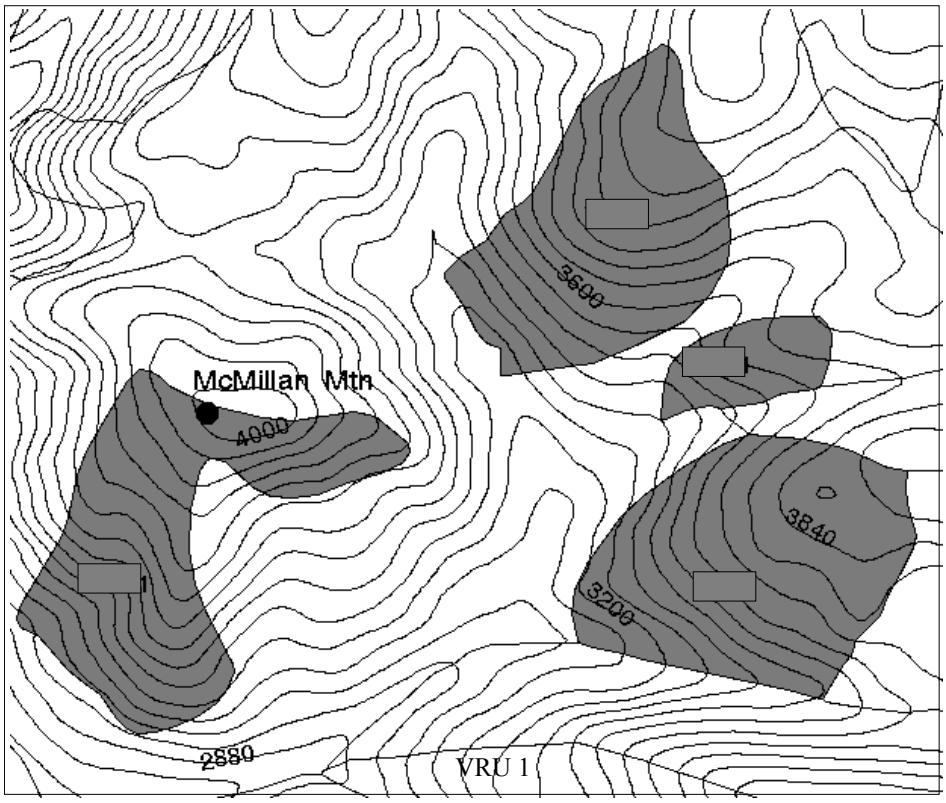
Vegetation Response Unit Description
VRU 1
Warm, Dry Habitat Setting

Ecosystem Setting and General Description

This vegetation response unit is a mix of forested and nonforest sites, characterized as a warm, dry setting. Where tree cover is present, it is ordinarily composed of open-grown park-like stands of mature, large diameter ponderosa pine at low stocking levels, with thickets of Douglas fir and a bunchgrass understory. Trees tend to be clumped where soil development is adequate. The sites are well drained mountain slopes and valleys or steep west and southerly aspects. Elevation ranges from 2,000 to 5,400 feet (Map 1) but averages 3,400 feet. Annual precipitation ranges from 14-25 inches, with most of that falling as rain. While the growing season is fairly long, the high solar exposure and shallow soils result in soils that usually dry out early in the growing season. This lack of soil moisture can create harsh growing conditions in late summer. This portion of the landscape in considered very low in vegetative productivity.

VRU 1 contains a variety of landtypes with the dominant ones being 111, 201, 302, 303 and 510. These landtypes vary from steep, rocky sites to glacially scoured ridge tops and ridge noses to moderately deep glacial till, with drumlins and moraines, to shallow and moderately deep residual soils. There is usually not a volcanic ash-influenced loess cap present. Anywhere from 15 to 40% of this unit has surface rock or outcrops. The average slope in VRU 1 is 32%. At this time approximately 1% of the Forest has been mapped as VRU 1.



Map 1 - Typical Physical Setting of VRU 1

Vegetative Composition

Across the landscape, this VRU is characterized as large ponderosa pine with open, grassy understories and occasional shrubs. The density and distribution of Douglas-fir understory and codominant trees varies directly with the degree that fire has been excluded. Western larch and lodgepole pine are largely absent on most sites due to high temperatures and lack of moisture. Historic vegetation research (Losensky 1994) indicates that around 1900 the ponderosa pine cover type occurred in 17% of section M333B, a portion of the ecological region that includes the Kootenai National Forest.

This VRU is composed primarily of habitat types within the warm and dry habitat group (Table 1). There are small inclusions of more moderate habitat types such as DF/ninebark, DF/snowberry, DF/elk sedge and occasionally some grand fir. These types are best represented in VRU 2 and are not featured in this description. Habitat types in the ponderosa pine series are generally not found on the Kootenai NF but may have been incorrectly typed. Bluebunch wheatgrass and DF/pinegrass-wheatgrass are the most common habitat types on this forest. Dominant shrubs in VRU 1 include snowberry, western serviceberry, bitter-brush, Oregongrape and spiraea. Forbs include arrowleaf balsamroot and heart-leaf arnica. Grass species include Idaho fescue, bluebunch wheatgrass, elk sedge, and pinegrass. Sensitive plants such as western moonwort, Howell's gumweed, Spalding's silene, common clarkia, and Geyer's biscuit-root may occur in unique microsites of this setting. Nonnative vegetation occurs in many areas and is discussed under Ecological Trends and Management Implications.

Table 1 **Habitat Types and Fire Groups within VRU 1***

Habitat Type Code	Habitat Type	Regional Habitat Group	Climatic Modifier	Fire Group Code MT	% of HG 1
130	Pipo/Agsp	HG 1	Warm and Dry	2	-
140	Pipo/Feid	HG 1	Warm and Dry	2	3
141	Pipo/Feid-Feid	HG 1	Warm and Dry	2	-
160	Pipo/Putr	HG 1	Warm and Dry	2	1
210	Psme/Agsp	HG 1	Warm and Dry	4	36
220	Psme/Feid	HG 1	Warm and Dry	5	8
230	Psme/Fesc	HG 1	Warm and Dry	4	14
311	Psme/Syal-Agsp	HG 1	Warm and Dry	4	9
321	Psme/Caru-Agsp	HG 1	Warm and Dry	4	27

* Note: Habitat types that comprise less than 1% of this grouping are indicated by a dash (-).

Disturbance Processes

Recurrence of disturbance and recovery within ecosystems is an important mechanism for energy flow, maintenance of habitat diversity, vegetative succession, canopy reduction, etc. The long term health of ecosystems is linked to disturbance. Understanding and incorporating disturbance processes, whether natural or human-induced, is also essential to meeting our resource needs.

Fire Regime - The habitat type groups on the KNF occurring within this response unit are in Fire Group 4. Historically, frequent low severity fire was the predominant disturbance type that maintained the open ponderosa pine stands and grasslands. The nature and impact of the light severity fires varied from underburning that essentially left the forest structure intact, to areas burned that reduced vegetation in a function that resembles natural thinning.

With a fire return interval from five to 25 years, these nonlethal, nonuniform burns regularly interrupted succession of Douglas-fir and largely determined the stand composition. During fire-free periods dense thickets of Douglas-fir commonly develop beneath the overstory. The overstory trees become very susceptible to crown fires when this situation occurs, as the ladder fuels provide access to an otherwise surface fire. Although rare, this condition can result in severe stand replacing fires. Mixed lethal fires were limited to small areas and resulted in a combination of underburning and stand replacement.

Fuels and Nutrient Cycling - Fuel loadings on representative habitat types of Fire Group 4 range from 10 to 20 tons per acre (ave. 11) and are composed of herbaceous material, tree litter and some large woody fuels (Fisher and Bradley 1987). The amount of fuels noted in this study represents levels that have increased due to fire exclusion. Historic fuel loadings may have been significantly less (ave. 5-9). The frequent, low severity ground fires burned through light surface fuels, creating a mosaic of fuel conditions. The fuel loadings varied at any given time and increased where periodic deadfall and natural thinning occurred, as well as absence of fire. These nonlethal fires have less potential to cause erosion as fine-root biomass is largely intact. Many of the sites have shallow, rocky soils with a thin duff layer which, in addition to a short growing season, results in a relatively low to moderate level of site productivity. Decomposition rates are low as compared with moist sites.

Insects and Disease - In most sustainable forest ecosystems, insects and pathogens are also the major nutrient recyclers. Disturbances caused by insects and diseases occur in all terrestrial ecosystems and as a group probably are the most evident. In this VRU, diseases don't play a major role in succession within the ponderosa pine cover type. Stem diseases such as western gall rust and atropellis canker affect tree growth and form but are not commonly problematic. However, root disease on these droughty sites can impact Douglas-fir, a major host species.

