of certain areas.

Although we have listed many management activities that would be appropriate in late-successional reserves, they have been kept very general. This was done purposefully to allow specialists to make recommendations based on site specific evaluation. However, some management activities are so encompassing that they do need clarification.

Density treatment means any manipulation of the density of vegetation on a given site. Activities to achieve desired density will vary by site condition and to be exempted from further REO review, typically will include:

- Manual release for survival of individual trees in younger plantations (<24 yrs.)
- Thinning of young trees to provide adequate growing space for adjacent trees.
- Selective thinning in young conifer and older stands to create groups of trees or provide variable spacing (25-80 yr. old stands).
- Creation of openings - generally less than 1 acre in size in 25 - 80 yr. old stands.
- Thinning densities can vary depending on the management objective and the successional pathway for a given environmental condition. Densities normally range from 40 - 110 trees per acre in 25-80 yr. old plantations.
- In Riparian Reserves if there is less than 50% suitable dispersal habitat, densities should not be reduced below 40% crown closure (or about 60 tpa at age 30-35).
- Unthinned areas (all age classes).
- Snag and CWD levels within the ranges indicated in **Tables 11 and 12**.

Treatments not meeting all of the above items will remain subject to REO review.

Salvage is defined as the removal of trees from an area following a stand-replacing event such as those caused by wind, fires, insect infestations, or diseases. Removal of dead trees from an area is an appropriate management tool. The decision to do so must be based on site-specific conditions, with the understanding that salvage operations should not diminish late-successional habitat suitability now or in the future. Appropriate reasons to remove trees from an area are defined on pages C-13-16 of the ROD.

Treatment from disturbances on less than 10 acres of land may be appropriate in the following instances, although these conditions were not specified in the standards and guidelines of the ROD. However, for these salvage or risk reduction treatments, REO review would be required. These conditions include:

- When the quantity of fresh material (less than 1 year old) on the ground is sufficient with a distribution that is contiguous and poses a high risk of Douglas-fir bark beetle outbreak. Consideration must be given to whether or not the predicted kill of surrounding large trees would render the surrounding stand non-functional for late-successional habitat (Hostetler, 1996).
- When disturbance occurs adjacent to private property boundaries, removal of portions of trees would be allowed if they: threaten the survival of trees on adjacent land owners, are a hazard to surrounding owners, or impact the management of surrounding lands.

Table 7: Management Triggers, Criteria, and Appropriate Activities Within Late-Successional Reserves

The following management criteria will be referenced throughout **Table 7**

1. Maintain minor native species, gaps, clumps, animal predation, natural mortality
2. Maintain site occupancy (stocked to maintain options for LSR objectives)
3. Maintain vigor and health to keep options open
4. Provide for natural regeneration from edges
5. Provide for variable spacing
6. Encourage natural diversity of floral species in the overstory and the understory
7. Grow large trees
8. Maintain snags and CWD to levels shown in tables 11 and 12
9. Create wolfy limbs
10. Grow large wood for fish habitat structure
11. Maintain and or establish multiple canopy layers
12. Recruit snags in larger diameter classes to levels shown in tables 11 and 12
13. Consider windfirmness
14. Consider understory shrubs/herbs/fungi/lichens
15. Provide CWD for structure in streams
16. Maintain Connectivity function of stand
17. Maintain Wolfy limbs
18. Restore soil productivity
19. Reestablish natural communities
20. Protect Green Trees
21. Maintain low risk of and reduce incidence of insect and disease outbreaks
22. Protect investments
23. Provide for safe conditions
24. Reduce sediment
25. ATM/TMO consistency
26. Provide adequate light for growth of conifer
27. Restore hydrologic function
28. Maintain early seral conditions
29. Meet RNA, ACEC, Botanical area objectives

MANAGEMENT TRIGGER	SERAL STAGE	MANAGEMENT CRITERIA	APPROPRIATE MANAGEMEN ACTIVITIES
Area on trajectory for attainment of late-successional structural characteristics (confirmed by site-specific evaluation) a. Natural hardwood stands b. Diverse natural stands c. Dense natural stands (50-80 yrs)	All (except mature) Refer to dense conifer for management objectives by seral stages	LSR management objectives are being met (Tables : 9,10,11,12)	No treatment Recruit snags Close roads

Table 7 cont.: Management Triggers, Criteria, and Appropriate Activities Within Late-Successional Reserves

MANAGEMENT TRIGGER	SERAL STAGE	MANAGEMENT CRITERIA	APPROPRIATE MANAGEMENT ACTIVITIES
Dense Uniform Conifer	Very Early < 10 yrs	1 - 8	Density treatment No treatment if management objectives cannot be met
	Early 11-24 yrs	1 - 10	Stand density treatment Fertilization No treatment if management objectives cannot be met
	Early 25-50 yrs	1, 3 - 15	CWD placement in streams Snag creation (refer to LSR components Table 11) Prescribed fire for creation of structure and control of species composition Underplanting Stand density treatment Down wood recruitment Fertilization No treatment if management objectives cannot be met
	Mid seral 50-80 yrs	1, 3 - 17	All of the above
Long-term productivity issues	All (except mature)	18	Silvicultural treatments to add nutrients to the site (i.e., fall and leave) Recruit snags Close roads

Table 7 cont.: Management Triggers, Criteria, and Appropriate Activities Within Late-Successional Reserves

MANAGEMENT TRIGGER	SERAL STAGE	MANAGEMENT CRITERIA	APPROPRIATE MANAGEMENT ACTIVITIES
An Existing Condition Of Phellinus >10 Ac. In Size That May Affect The Goals And Objectives Of The LSR	All (except mature)		Thin to low densities Replant resistant or non-host species No treatment if management criteria cannot be met
An Existing Condition Of Disturbance > 10ac And <40% Canopy Closure That Affects The Goals & Objectives Of The LSR		ROD C-13 - C-16	
a. Insect and Disease	All (includes mature)		Thin to low densities
1. Phellinus		1, 2, 4 - 8, 11, 14 - 16, 19 - 22	Replant resistant or non-host species Replant appropriate species
2. Douglas-fir Beetle		same as above	No treatment if management criteria cannot be met Apply pheromones, insecticides
b. Fire		1, 2, 4 - 8, 11, 14 - 16, 19, 20, 23	If objectives cannot be met with other treatments, salvage excess over CWD and snag requirements (refer to successnl. pathways and Tables 9-12)
c. Windthrow Areas		same as above	Salvage to ensure safe conditions
d. Landslides / debris torrents		23, 24, 25	Road restoration Slope stabilization

Table 7 cont.: Management Triggers, Criteria, and Appropriate Activities Within Late-Successional Reserves

MANAGEMENT TRIGGER	SERAL STAGE	MANAGEMENT CRITERIA	APPROPRIATE MANAGEMENT ACTIVITIES
Existing Species mix inappropriate for site potential a. Hardwood established in original conifer site i.e., conversion of site b. Inappropriate species for plant community c. Brush field (understocked) d. Noxious weeds/ non-native species	All	1,2,4 - 12, 14 - 17, 20, 26	Site conversion Establish appropriate species Control exotics/ noxious plants Stand density treatment Release Prescribed fire No treatment if management objectives cannot be met
Aquatic Conservation Strategy needs a. Degraded in-stream habitat b. Excess sedimentation c. Accelerated runoff d. Elevated stream temperatures e. Restore conifer recruitment potential	All	24, 27	Road closures / obliteration Slope stabilization Culvert replacement/ maint. Create stream channel complexity Place CWD in channels Soil restoration; i.e., subsoiling Recruit wood off-site Plant conifers in riparian zone
Special Habitat Areas a. Alpine Meadows b. Wetlands c. Rock outcrops d. Homestead meadows	Very Early	3, 6, 14, 28, 29	Prescribed fire Manual or mechanical clearing of vegetation Soil restoration Control exotics / noxious plants No treatment if management objectives cannot be obtained

Table 7 cont.: Management Triggers, Criteria, and Appropriate Activities Within Late-Successional Reserves

MANAGEMENT TRIGGER	SERAL STAGE	MANAGEMENT CRITERIA	APPROPRIATE MANAGEMENT ACTIVITIES
Non-Silvicultural Activities: Recreation: Improvement of existing facilities Expansion of existing facilities Development of new facilities Recreation Events	All	15,16,19, 22, 23, 24, 25, 29 ROD C-17 Meet ACS objtvs. Neutral effect on T&E species Apply Seasonal Restrictions Focus and Control Use	Trails/site relocation or construction Campsite construction or relocation Roads: stabilize, close, obliterate Culvert replacement / maintenance Restore Riparian condition Control exotic and noxious plants Designate appropriate use areas Provide information on resource protection
Genetic Development; i.e., Progeny sites Seed Orchards	All	22, ROD C-17	Manage existing sites
Special Forest Products	All	ROD C-18 Siuslaw NF Forest Products EA, BLM Handbook	Monitor to evaluate long term effects
Grazing	Early	ROD C-17	Upgrade or develop allotment management plans
Research	All	ROD C-18, 19	Allow as appropriate
Other: Rock Quarries Mining Mineral extraction Realty Actions Habitat Improv. Projects Electronic Sites * This is not an all-encompassing list *	All	ROD C-17	Identify appropriate areas

Desired Condition, Based on Successional and Structural Pathways

The overall goal for management of the LSR is to protect, maintain, and create late-successional forest ecosystems which serve as habitat for late-successional and old-growth related species. Management treatments will strive to re-establish connectivity of that habitat in the least amount of time to maintain functional, interacting late-successional forest ecosystems.

When attempting to accelerate attainment of late-successional characteristics, it is important to understand how successional pathways will affect proposed management activity. Successional pathways are defined by the typical, dominant compositional and structural stages that can be expected as vegetative communities develop following a disturbance. They describe the dominant tree species, relative tree density patterns, regeneration and lower layer species development, and ground cover trends through time. The pathways are controlled by local environment, original composition, and type of disturbance. Sub-series vary in their successional pathways both in the variety of species supported and the number of individual plants of a given species present.

To use successional pathways in evaluating proposed management requires knowledge of the physical environment (soil/climate zone, landform, and slope position), the biological environment (sub-series environment), and where the stand is in its successional development. This information would be used, in addition to other concerns (ACS, wildlife habitat distribution, etc.), to determine if the outcome of a particular management activity was acceptable. There may be instances when the dominant vegetation development pathways are bypassed to create conditions desired for specific purposes. For example, a wet environment in the western hemlock series densely stocked with conifer would be an uncommon site condition for that environment but, due to a severe deficit of large woody structure in the stream system, it might be desired and maintained for the benefit of other ecosystem components.

In characterizing the vegetative communities, sub-series environments (which group plant associations and communities into broad biological environments from wet to dry) (**Table 3**) (**Map 5**) were described and delineated. Sub-series environments were selected as the appropriate vegetation filter through which to assess possible management prescriptions.

Appendix G displays graphic examples of the successional pathways for each plant series environment by sub-series and by disturbance regime. Conceptual models of succession were developed for each environment by using inventory information (**Table 9**) and field observation. The following is a working hypothesis of successional pathways that would occur for four different climax vegetation series and their sub-series environments.

Series - Sitka Spruce
Zone - Coastal Fog

Environments - Wet, Moist, and Dry

Stands with a mix of western hemlock, Douglas-fir, Sitka spruce, and varying amounts of red alder, are found across all environments. Sitka spruce and western hemlock are prevalent throughout all environments because they are prolific seeders and shade tolerant enough to compete in all environments. The primary intermediate disturbance is wind. Unlike fire, these non-stand replacing events favor regeneration of the shade-tolerant conifers, such as western hemlock and Sitka spruce. Finer scale successional pathways and refined differences between environments need to be explored.

Series - Western Hemlock
Zones - Central Interior Alsea, Central Interior Marys Peak/Alsea Valley, Southern Interior

Environment -Wet

- The wet environments occur most often on lower slopes and in riparian areas. Soils have a high water table. Moving west to east through the Coast Range, from Central Interior Alsea to Southern Interior, the wet area becomes more restricted to narrow bands in the valley bottoms. After disturbance, regeneration of conifers is sporadic due to high vegetation competition. Salmonberry is the predominant understory shrub species. Red alder has a larger presence than conifer in early seral stages and remains a large component in young and mature stages.

- Two dominant tree communities occur in this environment. The first is a pure alder type, usually found in areas too wet for Douglas-fir, and in areas in which a significant amount of bare soil following a disturbance has created a desirable seed bed for alder. If undisturbed, the alder areas will begin to lose vigor and decay after 80 to 100 years of age. Shade-tolerant conifer species (western hemlock, western redcedar) will become established on a variable basis, depending on seed source. These conifers will begin to occupy the overstory as the alder deteriorates. In areas on or near the floodplain which experience higher frequencies of flooding or debris torrents, the alder will constantly be regenerated and kept in the system.

- The second type of tree community occurs where microsite conditions allow establishment of scattered Douglas-fir. A mix of red alder, in some places bigleaf maple, and Douglas-fir will predominate through the early and mid-seral stages. If no major disturbance occurs, alder will decline. The site will be dominated by scattered large Douglas-fir and variable amounts of shade-tolerant conifers filling in through the stages. **Table 9** illustrates this mature condition with 63 total trees per acre, 28% red alder and 40% Douglas-fir as the dominant species. This type has the lowest total trees per acre and the highest percentage of red alder of all the sub-series environments.

- Stands consisting of pure hemlock will also occupy these sites. Salmonberry brush fields may dominate in some areas as well. However, these types are considered more minor in distribution.

Environment - Moist

- The moist environments occur on deep, well-drained soils, usually mid-slope. After disturbance, regeneration of conifers is predominant, with initial densities dependent on exposure of organic/mineral soil, density of competing vegetation, and seed source.

- Two dominant tree communities predominate in this type. The first is a pure conifer type, usually found in areas following a disturbance which has created some exposed mineral soil seed bed that Douglas-fir prefers. Varying amounts of shade-tolerant species (especially western hemlock) may be present, depending on how much litter and duff exist in the newly disturbed stands. In these areas, usually dominated by Douglas-fir, stands will develop at a variety of densities. Herbs and shrubs will occupy most of the growing space the first 10 years after a stand-replacing disturbance. From age 11 to 80, Douglas-fir will dominate the growing space, in dense areas, going through intense inter-tree competition. By age 80, portions of these areas could be occupied by dense stands with slim tree boles and crown ratios less then 25%. Portions of stands with initial stocking levels of less then 100 trees per acre would have significantly larger diameters and crowns. Ground vegetation will begin to appear as these stands become more open. From age 81 to 150, mortality by inter-tree competition will continue and tree density will be reduced. As the stand opens, shade-tolerant conifer species will become established or be released, on a variable basis, depending on seed source and tree suppression conditions. **Table 9** illustrates this stand condition with 81 total trees per acre, 57% of which are Douglas-fir. Red alder accounts for only 10% of the stand density.

- The second type of tree community occurs in areas wet enough and with adequate seed source to favor some alder establishment. These areas could subsequently take two successional pathways, depending on the disturbance regime. Areas with small disturbances, such as landslides, will have frequent regeneration of alder. Without disturbance, the alder will begin to lose vigor and decay after 80 to 100 years of age, leaving more of an open Douglas-fir stand or establishment of shade-tolerant conifer species, depending on seed source.

- In all stands, after age 150, wind, root rot, inter-tree competition, and insects will continue to lower the overall density of Douglas-fir trees creating more variation in stocking. Varying densities and ages of alder, shade-tolerant conifer species, and Douglas-fir will be found in the understory.