Mature ponderosa pine and Douglas-fir are highly susceptible to western pine beetle and Douglas-fir beetle, respectively. Bark beetle outbreaks are often brought about by prolonged dry weather, fire weakened trees, or in conjunction with root disease. Overmature, slow growing, decadent or otherwise nonvigorous trees are prime breeding habitat for bark beetles. Pine engraver beetles, though usually secondary attackers, can cause significant tree mortality during dry weather or following stand disturbances. Fortunately, the duration of this effect is seldom more than one season.

Weather - Isolated windstorms and lightning occur. Snow damage is generally minor at the lower elevations. Periodic drought on these warm, dry sites is characteristic and influential in the functioning of this response unit and the resultant vegetation patterns. The most severe drought occurs in areas with abnormally low winter and spring rainfall, as summer water resources rely on winter snowpack. Due to low snow depths, this VRU is not likely to experience rain on snow floods which are a result of heavy rain falling on and penetrating existing snow cover.

Successional Pathways

The accompanying illustration (Figure 1) depicts the generalized pathway for a forest community in Fire Group 4 that evolves beginning with a stand replacement event. (Fisher and Bradley 1987). Under natural fire regimes, a grass/forb community develops and is followed by the establishment of ponderosa pine and Douglas-fir seedlings. Ponderosa pine seedlings and saplings are often able to withstand frequent, low severity fires. However, Douglas-fir saplings do not fare as well due to clustered and highly flammable needles, thin bark, and resinous blisters. As a result, ponderosa pine retains dominance as a major seral species. The tendency of ponderosa pine to self-prune lower branches, the loosely arranged open foliage, and the thick bark contribute greatly to its fire-resistant characteristics. The accumulated needle litter favors slow moving, low severity ground fires that continue to reduce the stocking of Douglas-fir and understory vegetation while maintaining an open grasslike condition with overstory ponderosa pine. Most old growth forests, in this VRU, likely evolved through this scenario.

In the event that fire is absent, the herb/shrub stage is replaced by ponderosa seedlings and later Douglas-fir. The density of the trees and the mix of species depends a lot on site conditions, the timing of regeneration and how long fire has been absent. Competing vegetation is a significant deterrent to early survival and development of young ponderosa pine seedlings. In addition, moisture stress reduces seed germination as well as seedling survival and growth in these warm, dry types. In time, light to moderate fires will thin the developing stand and eliminate understory and trees less tolerant of fire. Without fire, Douglas-fir gains dominance through advancement into the overstory and eventually outcompetes ponderosa pine as the climax species. This theoretical climax forest is a multi-storied or all-aged Douglas-fir forest. Since a prolonged fire-free period is not realistic, this scenario is unlikely to develop. Of course, both successional scenarios are broad and recognize the existence of mosaic or patchy conditions that represent variation in species composition, forest types, and stocking levels.

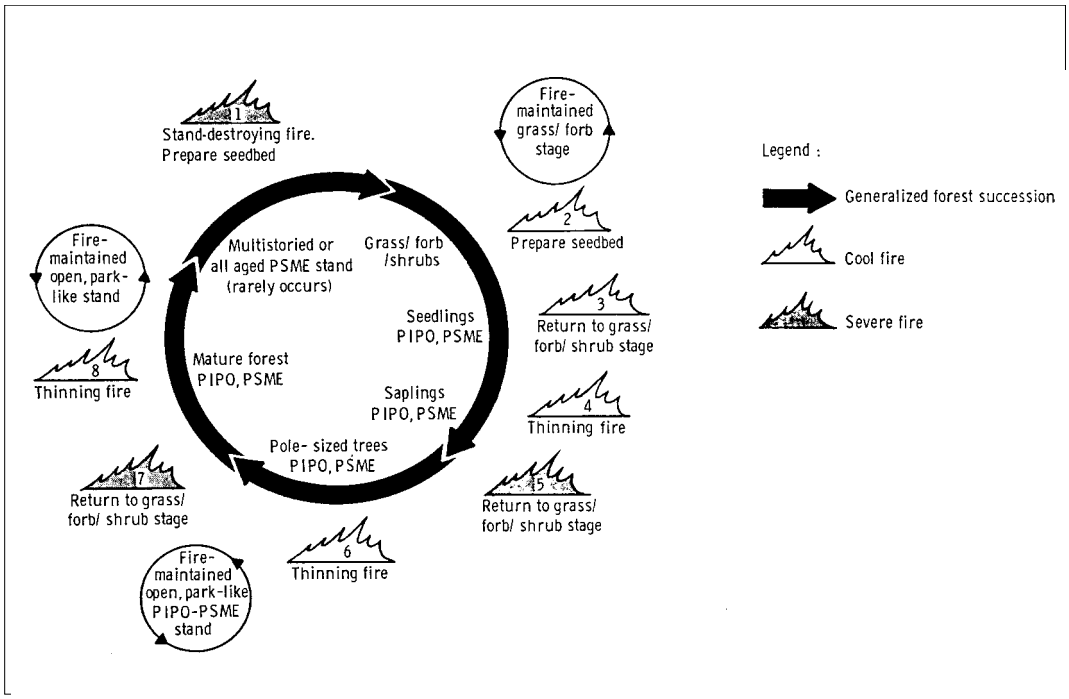


Figure 1 - Generalized Forest Succession in Fire Group 4

Vegetative Structure

Disturbance processes are largely responsible for the forest structure that develops across the landscape. Stand structure and the distribution of trees is also strongly influenced by the soil type and other physiographic features. As a product of low severity, frequent fires this VRU is generally made up of multiple age classes. Small patches of even-aged, single storied trees do occur. The periodic ground fires created a mosaic of microsites that facilitated age/size class diversity, and some species mix. Late successional multi-storied stand structure exists as scattered stands or stringers in protected areas that burned less frequently. Historic stocking levels were generally low and estimated to have ranged from 50 to 80 square feet of basal area per acre consisting of 5 to 20 overstory trees per acre (Steele 1994). Higher densities may occur on benches and areas with moderate soil depths.

Fire and aspect contrasts are the primary determinants of patch size and shape. This is important because of the effect it has on the amount of edge and interior forest that exists. Regular shaped patches (i.e. circle, rectangle) have less edge than irregular shapes. A species that prefers interior habitat with mature forest character would utilize the regular shaped patches that contain less edge. With the rare exception of high fire severity events, induced vegetation diversity is created by fire boundaries which often conform to aspect changes. Inherent boundaries also occur on aspect changes, as well as along streamsides, on abrupt slope changes, and where rock outcrops limit fire spread. Commonly occurring nonlethal ground fires will likely result in canopy gaps that provide a high amount of inherent edge. These openings support grass, forb and shrub communities. Vegetative diversity would likely be inherently high with the amount of edge represented by small openings. Patches that determine the extent of this response unit are irregular and vary significantly in size. Studies in the Bristow Creek area (KNF 1993) indicate a patch size of 20 to 200 acres may be a representative range for this VRU.

Age Class Diversity

The proportion of successional stages present within this VRU would have varied over time, but would be similar to that represented in Table 2. Historic age class distributions (**pre-1900)** are based on a synthesis of research of historic vegetation in the ponderosa pine type of northern Idaho and western Montana (Losensky 1994), studies in old growth forests of western Montana (Lesica 1995), ICBEMP scientific findings (USDA 1996), and results predicted from modeling age class proportions that would result from the average stand replacement interval.

It is interesting to note that while early and mid-seral stands were represented, late successional stages were more likely a dominant feature of the historic landscape largely due to the inherent nature of a low severity fire regime. Habitat with old forest characteristics (>151 years) was very common under natural conditions and was found to represent both multi-storied (16%) and single storied (48%) structural conditions (Losensky 1994). In contrast, research in Idaho (Lesica 1995) of stands in Fire Group 4, estimated that over 37% of the dry Douglas-fir type was in an old growth structural stage (>200 years) prior to European settlement, approximately the mid 1800's. Some of the dissimilarity in the amount of overmature stands depicted in these studies is likely due to the tree age considered by the individual researcher as having old forest characteristics.

ICBEMP scientific findings (USDA 1996) suggest that around the time of pre-European settlement, within the dry potential vegetation group (PVG), 30-50% of this portion of the landscape was composed of mature and old forest conditions (both single and multi-storied), and 5-10% in openings that contain primarily grasses, shrubs, and forbs. This PVG is considered the Douglas-fir series with and without ponderosa pine, as well as the dry end of the grand fir series.