Environment - Dry

- The dry environments occur on upper slope positions which experience droughty conditions in the summer. Due to the dryness of this area, fires usually burn hotter, removing competing vegetation and providing a good seed bed for Douglas-fir. Pure Douglas-fir stands are predominately found in these areas.

- Shrubs, such as salal, Oregon grape, and Pacific rhododendron will occupy most of the growing space the first 10 years after a stand-replacing disturbance. Like the moist sites, from age 11 to 80, Douglas-fir will dominate the growing space and in dense areas will be going through

intense inter-tree competition. The primary differences between the moist and dry areas is the higher proportion of dense stands and lower site productivity due to droughty soil conditions and lower available nutrients. This lowers the rate of stand development. By age 80, as in the moist areas, portions of these areas could be occupied by dense stands. From age 81 to 150, mortality will continue and overall tree density would be reduced. As the stand opens up, shade-tolerant conifer species will become established on a random basis depending on seed source. After age 150, wind, root rot, inter-tree competition, and insects will continue to lower the overall density of Douglas-fir trees creating more variation in stocking. **Table 9** shows that these stands are the most dense of the three environments with an average of 99 trees per acre; 68% of these are Douglas-fir and only 1% are red alder.

Mid-seral disturbances - Moist and Dry Environments

- Fires have a variable severity and occur more frequently in the Central Interior-Marys Peak/Alsea Valley and Southern Interior Disturbance Zones. These fires create more diversity in stand structure due to low-moderate intensity fires. This results in a two or more layered overstory canopy. Late seral conditions are achieved earlier here than in the Central Interior Alsea Zone.

- Wind is a common intermediate disturbance in the dry environment, producing small patches of blowdown along upper ridges and ridgetops. It may also accelerate late-successional structural characteristics if it occurs in mid-seral successional stages by removing overstory Douglas-fir and releasing shade tolerant western hemlock.

Series - Grand fir

Zone - Central Interior Mary's Peak/Alsea Valley, Southern Interior (outside of LSR boundaries)

Environment - Wet

- The wet environment for the grand fir occurs along creek bottoms that characterize the low elevations of the eastern slopes of the Coast Range.

- After a major disturbance the successional pathway would start with the establishment of sedges and grasses. Western swordfern, common snowberry, and vine maple are common ground cover in the early stages after disturbance. Co-dominant hardwoods such as Oregon ash and bigleaf maple are scattered in the early stages. Initially, conifers will be scattered due to high competition from the ground cover. As the hardwoods mature and the area begins to differentiate into different layers, scattered amounts of grand fir regeneration underneath the hardwood canopy begins to emerge in increasing density. The ground cover will become less dense as the canopy begins to close due to less light reaching the forest floor. Grand fir, western red cedar, and western hemlock are found in along the creek bottoms in this environment.

As the canopy cover begins to close, the shade-tolerant Grand fir would begin to increase in the understory and ground cover species would begin to thin out due to competition for available light

filtered by the dense overstory. Eventually, as the forest reaches late seral conditions, Grand fir will become the dominant conifer species in the canopy layer.

Environment - Dry

- The dry environment occurs on the slopes and rolling ridges that characterize the low elevations of the eastern slopes of the Coast Range.

- After a major disturbance, the successional pathway would start with the establishment of sedges and grasses from the valley, and a shrub layer of swordfern, salal, and common snowberry. The majority of the sedges and grasses would be annuals which would persist for 10 years and then decline. As ground cover becomes well established, seedlings of Douglas-fir, Oregon white oak, bigleaf maple, and lesser amounts of grand fir would dominate.

- As the area begins to differentiate into understory and canopy layers, several other tree and shrub species would become dominant. These species include bigleaf maple, golden chinquapin, oceanspray and poison oak. The ground cover will become less dense as the canopy begins to close.

- As the canopy cover begins to close, the shade-tolerant grand fir and golden chinquapin would begin to increase in the understory. As the forest matures, the canopy would be codominated by Douglas-fir, Oregon white oak, and bigleaf maple. Grand fir would then become the dominant conifer understory species. If the forest were to reach its climax stage, grand fir alone, or grand fir in combination with Douglas-fir, would become the dominant conifer in the overstory. In an old-growth condition, Douglas-fir, grand fir, and hardwoods would occupy various strata within the stand and coarse woody debris would become common and scattered throughout the forest.

Series - Noble Fir

Zone - Central Interior Marys Peak/Alsea Valley

- The alpine environment occurs at elevations greater than 3200 feet in this zone. Primary locations include Marys Peak, Grass Mountain, and Prairie Mountain. However, there is little noble fir on Prairie Mountain; western hemlock dominates this site, which tends to be dryer , with extensive grassy balds to the south.

- The successional pathway after a major disturbance would start with the immediate establishment of a variety of sedges and grasses; vine maple and Pacific rhododendron would soon follow. Shortly after the establishment of ground cover noble fir seedlings would become established. As the vegetation begins to differentiate into understory and overstory layers, the sedges and grasses will retreat to the shallow-soiled grassy balds. A major component of this environment, the grassy balds will remain dominated by sedges and grasses, with noble fir reproduction common around the perimeter. It is unclear how stable these balds will remain without some level of disturbance (wind, fire, or heavy snowpack, for example).

- Noble fir will continue to grow and be the dominant overstory conifer species for about the next 80 years. Douglas-fir and western hemlock will slowly become established as the understory conifer species sometime during the first 15-20 years after the disturbance and will remain there until a minor disturbance (i.e., snow or wind event) creates openings in the noble fir overstory. Where openings have been created, the Douglas-fir and western hemlock will then create a mixed canopy layer in this environment (a more mixed canopy layer of noble-fir, Douglas-fir, and western hemlock will be common at the lower elevations of this environment). The understory can be characterized as mostly open with the dominant shrub species consisting of vine maple and Pacific rhododendron. As the stand matures, so will its complexity, with conifers occupying various strata within the stand.

Management Implications Of Successional Pathways

Specific prescriptions for management activities should consider what is possible and appropriate for a given site. **Table 8** highlights some of the key components of late-successional forest habitat and evaluates the **potential** for a given environment to be able to support that component (or management objective). These are general relationships.

Table 8: Potential for sub-series environments to meet key structural components when considering dominant natural successional pathways.

MANAGEMENT OBJECTIVES RELATING TO LATE-SUCCESSIONAL STRUCTURAL COMPONENTS	SUB-SERIES ENVIRONMENT (western hemlock series)		
	WET	MOIST	DRY
Grow large trees	H	H	M
Establish multiple canopy of conifer	M	H	M-L
Establish multiple canopy of conifer/hardwood or hardwood	H	H	M-H
Recruit large diameter snags/coarse woody debris	M-H	H	M-L
Maintain high stocking (high stand density)	L	M	H
Provide coarse woody debris for aquatic structures	M-H	H	L
Provide variable spacing (gaps, clumpiness)	H	H	M-L
OTHER MANAGEMENT OBJECTIVES			
Consider wind firmness	L	M	H

H=High probability M=Moderate probability L=Low probability

Table 8 displays that not all management objectives occur equally in every environment. These are not absolutes; these conditions occur over a continuum throughout the various environments.

THE "WET" ENVIRONMENT has as the highest probability of supporting:

- A low density of conifers and have high spacing variability (due to competitive nature of shrubs)

- A canopy composed of a variety of species in each layer, with a large component of hardwood species
- A place to grow the largest trees (but not many of them)
- A good place to recruit those few large trees for future aquatic structure.

THE "MOIST" ENVIRONMENT, on the other hand, would have slightly different potential:
- The overstory will have moderate density of conifers and have variable spacing
- There will be multiple species in the canopy composed mainly of conifers with some hardwood component.
- There will be multiple canopy layers of conifer
- This is the place to grow and recruit a quantity of large diameter snags and coarse woody debris both on-site and for aquatic structure.