Table 2: **Age Class Distribution**

Age Class	Pre-1900 Condition	Existing Condition
0-40	10-20%	10%
41-100	10-30%	44%
101-150	5-25%	20%
150+	40-70%	22%
nonstocked	0-10%	4%

Table 2 displays **pre-1900 and existing age class distribution** for the Kootenai National Forest**,** based on stand year of origin data for Habitat Group 1 taken from the Timber Stand Management Record System (TSMRS). Approximately 19% of the stands in this grouping does not have complete inventory information and are not represented in this age class distribution.

Ecological Function and Habitat Features

Ecosystems consist of structures and elements that perform a number of functions. Insight into ecological function is important to our understanding of how the ecosystem operates and its relative measure of biological diversity. The ecological functions described include interactive processes that occur to varying degrees across the landscape.

Landscape Linkages - Within forested areas along the primary topographic ridges of this landscape, connectivity is relatively high. This feature results in important wildlife corridors for seasonal wildlife movement. However, the overall open-canopied stand structure and the increased edge associated with irregular patches provides little to no interior habitat.

Old Growth and Interior Habitat - This VRU makes up a very small percentage of the functional old growth and interior habitat across the forest. Although many of the stands within this VRU do not fit the classic mixed conifer description of old growth, they do contain many of the physical and structural characteristics which are important to wildlife, and they represent a distinct ecological type on the Kootenai. The frequency of underburning in this habitat does not favor the retention and development of downed logs and small mammal habitat. However, gaps created by fire have value for wildlife species that prefer such small openings.

Wildlife Habitat - Habitat within this VRU is considered valuable winter range habitat for elk, moose, whitetail deer, and bighorn sheep as snow levels are generally low in these areas. Upper elevations receive spring bear use and also may be important fall denning habitat. Hiding cover is provided in the many fir thickets that occur. Overall, thermal cover is scattered and located in timbered patches where crown closure is sufficient to intercept snow. Full crowned, individual overstory trees can also offer decent thermal cover. Where there are multi-storied conditions, large mammals can control body temperature without using fat reserves. Multi-storied conditions are also important for birds, as different species have adapted to using the various canopy layers.

Big game winter range use is one of the primary functions of this VRU. These forage areas are open, fairly extensive and have high solar exposure. However, the openings are generally avoided by whitetail deer when snow depths are excessive (>18"). Forage under open forest canopies is very important and may be composed of forage species such as bluebunch wheatgrass, Idaho fescue, arrowleaf balsamroot, and western serviceberry. Snowberry is considered marginal forage but may be browsed by deer and elk in late summer/early fall. Due to the warm, dry habitat conditions and sparse vegetation on these south slopes, high quality forage is generally limited during the summer months. Following low severity fires, the quality of forage is usually improved. In many cases, species such as arrowleaf balsamroot, snowberry and western serviceberry respond by increasing their abundance as well as palatability.

Dead trees are used by dependent species for feeding, nesting, roosting and resting. Snags are generally scattered across the landscape, composed of broken-topped Douglas-fir, as well as scattered fire-scarred ponderosa pine trees. Soft ponderosa pine snags attract cavity nesting wildlife and can be expected to function as such for an average of 10 years. Following fire events, increased snag levels and insect activity provide favorable short term habitat for dependent species.

Dead and down woody material is important habitat for small vertebrate animals, reptiles, amphibians and insects. The diversity of habitat is generally low in this landscape due to the shortage of downed logs. However, small mammals are attracted to the debris and litter produced by old growth stands. As these sites typically have shallow soils, blowdown will create additional small mammal habitat, as will a susceptibility to disease, mistletoe and insect mortality.

Rare Elements and Specialized Habitat - Overall structural, vertical, and species diversity is low as compared to moist, mixed conifer habitat. However, nonforested, natural openings occur and contain shrub and herbaceous vegetation often uncommon elsewhere. Specialized habitat is limited as large,

contiguous interior habitat is not as common when compared with warm, moist forest settings. Bogs and seeps are important habitat that exist in low elevations and depressions. Flammulated owls and other raptors utilize the habitat within this VRU. Some areas are likely used as selected nest sites by many bird species because of available cavities and broken-topped trees. This would include a compliment of adapted, neotropical migrant birds. In addition, osprey and eagles favor the relatively dense foliage that provides seclusion, large and stable branches for nesting platforms and preferred height associated with large trees. Pileated woodpecker feeding occurs but nesting site availability varies from moderate to high. Wild turkeys show a preference for the open nature of old growth ponderosa pine stands.

Silvicultural Importance -These sites contain important wildlife habitat, experience high recreation use, and have aesthetic values. In addition, an historic fire regime that included frequent, low severity fires provide good nutrient turnover which enhances soil productivity. This VRU is unique, having physical attributes that define the successional role of ponderosa pine as an important seral species. As the dominant tree species, the distribution of ponderosa pine is affected by fire. Although seedlings are readily killed by fire, larger trees possess thick bark which is effective at protecting living tissues from fire damage. Survival and growth of these trees are affected little if 50% or less of the crown is scorched by fire. This high fire tolerance allows ponderosa pine to maintain its primary role as a dominant seral. However, successful regeneration is the result of a chance combination of a healthy seed crop and favorable weather during the growing season that follows. Some autecological highlights indicate that while ponderosa pine is the least shade tolerant conifer it is the most drought tolerant, capable of withstanding the highest mean temperature. Ponderosa pine seed crop frequency is extremely low, while seed longevity is the highest, as is rooting depth.

Ecosystem Health, General Trends and Management Implications

Low elevation, ponderosa pine forests have historically experienced frequent, low severity fires as a predominant natural disturbance. Since the 1930's human activities have had a greater impact with fire suppression, timber management and private land development being a significant influence on ecosystem health and landscape patterns. As a result of fire suppression, this VRU has not experienced the typical fire cycles. This results in shifts in vegetative patterns, fuel loadings, and species composition in many areas. Large diameter, open grown ponderosa pine trees are not being maintained by fire and now are sharing growing space and limited site resources with less fire tolerant Douglas-fir. When fires do occur, they are often of a higher severity due to increased fuel accumulation largely attributable to thickets of Douglas-fir trees and accompanying dense, continuous fuels. In the absence of fire, ponderosa pine is not able to regenerate well and is very susceptible to crown fires due to the understory ladder fuels.

Additional effects of an interrupted fire regime and conifer encroachment include a reduction in the amount and quality of forage due to the decadent nature of the shrub community. Flammulated owl habitat has declined due to canopy closure and the shift in species composition to Douglas-fir. Also, without ground fires fire there is a general lack of small openings or gaps that would otherwise be created. Interruption of the frequent underburning cycle has allowed the accumulation of more fine fuels and downed logs for the benefit of small mammals. However, in many areas overall habitat diversity has been reduced as forest patches are more continuous and horizontal diversity is less.

The change in species composition and structure is creating additional concerns related to insects and pathogens. Dense multi-storied Douglas-fir stands are susceptible to and capable of supporting populations of western spruce budworm, resulting in severe defoliation and mortality. Douglas-fir

trees may be infected and killed by root pathogens and dwarf mistletoe due to low vigor and susceptible conditions. While budworm and dwarf mistletoe are not a problem on this Forest yet, this increased mortality and decadence does increase the fire hazard and presents conditions that have resulted in increased fire intensity and a change from surface to crown fires (Monnig and Byler 1992). Without fires or associated management action that disturb portions of the landscape, the range and intensity of these pathogens will undoubtedly increase and result in a community that is less resilient. These consequences may lead to a reduction in site quality and/or species diversity.

As outlined earlier, nonnative plants are becoming more persistent in disturbed areas and represent an alarming trend in many areas. Many of these plants are considered noxious weeds that pose a great threat to biodiversity as they have the potential to eliminate or adversely affect native flora and fauna. Dry, open grown forests are the most susceptible to noxious weed infestation. Management activities within this vegetation response unit should consider strategies that do not encourage the spread of nonnative vegetation. Some of the weed plants that may be found within this VRU include: slender crupina, rush skeletonweed, musk thistle, leafy spurge, three species of knapweed, tansy ragwort, dalmatian and yellow toadflaxes, comon St. John's-wort, and sulphur cinquefoil.

Desired Landscape Conditions and Silvicultural Strategies

The following habitat conditions are options for vegetation managers to **consider** in prescribing silvicultural treatments designed to create and maintain landscape conditions that are more desirable and biologically sustainable. The landscape attributes that are described are considered achievable under most conditions on the Kootenai National Forest and are based on personal experience with local forest conditions, ICBEMP scientific findings (USDA 1996) and applied research. Although considerable emphasis is placed upon restoring this landscape to be consistent with historic conditions, the intent is on sustaining the biological processes that produce these conditions. It should be noted that the extent and scale of vegetation management is dependent on project-level resource objectives with consideration of historic patch size.

Landscape Attributes - An open, multi-aged ponderosa pine community, that is largely single storied, can be perpetuated and maintained through prescribed fire and/or timber harvest. These activities are **intended to mimic nonlethal understory burns** and would occur at frequencies consistent with natural fire return intervals. Other stand structures would be featured to a lesser extent. A period of 15-25 years between prescribed burns would allow most seral species sufficient time to develop some fire resistance.

It would be desirable to create small openings (2-5 ac.) within an irregularly shaped, large treatment area (20-200 ac.) t**o emulate the mixed lethal fires** that undoubtedly occur in dense Douglas-fir thickets that establish during fire-free periods. Overstory trees become susceptible to stand destroying crown fires when such situations develop. These openings would create an element of edge that would be beneficial to some wildlife species. Openings also support the grass, forbs, and shrubs that are largely absent under canopy cover.

A variety of successional stages should be represented across the landscape, managed to approximate a range of past overstory proportions of seral and climax trees species. Based on historic research in the ponderosa pine community, a representative landscape within this response unit would have the majority of the area in an old forest structural development stage, both single

and multi-storied. Of course, gaps in the canopy created by insects, disease and fire would initiate regeneration of younger age classes. It is important to realize that this represents a general characterization of a dynamic ecosystem that shifts with disturbance. Within this response unit strive to maintain 10-20% early seral, 10-30% mid seral, 5-25% mature and 40-70% late seral. These percentages would be dynamic and represent averages that change as do successional pathways. The late seral conditions represent a combination of open, single storied forest conditions (35-60%) and multi-storied (5-10%). Natural openings that are nonstocked with trees are also considered a part of this landscape.

Silvicultural Systems - It is anticipated that the desired landscape objectives will be executed within individual stands or groups of stands. The specific treatments will vary, depending on the current vegetation conditions and whether or not they meet desired objectives. Where and when vegetation management is desirable, a cross section of silvicultural systems would be used to create forest structures that are prescribed. **These treatments recognize that a mosaic of age/size classes and species was historically maintained by creeping fires that occasionally torched out individual trees and patches.**

Where multi-storied, late seral stands are being featured to maintain or develop their old growth values healthy, multi-aged stands can be managed through individual tree or small group selection openings. These practices maintain shade and facilitate regeneration, while protecting the site. Ordinarily, a cutting cycle of 20-25 years is applied, removing excess trees down to the residual basal area that is prescribed. It is assumed that natural regeneration following each harvest entry will create the new age classes in 1/2 to 2 acre groups. By nature of this small opening size, shade-tolerant species will be the prevalent regeneration. Ponderosa pine is not likely to successfully grow in this condition. The most valuable old growth trees would be retained and desirable species released and carried for another cycle. Having 5 entries on a 25 year cutting cycle would regenerate 20% of the area at each entry with a conversion period of 100 years. Essentially this would create 5 age classes that are 25 years apart. Precommercial thinning would occur where needed (est. 25 yrs.) concurrent with harvest activities. Commercial thinning is an option to be considered. Individual tree selection is not recommended in stands where insects and pathogens are a concern, or on slopes >30%. This method will not assure the regeneration of intolerant species. Managers need to acknowledge the higher cost of managing uneven-aged stand structures due to repeated entries, low volume removal, and increased fuels management cost. The repeated low volume removals and regeneration of species particularly sensitive to basal wounding makes this type of management difficult.

Where it is desirable to develop a multi-aged, open forest condition that was historically more common and sustained by frequent fire, uneven-aged systems could initially be used. Following the establishment of this condition, the intended stand composition, age class distribution, and structure can be maintained using even-aged or uneven-aged systems. Initial entries would focus on removal of excess trees, thereby allowing the crop trees to develop the desired characteristics of the dominant overstory. Prescribed fire would be used to remove excess Douglas-fir understory, prepare the site for natural regeneration of seral species, and restore fire to the site. Regeneration of ponderosa pine and western larch would be established with the intention that they function as long term recruitment into the overstory.

Where maintaining fully stocked even-aged stands is an objective, a shelterwood system is recommended to create a two storied condition, composed of mostly shade intolerant species. A combination of shelterwood preparatory cuts and shelterwood seed cuts would likely be used to

develop multiple size classes. The former would thin the stand and focus more growth on selected crop/reserve trees, while the latter facilitates the development of a young cohort under the canopy of the reserves. A small-scale version of shelterwood cutting can be used to harvest and regenerate groups of trees, similar to a group selection method. This system is a viable option for regenerating ponderosa pine where stand conditions are poor or there is root disease or dwarf mistletoe concerns. In this case, the overstory trees provide conditions intended to secure regeneration that may be jeopardized due to moisture stress and solar exposure. Additionally, shelterwood cutting may be desirable where a fully stocked even-aged stand is desirable to meet scenic objectives or special habitat needs for wildlife. Planting will often be necessary to assure regeneration, as naturals are the result of chance combination of good seed crops and favorable weather during the growing season.

Intermediate harvest methods such as improvement cuttings and thinning from below are a very important component of landscape treatments that can **emulate the function of nonlethal underburns**. These methods can be used to remove undesirable trees, maintain a desired stocking level, and open up a stand while maintaining the large overstory component. Where a fully stocked, manageable condition can be maintained, sanitation cutting can also be used to remove undesirable trees. Also, precommercial thinning in the stem exclusion stage can effectively reduce stocking and redistribute growing space to the desirable species in the stand. A variable spacing technique that executes a best tree selection has the best chance of achieving desired results.

Fire and Fuels Management - **Restoring and maintaining fire as an ecological process** for landscape change is very important. In combination with thinning, prescribed fire is recommended to maintain open stands that favor large diameter ponderosa pine. Additional objectives include preparing sites for natural regeneration of shade intolerant species and providing a short-term nutrient flush for seedlings. Management activities would likely include slashing of the Douglas-fir understory and an accompanying reduction in fine fuels. The time of year to conduct burning will depend on resource objectives, fuels, weather, etc. Spring burns are preferred to enable the retention of adequate duff and woody debris, as fuels are light and duff is generally thin on most sites in VRU 1. Response of understory plants to burning will vary with their tolerance to disturbance, the season of burning and the plant's post-fire regeneration strategy (see Summary of Key VRU Attributes, page 5). It is expected that underburning would result in minimal overstory crown scorch and low levels of mortality in overstory trees. The extent of duff reduction and mineral soil exposure that results from prescribed burning is dependent upon the resource objectives, the burning prescription, etc. These results are best predicted at the project level at which they are implemented.

It is important to maintain approximately 5-9 tons/acre of coarse woody material (>3") for site productivity and small mammal habitat. This recommendation is based on studies that used ectomycorrhizae as an indicator of healthy, productive soils (Graham et al. 1994). This amount would include the contribution of standing dead as well as down woody fuels. These recommendations are not designed to immediately replace the present forest floor but to ensure their replacement over the next 100 years or more.

Reforestation and Species Management - Species composition in the developing stands is influenced by the size of the created openings. In general, target stands would be composed of mostly ponderosa pine (approximately 80%) with Douglas-fir maintained on upland slopes and draws where moisture is more available. A harvest opening less than 2 acres in size is not expected to successfully promote ponderosa pine, but rather would favor species more shade tolerant. Ponderosa pine would be emphasized on sites with root disease and dwarf mistletoe. These stands would represent habitat

types that include Psme/Agsp, Psme/Syal-Agsp, and Psme/Caru-Agsp. Drought conditions on these warm, dry sites limit regeneration success of other conifers due to soil moisture deficits and insolation. Although ponderosa pine regeneration relies on sporadic cone crops and favorable site conditions, its regeneration strategy is likely to be successful. However, most ponderosa pine regeneration in managed stands on this Forest is planted. Stockability is estimated to vary from 40 to 70% on sites typical of this VRU.

Wildlife Needs - Maintain key cover areas for dependent wildlife. **Forage conditions would be improved by increasing low severity disturbances that open the understory and rejuvenate browse species and grass.** It is desirable to emphasize silvicultural treatments that would create or maintain a mosaic of stand conditions over the landscape in relative proportion to forest conditions that experienced natural disturbances. Within this vegetation response unit silvicultural systems that create multi-aged stand structures would be common and compatible with many wildlife objectives, although implementation strategies should recognize unique situations where even-aged conditions can be maintained in small patches.