THE "DRY" ENVIRONMENT would support different structural characteristics:
- The highest density of conifers could be expected here, spacing could be less variable, however, harsh sites with shallow soils and fine scale disturbances may result in variably spaced trees with gaps.
- Wolfy limbed trees may be found in this environment, due to either fine scale disturbances (wind or disease) or harsh site conditions.
- There would be few hardwoods in the canopy
- Wind firmness is a consideration for management activities

IN ALL ENVIRONMENTS management activities would strive to:
- Maintain health and vigor of the plant communities on site
- Encourage natural diversity of species in all layers for all flora
- Maintain existing structure i.e., large trees, wolfy limbs, CWD, snags;
- Recruit snags and CWD
- Encourage vertical and horizontal diversity in stand development

Late-Successional Structural and Compositional Characteristics

The structure of natural Douglas-fir forests is extremely diverse because of numerous processes operating at different spatial and temporal scales. Stand development and succession are important processes that determine forest habitat. Differences in forest structure should be viewed on a continuum rather than in discrete classes (Spies and Franklin 1991). No one condition is appropriate across the landscape. Knowledge of late-successional structural and compositional characteristics is key in identifying the desired future conditions to strive for in management activities.

Differences In Forest Structure: Young - Mature - Old

Changes in vegetation structure and composition occurs between young, mature, and old-growth that may influence late-successional forest function (Spies and Franklin 1991). The condition of existing late seral forests within the LSRs provides a reference point to compare younger stands against when determining desired future conditions. Since the majority of the late-successional stands currently present in the LSRA are 75-150 years of age (USDA 1995, Teensma et al. 1991), there is sufficient local information available to characterize mature age-class conditions only. There is limited information available for the old- growth condition of late successional forests in the Coast Range. Recent (1994,1995) photo interpretation of vegetation for a few watersheds shows that 1.5 to 3 percent of those landscapes are in an old-growth, multilayered condition. Higher percentage may be found in areas where Wilderness areas have been established.

Tree density, mean stand diameter, and basal area are most important in discriminating among age classes. Tree density is about twice as high in young stands as it is in mature and old-growth stands. Basal area increases with age class, and mean tree diameter is highest in mature stands which lack the smaller diameter shade-tolerant trees common in the old-growth (Spies and Franklin 1991).

Stand condition also is influenced by the age of the stand. Percentages of snags with natural cavities, percentage of Douglas-fir boles with resinosis, and percent of tree crowns with broken tops all were higher in old-growth than in the younger age classes (Spies and Franklin 1991).

Understory vegetation also changes with stand age. Herb and deciduous shrub cover increased with stand age class. Density of shade-tolerant saplings is highest in old-growth, lowest in mature stands, and intermediate in young ones (Spies and Franklin 1991).

General characteristics of old-growth forests that differ from mature include: codominance of western hemlock in the overstory, diverse vertical distribution of vegetation, and large amounts of CWD.

Mature Forest Structural Characteristics

In **Table 9**, the description of stand conditions is expressed in terms of trees per acre by species and size class. Data is based on plot information from the 1987 Siuslaw National Forest Vegetation Resource Survey and the 1984 Siuslaw Ecology Intensive Survey. Those surveys sampled late-successional mature (less than 200 years old) and old-growth (greater than 200 years old) stands, so the data represents a mix of these conditions; however, given the limited occurrence of old-growth on the Siuslaw National Forest, the effect on the average is insignificant.

These structural element data represent the averages of mature conifer stand conditions. They should not be targeted as an average stand condition. There are a wide range of stand conditions

that are found across the Siuslaw National Forest. They do, however, provide a reasonable representation of the differences in species and trees per acre by sub-series environments. This information is appropriate within the Siuslaw National Forest boundaries in the LSRA. On lands in the eastern portion of the LSRA, stand structural components could be different. Identification and mapping of sub-series environments on these lands are currently in progress, and data from these inventories should be utilized when it becomes available.

The following statistically significant trends have been interpreted from the information in **Table 9 for mature stand conditions :**

Western Hemlock Series:

- total live trees per acre significantly increase from wet to dry environments
- the number of Douglas-fir trees per acre increase from wet to dry environments
- the percentage of red alder decreases from wet to dry environments

Western hemlock and western redcedar were found in all environments. Trends in snags and coarse woody debris (CWD) were not significant.

Sitka Spruce Series:

- live trees per acre increase from wet to dry to moist environments

Western hemlock is a common codominant component in all environments, more common than western redcedar. Snags and CWD did not significantly vary among environments and were not included in the table.

It is important to note that these trends may also be associated with fine-scale disturbance differences as well as environmental differences. Dry environments may experience more within-stand wind and disease-related events than the other environments, for example.

Table 9. Structure and Composition of the Mature Condition of Late-Successional Stands by Sub-Series Environments. Information is expressed in number per acre

	Hemlock- Dry (120 plots)					Hemlock- Moist (73 plots)					Hemlock- Wet (95 plots)				
Species	Small	Med.	Large	Giant	Total	Small	Med.	Large	Giant	Total	Small	Med.	Large	Giant	Total
Bigleaf maple	3				3	3				3	4	1			5
Red alder	8				8	7	1			8	15	2			18
Sitka spruce						1	1			2					
Douglas-fir	34	22	9	2	67	16	15	13	3	46	7	8	8	2	25
Western redcedar	4	1			5	4	1			5	6	1			7
Western hemlock	13	3	1		17	11	5	1		17	5	2	1		8
Total Live Trees	62	25	10	2	99	42	22	14	3	81	38	15	9	2	63
	Hemlock -Dry (56 plots)					Hemlock - Moist (59 plots)					Hemlock - Wet (30plots)				
Snags	12.03	2.95	2.44	0.39	17.81	9.30	2.67	2.49	0.64	15.10	7.26	2.29	3.26	0.93	13.74
Logs	18.13	2.86	1.89	0.44	23.32	23.57	7.05	2.78	0.67	34.07	20.01	5.24	3.42	0.53	29.20
	Spruce- Dry (13 plots)					Spruce- Moist (45 plots)					Spruce- Wet (32 plots)				
Red alder	4				4	10	1			11	11	1			12
Sitka spruce	6	5	4		15	11	10	6	1	28	13	6	3	1	23
Douglas-fir	10	14	12	1	37	10	7	4	1	21	14	10	7		30
Western redcedar	1				1	2				2	2	1	1		3
Western hemlock	25	10	3		38	24	12	4		40	4	3	2		8
Total Live Trees	46	29	19	1	95	58	30	13	2	102	43	21	12	1	76
	Spruce -Dry (4 plots)					Spruce - Moist (5 plots)					Spruce - Wet (7 plots)				
Snags	3.31	1.32	2.10	0.81	7.54	13.13	5.29	1.53	0.81	20.76	9.31	1.30	1.35	0.48	12.44
Logs	3.40	1.34			4.74	19.24	4.71	1.91		25.86	11.18	0.38	0.80	0.95	13.31

Data Sources:

Live tree data from
1987 Vegetation Resource Survey - 194 plots
1984 Siuslaw Ecoplot Intensive Survey - 184 plots.

Snag and Log data from
CVS and Ecology plots. Hard and soft snag and log condition were not separated.

Size classes:

Small = 9.0-20.9 inches dbh
Medium = 21.0-31.9 inches dbh
Large = 32.0-47.9 inches dbh
Giant = 48.0+ inches dbh

Old-Growth Forest Structural Characteristics

Basal area of shade-tolerant tree species is an important characteristic of old-growth forests. In general, moist sites have higher basal areas of shade-tolerant species than do moderate or dry sites. The density of large-diameter Douglas-fir decrease with increasing moisture in the Coast Range. The density of subcanopy trees generally decreased with increasing site moisture, probably as a result of increasing basal area of shade-tolerant trees in the upper canopy that creates low-light conditions unfavorable to understory trees (Spies and Franklin 1991). **Table 10** outlines significant structural and compositional characteristics by moisture classes. Moisture classes are similar to the sub-series environments identified earlier in this document.