While it is recognized that this VRU does not typically provide a long term source of high quality snags, the retention of existing snags, broken-topped live trees, and down logs provides habitat for a variety of wildlife species. The reserve tree emphasis would be a landscape consideration rather than an individual stand basis. Maintain wildlife travel corridors to provide a more continuous level of connectivity between habitat features. In addition, the retention of large diameter trees is important as snag replacement and seed sources, and these trees represent a unique component of the VRU that typically survived nonlethal fire events.

Special Considerations - Silvicultural prescriptions should recognize that site productivity is low as the nutrient holding capacity is inherently low and soils are dry and shallow. Soil compaction potential is low to moderate for the same reasons. Soil displacement can result in loss of site productivity as many sites have limited soil development and little to no loess deposits.

Retention and planting of native vegetation is emphasized to limit the spread of noxious weeds. However, if spotted knapweed is present, mechanical site disturbance may dramatically increase its spread. Understory vegetation is maintained through implementation of site preparation techniques that consider plant phenology. This vegetation response unit would benefit from the planting of nitrogen fixing plants.

Wetland areas are particularly rare in this VRU, but nonetheless important. These areas serve a special ecological function and should be sustained.

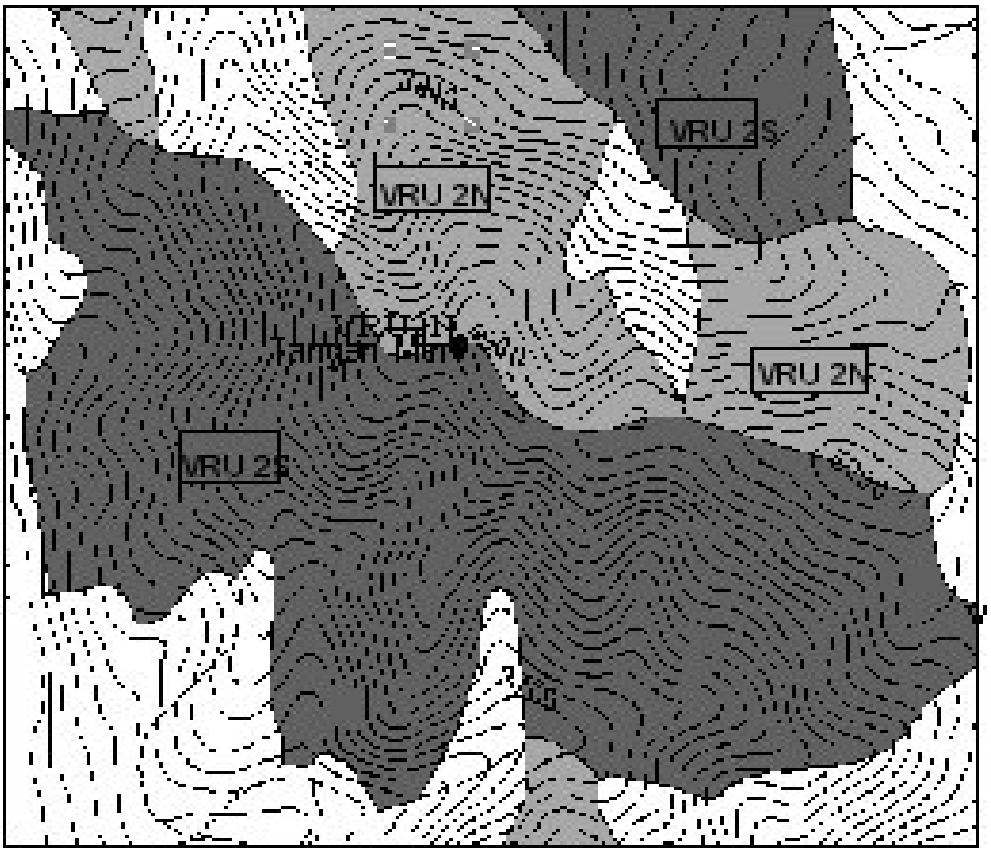
Maintain the health, vigor, stocking, species and age class diversity of vegetation by promoting a forest resilient to insect and pathogens. The long term health and productivity of this vegetative response unit can be insured by maintaining an endemic level of insect and pathogen activity. Management strategies recognize the beneficial role of insects and pathogens in ecosystem functioning. Ideally, a mosaic of age classes is desired. Single storied, second-growth stands of ponderosa pine are very susceptible to attack by bark beetles. Maintaining good vigor through stocking control can prolong the life of some stands by reducing overstocked conditions. A stand basal area less than 120 sq.ft. per acre has proven effective in reducing stand susceptibility to mountain pine beetle in maturing stands where epidemic conditions have not yet occurred.

Vegetation Response Unit Description
VRU 2
Moderately Warm and Dry Habitat Setting

Ecosystem Setting and General Description

This vegetation response unit is characterized as moderately warm and dry but is a transitional setting that includes warm, dry grasslands and moderately cool and dry upland sites. The dry, lower elevation open ridges are composed of mixed Douglas-fir and ponderosa pine in well stocked and fairly open grown conditions. Moist, upland sites and dense draws also include western larch and lodgepole pine, with lesser amounts of ponderosa pine. Tree regeneration occurs in patches and is largely absent in the understory. The sites are well drained mountain slopes and valleys located on most topographic aspects at an average elevation of 3,600 feet, but ranging from 2,000 to 5,800 feet (see Map 2). Annual precipitation ranges from 16 to 30 inches, about 75% of that falling as rain. Approximately 16% of the Forest is currently mapped as VRU with only 3% of this being on northerly aspects (VRU 2N).

This vegetative response unit contains a variety of landtypes that include 201, 251, 252, 301, 302, 323, 324, 355, 502, and 555. These landtypes occur on moderate slopes (ave. 30%) and vary from fairly deep glacial till, associated with drumlins and moraines, to shallow and moderately deep residual soils. Unlike its similar neighbor VRU 1, there is usually little exposed rock and bare soil. With the exception of a few landtypes, there is usually not a volcanic ash-influenced loess cap present. In general, these soils can be characterized by silt loam topsoils with gravelly loam to sandy silt loam subsoils. Duff depth averages 2 to 4.5 cm. While the growing season is fairly long, high solar input and moderately shallow soils often result in soils that often dry out early in the growing season. This lack of soil moisture and the general absence of volcanic ash influenced soils, results in low to moderate site productivity.



Map 2 - Typical Physical Setting of VRU 2

Vegetative Composition

These moderately dry sites are mostly within the Douglas-fir habitat type series (Table 3). At the low elevations these sites contain Douglas-fir and ponderosa pine with a shrub understory. On the higher and more moist sites ponderosa pine is less evident and lodgepole pine and western larch make up the general stand composition. Lodgepole pine is typically a dominant seral in the DF - dwarf huckleberry habitat type. While not very common on this Forest, coniferous species within the grand fir habitat types include lodgepole pine and western larch on moist sites with Douglas-fir and ponderosa pine occurring as persistent serals on the dry sites. Western white pine and grand fir are a minor component on the mesic sites, but otherwise generally absent.

Historic vegetation research (Losensky 1994) indicates that around 1900, the Douglas-fir cover type occurred in 2% of western Montana and northern Idaho (Climatic Section 9 - Pend Oreille). Under these more natural forest conditions, associated seral species were more common due to availability of growing space and periodic fire disturbances.

Table 3 **- Habitat Types and Fire Groups within VRU 2 ***

Habitat Type Code	Habitat Type	Regional Habitat Group	Climatic Modifier	Fire Group Code MT	% of HG 2
250	Psme/Vaca	HG 2	Mod Warm and Dry	6/7	9
260	Psme/Phma	HG 2	Mod Warm and Dry	6	17
261	Psme/Phma-Phma	HG 2	Mod Warm and Dry	6	10
262	Psme/Phma-Caru	HG 2	Mod Warm and Dry	4	11
263	Psme/Phma-Smst	HG 2	Mod Warm and Dry		1
280	Psme/Vagl	HG 2	Mod Warm and Dry		1
281	Psme/Vagl-Vagl	HG 2	Mod Warm and Dry	6	1
282	Psme/Vagl-Aruv	HG 2	Mod Warm and Dry	6	-
283	Psme/Vagl-Xete	HG 2	Mod Warm and Dry	6	1
292	Psme/Libo-Caru	HG 2	Mod Warm and Dry	6	7
310	Psme/Syal	HG 2	Mod Warm and Dry	6	4
312	Psme/Syal-Caru	HG 2	Mod Warm and Dry	6	9
313	Psme/Syal-Syal	HG 2	Mod Warm and Dry	6	1
320	Psme/Caru	HG 2	Mod Warm and Dry		9
322	Psme/Caru-Aruv	HG 2	Mod Warm and Dry	6	6
323	Psme/Caru-Caru	HG 2	Mod Warm and Dry		5
324	Psme/Caru-Pipo	HG 2	Mod Warm and Dry	4	2
330	Psme/Cage	HG 2	Mod Warm and Dry		1
340	Psme/Spbe	HG 2	Mod Warm and Dry	4	-
350	Psme/Aruv	HG 2	Mod Warm and Dry	6	-
360	Psme/Juco	HG 2	Mod Warm and Dry		-
370	Psme/Arco	HG 2	Mod Warm and Dry		-
505	Abgr/Spbe	HG 2	Mod Warm and Dry	4	-
506	Abgr/Phma	HG 2	Mod Warm and Dry	4	-
507	Abgr/Phma-Cooc	HG 2	Mod Warm and Dry	4	-
508	Abgr/Phma-Phma	HG 2	Mod Warm and Dry	4	1

* Note: Habitat types that comprise less than 1% of this grouping are indicated by a dash (-).

This VRU is composed of habitat types that are categorized within the moderately warm and dry habitat types. There are inclusions of several warm and dry habitat types (Psme/Phma-Caru, Psme/Caru-Pipo, Psme/Spbe) and several moderately cool and dry habitat types (Psme/Vagl, Psme/Libo-Caru, Psme/Caru). Dominant shrubs within this vegetation response unit include common snowberry, mallow ninebark, dwarf huckleberry, ocean-spray, Rocky Mountain maple, common juniper. Wetter microsites may contain redstem ceanothus, western serviceberry, and Scouler willow. Forbs include shiny-leaf spirea, kinnikinnick, Oregongrape. Grass species include elk sedge and pinegrass. Sensitive plants such as western moonwort, Howell's gumweed, Spalding's silene, common clarkia, and Geyer's biscuit-root may occur in unique microsites of this setting. Many nonnative plants are found in this area as well.

Disturbance Processes

As the long term health of ecosystems is linked to disturbance, understanding and incorporating natural or human-induced disturbance processes into land management planning is essential. Recurrence of disturbance and recovery within ecosystems is an important mechanism for energy flow, maintenance of habitat diversity, vegetative succession, canopy reduction, etc. Disturbance drives forest structure which influences ecological function and ultimately determines biological diversity. Any given disturbance event may be the result of numerous, interconnected factors.

Fire Regime - Vegetative conditions can represent large variations in moisture and temperature which are reflected in different frequency and intensity of fire regimes. A fire regime will usually follow elevational gradients and differing aspects and result in varying fire intensities and a mosaic of stand ages and types. The habitat type groups on the Kootenai occurring within this vegetation response unit are primarily in Fire Group 6 with some Fire Group 4. The fire group concept is based on the response of various tree species to fire and the roles these species play in forest succession. As described below, three different fire regimes represent the environmental gradient within this fire group.

The first fire regime (nonlethal) is representative of VRU 2S on moderately warm dry sites, while the latter (mixed lethal and high severity/ SR) are representative of VRU 2N, on cooler and more moist sites. Between these extremes are a mosaic of stand and age class structures that result in a unique landscape condition.

Prior to intensive fire suppression, fire was an important agent in controlling density and species composition in this VRU. **Low to moderate severity fires on a frequency of 15 to 45 years were the predominant disturbance, in the drier habitat types, playing a major role in maintaining the seral community of conifers.** Nonlethal, nonuniform underburns were the most common type, typically on low elevations and on southerly aspects. These low severity fires would burn nonuniformly consuming the litter and undergrowth. This usually left an open overstory of larch, ponderosa pine and Douglas-fir largely intact and created small canopy gaps. Structural diversity remained high under these mosaic conditions. Mixed lethal, mosaic fires typically occurred at mid to upper elevations and northerly aspects, creeping along the surface and occasionally flaring up, killing trees in patches and aiding the creation of multiple age classes. Western larch and ponderosa pine were favored in this situation due to their inherent fire tolerance and ability to regenerate under these conditions.

In a third scenario, high severity fires occurred much less frequently on an average of every 225 years but ranged from approximately 150-400+ years (Arno et. al. 1995). The variability in this Fire Return Interval (FRI) is largely attributed to variations in topography, habitat type and species mix. These lethal fires very likely occurred within overstocked stands or in draws that may have contained heavy fuels due to long fire-free intervals. In many cases, a dense understory of trees creates a fuel ladder that carries fire up into the crowns and through a stand. Although not uniform or expansive, these patchy fires typically resulted in overall stand replacement with even-aged stands of westerrn larch, ponderosa pine, Douglas-fir and/or lodgepole pine. While considered outside of a representative range of variation, the stand replacement fires are important to consider, given the nature of existing stand conditions and their predisposition to high severity fires. This is of particular relevance on steep slopes where lethal fires are more common due to crowning effects.

Fuels and Nutrient Cycling - Forests evolve with a continual flux of coarse woody debris. The creation and accumulation of which vary according to forest type, stand density, insect and disease activity, decay rates, fire return interval, age and stand history. In most sustainable forest ecosystems, insects and pathogens are also the major nutrient recyclers. On sites such as these, fire will likely play a more dominant role in maintaining site productivity due to its more frequent presence.

Coarse woody debris performs many important physical, chemical, and biological functions in a forest setting. On moderately warm and dry sites this debris can be an important source of moisture for vegetation during periods of drought. In this vegetation response unit, a frequent, low severity fire regime has generally kept duff depth low and reduced fine fuels, creating a mosaic of fuel conditions. In recent decades this situation has changed, as fire is not functioning in its historic role, and fuel accumulations have increased. In addition, decomposition rates are low compared with moist sites.

Within Fire Group 4 and 6 herbaceous material, tree litter and large woody fuels averaged 11-12 tons per acre in research plots of representative habitat types (Fisher and Bradley 1987). Heavier fuels existed where mortality from insects or disease was high and on the moist, more productive sites. The most hazardous conditions occur in well stocked stands with dense Douglas-fir understories. Under natural conditions it is likely that fuels would have been somewhat lighter due to more frequent fires that consumed some of this.

Insects and Disease - Disturbances caused by insects and diseases occur in all terrestrial ecosystems and as a group probably are the most evident. As ponderosa pine and western larch are the predominant stand components, diseases do not play a major successional role in this vegetation response unit. Dwarf mistletoe is often endemic to the stand and appears in scattered relic overstory trees. Stem diseases such as western gall rust and atropellis canker affect tree growth and form but are usually not a major concern. Root disease on these droughty sites can impact Douglas-fir, a major host species, as well as grand fir.

Mature ponderosa pine and Douglas-fir are highly susceptible to western pine beetle and Douglas-fir beetle, respectively. Bark beetle outbreaks are often brought about by prolonged dry weather, fire weakened trees, or in conjunction with root disease. Overmature, slow growing, decadent or otherwise nonvigorous trees are prime breeding habitat for bark beetles. Pine engraver beetles, though usually secondary attackers, can cause significant tree mortality during dry weather or following stand disturbances such as blowdown. Fortunately, the duration of this effect seldom lasts more than one season. Dense pole-sized stands of ponderosa pine can be susceptible to mountain pine beetle during extreme epidemic conditions or in conjunction with drought. Mature lodgepole pine are a primary host for bark beetles as well, particularly where they have regenerated in patches and exhibit signs of low vigor.

Weather - Occasional thunderstorms occur during the summer as a result of late afternoon convection buildups. Severe storms with damaging winds seldom occur. Snow damage is generally minor at the lower elevations. Periodic drought is characteristic in VRU 2S and influential in the functioning of this response unit and the resultant vegetation patterns. The most severe drought occurs in areas with abnormally low winter and spring rainfall as summer water resources rely on winter snowpack. Due to generally low snow depths, this VRU is not likely to experience rain on snow floods which are a result of heavy rain falling on and penetrating existing snow cover.

Successional Pathways

The following scenarios and accompanying illustration (Figure 2) depict broad pathways that are generally representative of vegetation succession under the influence of both natural fires and periodic absence of fire (Fisher and Bradley 1987). The descriptions recognize the existence of mosaic or patchy conditions that represent variation in species composition, forest types, and stocking levels. In general, the associated plant communities that are disturbed by fire gradually regain their composition and structure similar to what existed before the event. Depending on the habitat type and the survival mechanism of the plant, most vegetation will renew itself with time.