Stand condition (snags, cavities, broken tops, etc.) did not seem to vary by moisture class in the Coast Range in work done by Spies and Franklin, 1991.

Table 10. Mean And 95% Confidence Limits Of Some Structural Components Of Old-Growth Stands In The Coast Range By Moisture Classes (From Spies And Franklin 1991)

STRUCTURAL COMPONENT	DRY	MODERATE	MOIST
Basal area of shade tolerants (ft^2/acre)	9.6 (0 - 47.5)	69.7 (26.1 - 139.4)	135.0 (43.6 -274.4)
Basal area of shade-intolerant (Douglas fir) trees (ft^2/ac)	261.6 (147.8 - 369.7)	222.4 (117.5 - 322)	169.6 (17.4 - 317.6)
TOTAL basal area (ft^2/acre)	283.1 (200.4 - 405.1)	304.9 (222.2 - 418.2)	313.6 (196.0 - 500.9)
> 40 inches dbh Douglas-fir density (#/acre)	12 (4-23)	10 (4-19)	7 (1 - 10)
> 40 inches dbh total tree density (#/acre)	12 (4 - 23)	11 (4 - 21)	10 (2 - 25)
Density subcanopy trees (#/acre)	17 (0 - 59)	21 (2 - 61)	0

Snags and Coarse Woody Debris (CWD)

Coarse woody debris (CWD) includes both snags and down logs, however, for this LSRA, CWD will be separated into snag components and down log components, since these ecosystem components are evaluated separately in management prescriptions. Research indicates that the numbers of fallen trees are generally similar to those of snags - or, about 50 percent (range 40% - 60%) of the coarse woody debris component of a stand is snags (Spies et. al. 1988).

Both snags and down logs are important components of forest ecosystems. The variability with which they are expressed across the landscape, however, needs to be understood. Recent work by the Pacific Northwest Forest and Range Experiment Station (Spies in progress) with the Pilot Province Monitoring Project has shown that the two forest structural characteristics that help to define late-successional and old-growth forests are: 1. The number of trees in the larger size classes (70cm and 100cm respectively); and 2. The degree of layering. Although CWD is a critical component of old-growth ecosystems, the number of snags and log biomass were not good predictors of late-successional and old-growth forests due to the wide variation of these structural components in forest ecosystems. The following recommendations for management of the CWD components in young forest plantations need to always be balanced with the need to apply thinning regimes which will accelerate the attainment of other late-successional and old-growth structural components as well.

Snag Levels in Unmanaged Forests

Table 11 displays the range of snags levels for various size classes found when natural forest conditions were assessed in the Oregon Coast Range. This table represents the best information available at this time for natural conditions in the Coast Range and will be utilized to indicate reference and desired conditions. When looking at the values, the degree of variability becomes readily apparent. The greatest variability shows up in the numbers of snags less than 20" in diameter for both the young (24-58 tpa) and mature (11-83 tpa) age classes. Variability should be applied in both quantity and spatial arrangement of snags in prescriptions.

The measured field data in **Table 11** shows that the majority of snags found in natural forests are less than 20 inches in diameter at breast height (dbh). While all size classes serve an important ecological function, it is the larger snags (greater than 20" dbh and 20' tall) which are critical for wildlife, such as cavity-dependent species. Large snags provide nesting habitat for the northern spotted owl and are used by colonies of bats and swifts.

The values for "all heights" represents the number of snags greater than 4 inches in diameter and greater than 4.5 feet tall. Also included in **Table 11** are the cu.ft./acre values from a recent CWD model done for the Siuslaw National Forest. The values from the Wright Model represent half of

the CWD component that is modeled to occur in these systems, the other half of the values are displayed in **Table 12** with the down wood component.

Table 11: Range of Snag Levels in Natural Stands in the Oregon Coast Range. The numbers represent the mean values with the expected ranges of conditions shown in parentheses.

	Number of Snags/Acre (Spies 1988)			**Snag Biomass**	
Stand Age	Total >= 20" dbh all heights	>= 20" dbh and > 16' tall	Total < 20 dbh all heights	cu.ft./ac (Spies 1988)	cu.ft./ac (Wright Model)
Young (<80 yrs)	7 ** (4-10)	2** (0–4)	41** (24 to 58)	1229 (697 - 1761)	3794 (2844-4839)
Mature (80-199 yrs)	7 (2-12)	3 (1-5)	47 (11-83)	1486 (649-2326)	1644 (1603-1686)
Old-Growth (>199 yrs)	7 (5-9)	4 (2-6)	9 (7-11)	2115 (1247-2983)	1906 (1867-1946)

** Knowledge of the types of forests where this data was taken suggests that these values and ranges are on the low end of the range of conditions for the Oregon Coast Range. Natural forests that are less than 80 years of age that were sampled included many stands that resulted from settlement-related fires (some burned 2-4 times) after the Yaquina fire. Under this type of disturbance, the levels of down wood would be low. To find the average levels of woody material following a single disturbance event, other studies may be more appropriate.

+ Modeling completed recently by Wright suggests that the mean range for CWD in young stands at 30-50 years of age under natural conditions would be 265 m3/ha or 3794 cu.ft./acre. These values represent what would be expected following a single fire event in 30-50 year age class of forest stands in the Central soil/climate zone. (note: values displayed are half of the actual values modeled since model values included snags and down logs which are found in approximately equal proportions in stands)

Existing Condition of Snags

Management activities (i.e., falling, yarding, and site preparation), resulted in a loss of snags in harvest units across the landscape. Much of the material described as the "lost legacy" (**Figure 4**) - that quantity of wood that has been removed from the system during timber harvest activities would have contributed to this snag component.

Loss of that large snag component is long-term. There is very limited opportunity to create snags >20" in diameter in the 25-50 year old plantations. Prescriptions can be implemented which would establish conditions that would accelerate the attainment of green trees in the larger size classes for creation of snags at a later date. **Table 11** provides guidelines for snag levels over

time on a landscape level. At the time of initial commercial entry, i.e. 25-50 years, prescriptions are usually not going to meet the young stand levels of snags, even those in the small size classes. Treatments should set stands on a trajectory to meet the mature and old-growth snag levels and sizes.

Management Options for Snags

- Considerations for prescriptions in young managed stand ages could include:
- Protect all existing large snags. Smaller existing snags, if knocked over during management activities, will be retained as down wood.
- Accept a short-term deficit in the quantity of snags in order to manage for long-term gain in appropriate sizes and numbers - establish trajectory. This is appropriate since smaller trees are not persistent as snags, mostly sap wood.
- May have few 15-20" snags in younger age classes (25-50 years).
- The largest green trees available may be ones you want to keep for future structural components (i.e., to become wolf trees for marbled murrelet nesting habitat).
- Leave enough trees to grow and become snags at a later date
- Stem inoculation of small trees to initiate heart rot so that cavity nesters can use them earlier.
- Create snags in adjacent mature stands

The priority decision is to meet the range of snag levels outlined in **Table 11** in the mature and old-growth stands. If conditions are appropriate to meet the larger size classes of snags in young stands, then meet those levels in young stands. Subsequent entries (i.e., at 60-80 years), may be needed to initiate snag development in the larger size classes. It's more important to reserve larger green trees at the initial entry and not be so concerned about the numbers of snags less than 20" in diameter in the younger age classes.

In stands over 50 years old, snag numbers within the ranges listed on Table 11 will be met if recruitment trees of sufficient size are available within the stand, or the project will remain subject to REO review. In stands younger than 50 years, meeting Table 11 numbers in the short term may prevent meeting snag requirements in the longer term. Where that is the case, short term snag numbers will be reduced from Table 11.