Under a **nonlethal fire regime** typical of VRU 2S, ponderosa pine and western larch retain dominance over Douglas-fir as major seral species. On flat to moderate slopes (<25%) the natural accumulation of needle litter favors slow moving, low severity ground fires that reduce the stocking of Douglas-fir and understory vegetation to mosaic patches. This scenario maintains a relatively open stand condition with overstory ponderosa pine, western larch and scattered Douglas-fir. Openings contain grasses, forbs and shrubs. Most old growth forests in this VRU likely evolved through this scenario. Steeper topography will create a different condition as vegetation burns more quickly and higher into the crowns.

On the cooler and more moist sites of VRU 2N, succession following **mixed lethal fires** created a variety of conditions facilitated by the availability of growing space and sunlight. Stand conditions are open with western larch and Douglas-fir overstory interspersed with small openings created by patchy tree mortality. Larger openings allow regeneration to lodgepole pine in even-aged patches. The tendency for some sites to be frost pockets (i.e. DF/dwarf huckleberry) also favored lodgepole pine development. Another condition resulting from the mixed severity fires are the multi-storied stands of western larch and Douglas-fir overstory that develop with a younger cohort of the same species underneath. Without a fire event, these multi-storied conditions can convert to mostly single storied stands at high stocking levels. These stands often develop low levels of vigor and health due to poor regeneration and growth.

In general, low to moderate severity fires in early seral stands kill susceptible trees and convert dense stands of pole size and larger trees to a more open condition. If the fire intensity is very low, young ponderosa pine trees may survive due to fire-resistant characteristics. In these fairly young stands, competing Douglas-fir is also at risk from fire due to low, sweeping crowns and reduced fire tolerance. As ponderosa pine matures it develops characteristics such as open crowns, fire-pruned lower boles, large protected buds, high foliage moisture and thick insulating bark protecting it from the heat of fires.

After a long enough fire-free interval**, stand replacement fires** can occur in the more moist settings of this VRU under varying forest conditions. Mature, multi-storied stands of Douglas-fir, mid seral stands of Douglas-fir and lodgepole pine, and mature Douglas-fir stands with scattered lodgepole pine are particularly prone to lethal fires. These three conditions all typically have an understory of Douglas-fir, with or without lodgepole pine and western larch, which can provide access for fire into the upper crowns of overstory trees. Stand replacement can also be facilitated by periods of extended drought.

Following a stand replacement fire in conditions such as these, openings of grass, forbs and shrubs would develop into contiguous areas of sapling and pole sized seral species. A scattered overstory of surviving western larch and occasionally Douglas-fir would likely be present. If vegetation development continues without a fire event, these two storied conditions would convert to mixed species with a moderate to high representation of lodgepole pine. Over time, if the fire-free interval is long enough, lodgepole pine may develop the physical characteristics that are attractive to bark beetles. This stagnated and overstocked condition can create heavy fuel loadings and significant threat of stand replacement, in the event a fire occurs.

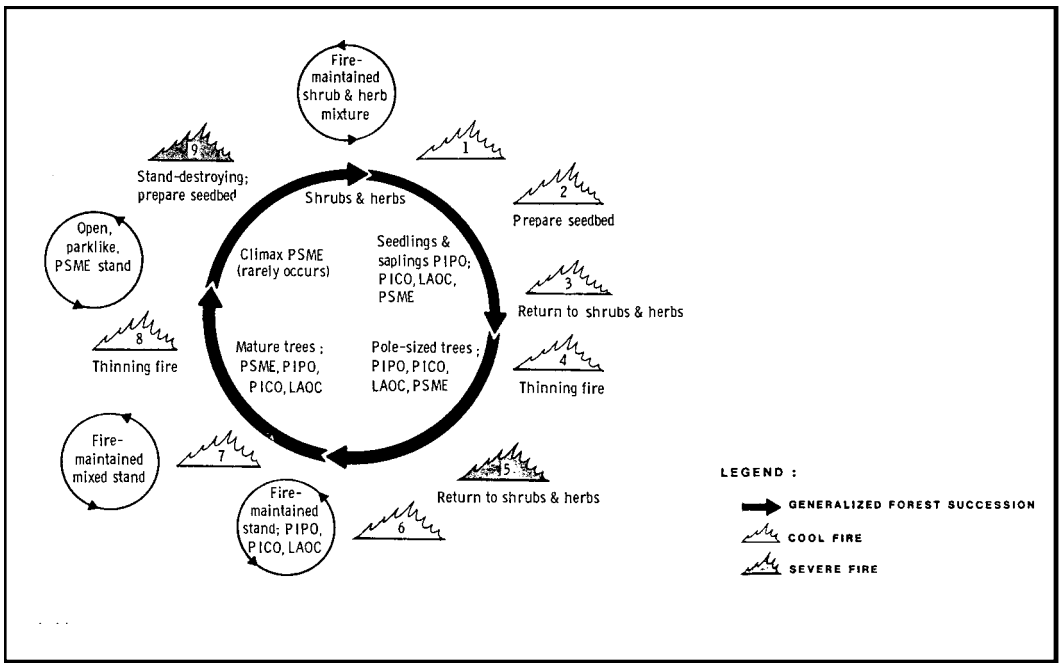


Figure 2: Generalized Forest Succession in Fire Group 6

Without fire, Douglas-fir gains dominance through advancement into the overstory and eventually outcompetes ponderosa pine as the climax species. Competing vegetation is a significant deterrent to early survival and development of young ponderosa pine seedlings and Douglas-fir is the only species that continues to regenerate in any abundance without disturbance. In addition, moisture stress reduces seed germination as well as seedling survival and growth. This theoretical climax forest is a multi- storied or all-aged Douglas-fir forest that develops after a prolonged fire-free period. In some cases, where Douglas-fir is the seral dominant (i.e. DF/ninebark and DF/pinegrass habitat types) frequent low to moderate severity fires can create open, parklike stands of Douglas-fir in a climax condition.

Vegetative Structure

Forest structure has a primary influence over ecological function and ultimately the inherent biological diversity. Disturbance processes are largely responsible for the forest structure that has developed in this vegetation response unit. Stand structure and the distribution of trees is also strongly influenced by the soil type and other physiographic features. As a product of frequent low to moderate severity ground fires, and occasional stand replacement events, this VRU is generally made up of a mosaic of stand ages and forest types. The characteristic low to moderate fire regimes tend to creep along the ground with occasional flare-ups. The accompanying short, fire-free interval perpetuates two storied and multi-aged stands of ponderosa pine, western larch and Douglas-fir, with inclusions of lodgepole pine. Multi-storied stands representing late successional stages also occur as stringers in protected areas that burned less frequently. Patches of even-aged, single storied stands develop after severe burning conditions within a dense understory or an overstocked pole stand after a long fire-free period.

Based on studies of forest structural conditions in stands on the Lolo, Bitterroot and Flathead Forests (Arno et al. 1995) stocking levels around 1900 ranged from 57-100 sq. ft. of basal area per acre on DF - dwarf huckleberry habitat types and 65-150 on DF - pinegrass habitat types. The upper end of

these ranges occurred on benches and areas with moderate soil depths. These studies of historic age class structures were based on reconstruction of fire history records and individual tree measurement data. Other research (Steele 1994) estimates stand density at 15-30 overstory trees per acre with a total stand basal area of 60-100 sq. ft., slightly higher on northerly slopes.

If managing for species diversity is an objective, understanding the effects of different but adjoining stand structures on diversity and the influence that fire has on forest stands is important. Fire, slope and aspect contrasts are the primary determinants of patch size and the resulting influence on species richness due to creation of edge. Inherent edge is generally thought of as a relatively stable, natural feature of the land that results from a meeting of two plant communities (i.e. habitat types). As influenced by fire, these boundaries occur on aspect changes, along streamsides, on abrupt slope changes, and where rock outcrops limit fire spread. Commonly occurring nonlethal ground fires will likely result in canopy gaps that provide a high amount of inherent edge containing a diverse compliment of vegetation within the openings. Induced edge refers to plant communities of different successional stages that have more likelihood of change with time. With the exception of rare, high fire severity events that typically create large patches, induced diversity is created by fire boundaries which mostly conform to aspect changes. Both inherent and induced edge are a direct reflection of the total diversity in the area and are important to consider when evaluating stand structures at a landscape level.

The size of a particular habitat is very important in consideration of species richness. Patches that determine the extent of this response unit are irregular and vary significantly in size. Studies in the Bristow Creek area (KNF 1993) indicate a patch size from 20 to 200 acres may be a representative range for this VRU. Vegetative diversity would likely be inherently high given the amount of edge represented by small openings and their irregular shape.