Log Levels in Unmanaged Forests

Table 12 displays the mean and the range of conditions that could be expected in the Oregon Coast Range under natural conditions. The amount of down wood in young natural stands (measured at 50-80 years of age) ranges from 596-1604cu.ft./ac. These values represent conditions following various types of disturbances. At the time of measurement, much of the initial input of down wood from the disturbance event (**Figure 4**) had already been incorporated into the soil. Mature forests have less down wood ranging from 776-2682 cu.ft./ac. Old-growth forests have higher levels of down wood at 2390-4126 cu.ft./ac.

Table 12 represents an assessment of current ranges of the variability, both measured and modeled, in the down wood component in natural forests in the Oregon Coast Range. This information, along with the inventory of existing down wood levels in plantations (**Tables 13 & 14**) and the management alternatives at the end of this section will be utilized when prescribing down wood for activities implemented in the LSR.

Table 12. Range of down wood in unmanaged forests in the Oregon Coast Range

	Down Wood Volume (Spies 1988)		**CWD Volume**
Stand Age	cu.ft./ac (Spies Data)	Percent Cover !	cu.ft./ac (Wright Model)
Young (<80 yrs)	1100 ** (596 - 1604)	3.9% ** (2.8 - 5.0%)	3794 (2844 - 4839)
Mature (80-199 yrs)	1729 (776 - 2682)	5.2% (2.8 – 7.5%)	1644 (1603 - 1686)
Old-Growth (>199 yrs)	3258 (2390 - 4126)	6.1% (4.9 – 7.3%)	1906 (1867 - 1946)

! Coast Range had the lowest % down wood ground cover of PNW ecosystems assessed. Percent cover is an expression of projected horizontal area covered by wood. It is from log length and diameter.

** Knowledge of the types of forest where this data were taken suggests that these values and ranges are on the low end of the range of conditions for the levels of down wood found in the Oregon Coast Range. Natural forests that are less than 80 years of age that were sampled include stands which resulted from repeated settlement-related fires (some may have burned 2-4 times) after Yaquina fire. Under this type of disturbance, the levels of down wood would be low. To find the average levels of woody material following a single disturbance event may require additional research

+ Modeling completed recently by Wright suggests that the mean range for CWD in young stands at 30-50 years of age under natural conditions would be 265 m^3/ha or 3794 cu.ft./acre. These values represent what would be expected following a single fire event in the Central soil/climate zone. (note: values displayed are half of the actual values modeled since modeled values included both snags and down logs which are found in approximately equal proportions in stands)

Dynamics of CWD (Snags and Down Wood) Over Time and Space (Information from Research)

The CWD Cycle

Figure 4 displays the cycle of coarse woody debris over time for a single disturbance event. It is presented to display the quantities of coarse woody material that are initially input following a disturbance event (Spies 1988, Wright -in progress). This diagram also assists in development of

a number of alternatives that can be employed by management that will guide the levels of CWD that are prescribed.

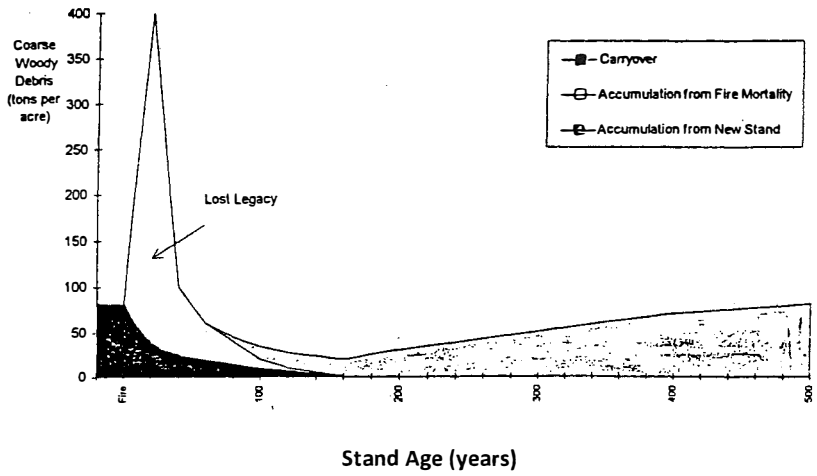


Figure 4. CWD Accumulation and Decay Over Time Following a Disturbance Event (Spies and Cline 1988)

As discussed by Spies and Cline, 1988, **Figure 4** displays that:

- Following an initial disturbance event, new CWD is not added into a stand until the stem exclusion and understory reinitiation stages. Mortality rates of young stands are estimated at 12% per year. These are mainly small (<4" trees) that will decay rapidly.
- CWD accumulates slowly over the 1st 100 years and more rapidly between 100-400 years.
- At 100-150 years, CWD accumulations begin to increase as trees die.
- The dynamics of CWD modeled for 3 fire histories each beginning with an initial fire in an old growth stand but differing in number and severity of subsequent fires. All three models exhibited low values of CWD between 80-200 years. The lowest and most prolonged minimum in CWD during succession occurred when additional fires burned early in succession (Spies et. al. 1988).
- Researchers have found three main differences in CWD between natural and managed stands (Spies and Cline 1988):
    1. The quantity of CWD is drastically different immediately following the disturbance event.
    2. The size of wood is different; what's left after logging is smaller and it decays faster
    3. In plantations, loss of trees is slower due to thinning and spacing of management. Thinned material is harvested and removed from the site.

- At least six times more wood carries over after wildfire in old-growth systems than is left after logging in old-growth.

These statements support the need to provide for CWD in density management prescriptions in the LSR to achieve wildlife habitat objectives.

The following is from Pam Wright's draft of "Coarse Woody Debris Groups of the Siuslaw National Forest:

- CWD enters the system in two ways:
  1. Through incremental mortality from the live stand
  2. Through disturbance. This is the biggest factor and the existing level of CWD depends on:
     a. the time since disturbance
     b. the magnitude of the disturbance
- Due the rapid decomposition rates in the Coast Range, most of the CWD from the previous stand is not detectable 100-150 years after it reaches the forest floor.
- It's important to look at levels of CWD based on soil climate zones. The Coastal Fog Zone has the greatest CWD mass of the ecosystems assessed at about a 10% increase over the Central Interior Zones in young stands and 33% increase in older stands.

These statements support evaluation of the types of disturbances and time since disturbance on individual sites to help establish appropriate levels of CWD. Soil/climate zones especially play a role in CWD levels and should be considered in management prescriptions.

Decay Classes

According to Spies, Franklin and Thomas, 1988:

- In general the proportion of total biomass in highly decayed material (decay classes IV, and V) was highest in young stands and lowest in old-growth.
- The distribution of woody debris in young stands (<80 years) was concentrated in decay classes III, IV, and V. In mature stands, woody debris was more evenly distributed among decay classes II through V, with a higher proportion of total CWD biomass attributed to decay class II. In old-growth stands, woody debris was concentrated in decay classes II and III.

The above statements from the Spies study support high proportions of CWD in young stands (<80 years) in the advanced decay classes III, IV and V. Under natural conditions, trees killed in a major disturbance would eventually fall and decay on the forest floor.

Distribution of CWD

Coast Range stands have less CWD in all three age classes than stands in the two Cascade provinces. Mass and volume in young stands (<80 yrs) in the Coast Range was <40% of the values in young stands in the Cascade provinces (Spies et.al. 1988).

Coarse woody debris is unevenly distributed in the forest. The amount may vary tenfold between closely adjacent areas and more than half of the coarse woody debris may fall on less than one-fifth of the total area. Several factors contribute to such patchy distribution: The large successional overstory trees that contribute heavily to the dead wood supply are irregularly distributed. Mortality from natural causes is often patchy. Dead wood may be moved downslope to accumulate at a resting place on concave topography (Spies and Cline 1988).

For Coast Range stands, aspect and topographic position alone accounted for 63% of the variance in CWD biomass. Moist sites had the highest amounts of CWD (more live biomass, larger tree boles, wetter, more slowly decaying wood, less subject to surface fires that can consume CWD). The importance of site characteristics in the Coast Range in explaining variation in CWD in relatively young stands suggests that fire history, as affected by topography, controlled the amounts of CWD in stands <150 years old. It is probable that stands on north facing slopes and moist sites experienced less severe and less frequent fires than the drier sites. Consequently young stands on more protected sites probably inherited more CWD than fire-prone sites because they were preceded by older, more massive stands rather than young stands or mixed-aged stands (Spies et. al. 1988).

These statements from Spies' study support the need for variability in the prescriptions to create varying levels of CWD relative to soil/climate zone as well as stand age and fire history.

Existing Condition of CWD

In order to evaluate down wood needs on a site specific level, existing levels of down wood should be evaluated. **Tables 13 and 14** display two data collection efforts on the Siuslaw National Forest which provide an indication of the average and range of down wood levels that can be found in managed stands. The existing levels are spatially highly variable.

Table 13 represents the levels of down wood at the time of final harvest. This information was collected for a fuels inventory by Peterson and Barnes and compared favorably to previous fuels data inventories. The information shows the majority of material is in the 9" to greater than 20" size classes. The smaller material is consumed by slash burning at a higher rate than the larger size classes. On the average, 2901 cu.ft./ac. of material remains on site after harvest activities. Approximately half is this is lost during site preparation, with an average of 1487 cu.ft./ac. remaining after slash burning.

Table 13: Down Wood Conditions Following Clearcut Harvest (1980 - 1990)
CWD Levels
(cu.ft./ac by diameter class)

Site Condition	3-9"	9-20"	> 20"	Total
Pre burn[1]	801	1082	1018	2901
Post burn[2]	81	541	865	1487

[1] Peterson, J.L. and D.A. Barnes, Comparison of Biomass Characteristics on clearcut units on the Siuslaw National Forest with other western WA and Oregon

[2] Post burn consumption based on professional judgment of worst case scenario. Assumed 3-9" material 90% consumed. 9-20" material 50% consumed, over 20" material 15% consumed.

Table 14 displays down log information collected from Siuslaw National Forest Managed Stand Survey data. The values indicate the average and one standard deviation (in parenthesis) representing the range. Depending on the plantation age, the average down wood volume ranges from 3010 to 3409 cu.ft./ac. This information is within the ranges reported by BLM - Salem and Coos Bay where stand exam information for 40 year old plantations shows down log quantities mostly in the larger diameter classes with an average of 3085 cu.ft./ac. (range 1831 - 4083 cu.ft./ac). Most of the down wood volume is in the soft log category (decay classes III-V). This is consistent with information presented by other researchers (Spies et.al. 1988). Log lengths were also surveyed. On the average, 51% of the down logs inventoried were greater than 20 feet in length. The values ranged from 29% to 61% greater than 20 feet in length.

The variability of CWD in plantations is readily apparent. Both the low and high ends of the range of existing conditions found in the managed stands are outside of the range of variability measured by Spies or predicted by Wright (**Table 12**). When these conditions are encountered, there are opportunities to bring CWD values within the historic range (low end) or to exceed the historic range (high end).

Table 14: Existing Down Log Volumes in Plantations

Plantation Age	Average Hard Log Volume (cu.ft./ac)	Average Soft Log Volume (cu.ft./ac)	Total Log Volume (cu.ft./ac)
11 - 24 yrs	630 (0 - 2094)	2423 (0 - 5049)	3010 (0-6084)
25 - 49 yrs	413 (0 - 1346)	2946 (0 - 7216)	3409 (0-7787)

The variation in the levels of down wood can be attributed to both natural and managed conditions. Age at which the stand was harvested and past disturbance regimes can effect the condition at the time of harvest. The amount of yarding and piling of unutilized material, the utilization standards, and the site preparation techniques all play a role in the quantities of woody material left on site following timber harvest activities.

The existing level of down wood should be assessed during project planning. Several inventory techniques are available (Harmon 1996) and the use of fuels inventory transects or stand exam information should be assessed. Statistically valid inventories of down wood, however, require extensive survey involving a number of transects. It is recommended that an individual on each interdisciplinary team take on the responsibility of assessing down wood levels. It is expected that the individual would be able to make qualitative assessments (low, moderate, high) based on previous experience of having done transects or surveyed areas with known down log biomass.

Management Alternatives

The peak in **Figure 4**, represents the "Lost Legacy." This is the organic material (CWD) that has been removed from the system and sold as commercial forest products. We cannot expect to replace this loss. At this point, the existing levels of CWD are lower than the natural systems would be. The predominate reasons for this is that:

- The forest was harvested at an age when the levels of CWD were naturally at the lowest level in the chronosequence of development (Spies et al 1988).
- The majority of the biomass that would have been killed by a fire event and reincorporated into the system was removed and sold as commercial timber.

CWD levels identified in Table 12 will be met by existing and new material left after thinning. Table 12 lists a range, however. Where to hit on that range depends on the age or the stand and the conditions in and around the stand. Our decision space is to start at the decay portion of **Figure 4** in early stand development and select an approach which will determine at what rate the stands will approach the accumulation phase line of the CWD cycle. Management should not try to strive for the average condition all the time. There are opportunities to work within the whole spectrum of the historic natural range to replicate the natural variability found on the landscape and to take advantage of opportunities to exceed the natural range. Below are 4 alternatives which will help to determine that rate.

Alternative Prescriptions for Coarse Woody Debris

Alternative #1

Leave Large Amounts of CWD in the Short Term

Objective: Provide for soil nutrient/ fungal and soil invertebrate health and maintenance.

Prescription: Input down wood in the short term: Drop as many trees as possible, to meet the high end values of **Table 12** (1604-4839 cu.ft./ac) for young stands. Half of the CWD should be left as snags to spread the down wood input over time. **Goal:** Provide CWD as a substrate for

soil micro-organisms to restore nutrient cycling regimes in areas which currently have very low levels of CWD.

Consider this alternative when one or more of the following conditions occur:

: there is a need to recover microorganisms, soil nutrients and or soil structure
: areas have experienced hot or repeated burns which have resulted in low levels of soil organic material
: severe erosion has occurred and bare mineral soil is exposed

It is expected that this alternative would only be applied in fairly isolated instances on sites or portions of sites that have experienced very harsh disturbances.

Benefit: Provides immediate increase in CWD levels for a while, a peak in CWD levels. Maintains fungal, microorganism, small mammal habitat.

Disadvantages: Short term, small diameter, rapid decay, lost potential for larger CWD and larger snags in the future. Size class insufficient for species that need large logs and snags. Minimum economic return for projects in short term. Limited number of trees left on site for the future.

Alternative #2
Leave Small Amounts of CWD Over Time

Objective: Supply a steady input of down wood and snags over time to provide conditions for down wood processes and snag-dependent species over time.

Prescription: Fell some now, leave some for the future: Drop trees and/or create snags to meet low to moderate ends of **Table 12** (1100-3794 cu.ft./ac.) at each entry. Leave up to half the volume as snags. Consider topping trees in adjacent mature stands to provide snags in the larger diameter classes. Insure that the prescription will be able to meet the low to moderate values of **Table 11** (0-7 snags >20" dbh which includes 0-3 >16' tall) and **Table 12** (776-1644 cu.ft./ac of down logs) in the mature condition in the future. Half of the CWD should be left as snags to spread the down wood input over time.

Goal: Balance long-term and short-term needs.

Consider this alternative when one or more of the following conditions occur:

: nutrients in the forest floor, soil, and fungal communities are low, but not a major concern
: primary cavity nester population levels are at or below the 40% level on the landscape.
: the surrounding older forests can carry the habitat for most species in the short-term.

It is expected that this alternative would be the one of two (alternatives 2 and 3) applied most frequently. **Benefit:** Provides incremental input of CWD and snags over time. Strives to maintain habitat for CWD and snag dependent species while still maintaining future options. Some economic benefit in creating snags and CWD at a later date.

Disadvantage: May not have the optimum levels of CWD and snags in short-term. May take longer to get at desired sizes and quantities in the long-term since a higher number of trees per acre would be left on site to incorporate over successive entries.

Alternative #3
Grow Large Diameter Trees for Inclusion as CWD in the Future

Objective: Provide quality conditions for down wood and snag dependent species and processes in the future.

Prescription: Leave minimum levels of CWD and snags in the short term. Drop trees and/or create snags to meet the lowest ranges of **Table 12** (596-2844 cu.ft./ac.). Consider topping trees in adjacent mature stands to provide snags in the larger diameter classes. Half of the CWD should be left as snags to spread the down wood input over time.

Goal: Maximize long-term quantities and sizes of CWD and snags.

Consider this alternative when one or more of the following conditions occur:

: the current levels of CWD and snags are within the parameters outlined in **Table 12** for natural young stands
:the adjacent stands have sufficient CWD and snags to carry the habitat.

It is expected that this alternative would be one of the two (alternatives 2 and 3) applied most frequently.

Benefit: Maximizing the size and quality of down wood and snags for future use by down wood and snag dependent species and processes. There is an increased probability of providing large CWD and snag habitat in a mature condition. More economical to pay for logs and snags at a later date

Disadvantage: Minimizing short-term habitat for down wood and snag dependent species and processes.

Alternative #4
Let Natural Successional Processes Incorporate CWD

Objective: Allow natural succession processes to dominate

Prescription: No Action - natural suppression, no thinning.

Goal: Maintain some untreated areas.

Consider this alternative when one or more of the following conditions occur:

: vegetation manipulation is not scheduled to occur in an area
: stands are already on the trajectory for attainment of late-successional conditions
: adjacent stands provide habitat.

Benefit: Diversity of habitat, constant input of wood over time. Can be used as an experimental control to monitor differences between treatments.

Disadvantage: No economic return. Will take longer to attain other LSR objectives and to accumulate quantities of large CWD and snags.

Selecting an Alternative: For project implementation, the "best" option, ecologically, is not known. As a result, it is important to apply the range of alternatives described above, sometimes even varying the treatments within a specific unit to accommodate special conditions. Management prescriptions need to balance the benefits and disadvantages of the various prescriptions to account for the overall LSR structural objectives. In addition, the application of any one of these alternatives needs to be considered in context with the conditions on the surrounding landscape. For multiple entries, consider what would/could be done at each entry.

The process to determine which Alternative(s) are appropriate in a given situation would include the following steps:

1. Determine the overall objectives of the area under consideration i.e. LSR Zones, Landscape Cells, and the objective for attainment of other structural features including accelerating growth to achieve the desired stand diversity and large diameter green trees as well as CWD levels.
2. Evaluate existing levels of CWD (qualitatively if quantitative measures are not known) in context of both the individual plantation and the surrounding landscape.
3. Determine specific project area resource objectives for soil, wildlife and aquatic resources.

Selecting CWD Levels Within an Alternative

Within each alternative there is a specified range of values for the volume of CWD that would be appropriate. These values are taken from **Table 12** and represent the range of historic conditions. There may be times, depending on specific resource objectives, when the target value selected may be above this range. An example would be when it is determined that the opportunity exists to provide habitat for small mammals or cavity-dependent species and the objective is to exceed historic levels to accomplish that objective. There are a variety of reasons to leave varying levels

of CWD within a unit. It is not appropriate to always meet the low end, the middle, or even the high end of the range. CWD is naturally variable on the landscape and prescriptions should strive to retain that variability.

In addition to the quantity of down wood, the quality of down wood (features such as size and decay class) and arrangement should be a consideration for management. While all size classes serve an important ecological function, it is the larger diameter logs and snags that are important for many wildlife species. Large logs serve as denning sites for marten and fisher and retain moisture through the summer months, thus providing important habitat for terrestrial amphibians and small mammals. Large snags provide critical habitat for many species, including spotted owls, bats and swifts. Bears also utilize the large hollow snags for denning.

Research has shown that in young natural forests, the down wood component is found mostly in decay classes III-V. The majority i.e. 60% of log pieces are in the small (<12") size class. A third of the pieces are in intermediate size classes (12"-24"), and about 6% are greater than 24" in diameter (Spies et.al 1988). If the larger size classes are not currently existing, prescriptions should accommodate the addition of this material at a later date. By the time a forest is in an old-growth condition about 11% of the down wood and snags are greater than 24" in diameter.

Determination of appropriate levels of CWD to leave would include:

1. Determine specific site resource objectives for soil, wildlife and aquatic resources.
2. Evaluate economics - the ability to pay for the operation versus the value. Current funding mechanisms often do not allow for some of the prescriptions that would be appropriate to employ. The choice is often between doing nothing or removing more trees from the site than is desirable in order to pay for the operation. ID teams often struggle with weighing the benefit of thinning plantations to encourage growth of larger trees and more diverse structure with attainment of CWD levels.

Evaluate the risk to the stands or watershed (blowdown, beetle, root rot, fire, etc.).

Example:
An Inter-disciplinary team (IDT) is assessing an area within the LSR to accelerate attainment of late-successional characteristics. Initial consultation of this LSRA shows that the planning area is within the CORE LSR Zone and specifically within Landscape Cell #3, which means that the vast majority of the landscape is in early an seral condition (about 30 years old). The goal of this area is to provide contiguous late-successional habitat and to increase the connectivity and dispersal habitat across the landscape. After reconnaissance, it was determined that the majority of the plantations in the planning area had low levels of down wood and snags, around 700 cu.ft./ac. The units have been densely planted to 350 tpa. The site-specific resource objective is to provide connectivity for late-successional species in both the short- and long-term.

Alternative 2 would be appropriate in this case - provide for CWD over time.

Using an average size tree for a 30-or 35-yr. old plantation in the Oregon Coast Range (12"dbh and approximately 90 feet tall to a 4 inch top), the volume of the average tree would be 31 cu.ft.

Alternative 2 provides a range of values that will provide CWD habitat over time (i.e., 1100 3794 cu.ft./acre). To be within this range, it would be appropriate to leave between 13 and 100 trees per acre as snags or down wood.

The great variability that is found in CWD levels leaves the team with a variety of levels that would be appropriate in different parts of the same unit or in different plantations throughout the planning area, depending on the desired resource objectives.

The number of trees in the stand (350 tpa) and the need to leave a fairly dense stand (100-120 tpa) for future recruitment of CWD and to maintain sufficient canopy closure for connectivity, still leaves a sufficient number of trees to sell to pay for the operation. The contract value of the sale is such that up to 40 tpa could be left as down wood or snags and the project still pay for itself. No hazard from a fire, insect, or disease standpoint is involved, so the team chooses to leave 40 tpa (or about 1200 cu ft./acre) as down wood and snags. This would be in addition to the existing CWD biomass of 700 cu.ft./ac, bringing the total up to 1900 cu.ft./acre after harvest operations.

If the current level of CWD in the above example was more in the average range of the existing conditions (i.e., around 3400 cu.ft./ac. from **Table 14**), a different determination of CWD needs would be made. In this case, the desired range (1100-3794 cu.ft./ac.) would result in a prescription which varied from 0-13 tpa needed for down wood and snags ((3794-3400)/31)=13. Since the contract value supports leaving up to 40 TPA as down wood or snags, the team may decide to leave a minimum of 13 TPA as CWD or perhaps take the opportunity to exceed the natural range and again leave 40 trees per acre as down wood or snags which would result in a volume of CWD of 4600 cu.ft./ac.

Projects may be appropriate which do not employ this method of assessment and determination of CWD levels. These projects will be submitted to the REO for review prior to implementation.