Age Class Diversity

Forest successional stages and their relative proportions are a key habitat element that is a useful measurement indicator for comparing different management options. Each successional stage present will provide distinct ecological conditions that fulfill the requirements of many terrestrial species. For example, early seral stages provide key forage for wildlife, while mid to late seral conditions generally provide thermal cover when canopy closure is adequate. Snags for cavity nesting species and downed logs for small mammals are generally available at each stand development stage, although to varying degrees depending on the nature of recent disturbances.

The proportion of age classes represents successional stages that have varied over time, but would be similar to that shown in Table 4. It is important to realize that this represents a general characterization of a dynamic ecosystem that shifts with disturbance. Historic age class distributions (**pre-1900)** are based on a synthesis of research of historic vegetation in the Douglas-fir cover type of northern Idaho and western Montana (Losensky 1994), studies in old growth forests of western Montana (Lesica 1995), ICBEMP scientific findings (USDA 1996), and results predicted by modeling age class proportions that would result following the average stand replacement interval for VRU 2.

Losensky found that stands where ages exceeded 150+ years (37%) were evenly mixed as multi-storied and single storied. The latter condition was facilitated by the frequent, low severity and mixed fire regimes that typify this VRU. Based on research of Fire Group 6 in northwest Montana (Lesica 1995) it was estimated that 34% of the moist Douglas-fir type was in an old growth

structural stage (>200 yrs.) prior to European settlement, approximately the mid 1800's. Losensky also found that approximately 15% of the area was nonstocked openings with shrubs and grasses.

Table 4: **Age Class Distribution**

Age Class	Pre-1900 Condition	Existing Condition
0-40	15-25%	15%
41-100	15-35%	40%
101-150	10-30%	26%
150+	20-50%	15%
nonstocked	10-20%	4%

Although intended for application at a much broader scale, scientific findings from ICBEMP (USDA 1996) suggest that around the time of pre-European settlement, within the dry potential vegetation group (PVG), 30-50% was composed of mature and old forest conditions (both single and multi-storied) and 5-10% in openings. The dry PVG is considered the Douglas-fir series with and without ponderosa pine, as well as the dry end of the grand fir series.

The information in Table 4 also illustrates the **existing age class distribution** for VRU 2 on the Kootenai. It is based on stand year of origin data for Habitat Group 2 taken from the Timber Stand Management Record System (TSMRS). Approximately 12% of the stands in this grouping does not have complete inventory information and are not represented in this age class distribution.

Ecological Function and Habitat Features

Ecosystems consist of structures and elements that perform a number of functions. Insight into ecological function is important to our understanding of how the ecosystem operates, identifies important habitat components, and describes the relative measure of biological diversity. The ecological functions described include interactive processes that occur to varying degrees across the landscape and are what makes an ecosystem dynamic.

This vegetation response unit is a transition between the warm dry environment containing open, multi-aged stands of ponderosa pine (VRU 1) and the moderately cool and moist environment containing mixed conifer species such as grand fir, western hemlock and western redcedar (VRU 5). With these unique and diverse habitat features, this landscape serves as important wildlife habitat that is utilized by most terrestrial species of the Kootenai. The low elevation areas are important winter/spring range, while mid to upper elevations are utilized primarily in summer. In addition, a frequent low severity fire regime provides good nutrient turnover and enhanced soil productivity, a significant ecological role.

Landscape Linkages - How habitat features are connected relates directly to the resiliency of the landscape. Habitat linkages are important to such species as wolves and grizzly bear. Wide ranging carnivores such as wolverine, lynx, fisher and some old growth associated species rely on these corridors. At a finer scale, forested areas provide movement linkages for many species that travel from watering to feeding to bedding sites. Of course, these types of areas are commonly used by animals moving between seasonal habitat. Within this landscape, connectivity is relatively high and results in important corridors for wildlife movement. This is largely attributed to small but variable patch sizes which generally include primary topographic ridges within them.

Old Growth and Interior Habitat - This VRU makes up a very small percentage of the functional old growth and interior habitat across the forest. Although many of the stands within this landscape do not fit the classic mixed conifer description of old growth, they do contain many of the physical and structural characteristics which are important to wildlife, and they represent a distinct ecological type on the Kootenai. The frequency of underburning in much of this landscape does not favor the retention and development of downed logs and storied stand structures which are characteristic of late seral forest conditions. Contiguous areas of vegetative cover provide specialized habitat to interior dependent wildlife species, while gaps created by fire have value for wildlife species that prefer small openings.

Wildlife Habitat - Low to moderate snow levels in this VRU create valuable winter range habitat for elk, whitetail and mule deer, moose and bighorn sheep. Following hibernation, bears utilize upper elevation areas during early spring foraging and as fall denning habitat. Draws, dense Douglas-fir stands and shrub thickets provide good hiding cover. Full crowned overstory trees effectively intercept snow and can offer decent thermal cover in patchy openings. Where there are multi-storied conditions, large mammals can control body temperature without using fat reserves. Multi-storied conditions are also important for birds, as different species have adapted to using the various canopy layers.
While there is considerable canopy closure across this landscape, a good browse component is available to wildlife species and enhances the areas' value as big game winter and spring range. The primary forage areas are steeper, west and south exposures located on open ridges and natural openings within forest patches. Whitetail deer avoid openings where snow depths are excessive (>18"). Forage under open forest canopies is important to many species. South slopes have limited forage value in late summer due to the relatively warm, dry habitat conditions which tend to support less vegetation.

Important winter forage grasses for mule deer, elk and bighorn sheep include bluebunch wheatgrass and rough fescue. Elk sedge is an important forage for black bear, deer and occasionally elk in the early growing season. Western serviceberry is a key forage for whitetail deer, mule deer, elk, sheep and moose during the winter and early spring. Common snowberry is frequently found and is marginal as forage but is utilized by deer in the summer and fall. There is use by elk when other desirable forage species is not present. Russet buffalo-berry, bitter-brush, chokecherry and Rocky Mountain maple are not common, but have winter forage value as well. Kinnikinnick and Oregongrape are common and provide light to moderate big game winter forage. In addition, bears utilize the berries in spring and fall. Deer are also known to browse on Douglas-fir seedlings and saplings during winter months.

The frequent, low severity fire regime that is characteristic has a definite effect on wildlife habitat through its effect on vegetation. The combined result of killing overstory trees, reducing understory competition and rejuvenating plants through top kill can promote the availability and palatability of many browse and forage species such as western serviceberry, common snowberry, mallow ninebark, elk sedge and pinegrass.

Snags provide a portion of the life support system for many species of plants, invertebrates, birds, and mammals. Snags are utilized for feeding, nesting, roosting and resting. While snags and cavity habitat in VRU 2 is relatively low, as compared with moist sites, there is scattered distribution of suitable trees across this landscape. Douglas-fir and ponderosa pine snags are typically short term providers of cavity habitat, when compared with western larch, but are nonetheless important. Study of cavity nesters in northwest Montana (McClelland et al. 1979) found that 74% of sampled nests

were in western larch, 30% in hardwoods, and 6% in Douglas-fir or ponderosa pine. Disturbances such as root disease, bark beetle infestation and fires of varying intensities created snags that contain cavity habitat in many species and potential nesting sites for raptors in ponderosa pine. Dead and down woody material in various stages of decay are important to small vertebrate animals, reptiles, amphibians, and invertebrates. Dense shrub thickets, draws, and heavily timbered areas provide a great setting as vegetation and woody material is readily available. As most sites within this habitat have moderately shallow soils, blowdown can create additional small mammal habitat, as will susceptibility to disease, mistletoe and insect mortality. In a landscape with frequent low severity ground fires, diversity of this type of habitat is generally low to moderate due to the shortage of downed logs. However, this habitat has increased in recent decades due to greater biomass accumulation and less frequent fires.

Rare Elements and Specialized Habitat - Habitat provided by unique topographic and biological features serve an important function that is not provided by plant communities or successional stages elsewhere. Snags, down woody debris and edge habitat have been discussed in previous comments and play a vital role in this. Unique habitat such as bogs, seeps, caves, cliffs, and talus slopes are not very common in this landscape, yet they are disproportionately important as wildlife habitat. As they are typically fragile environments, there is little or nothing that can be done to improve them and they should be recognized as rare. Nonforested, natural openings occur and contain shrub and herbaceous vegetation often uncommon elsewhere.

Flammulated owls and other raptors utilize habitat in VRU 2, but the increase in shade tolerant species and limited ponderosa pine has reduced suitability for flammulated owl use. Available cavities and broken-topped trees are likely used as selected nest sites by many bird species, including adapted neotropical migrants. In addition, relatively dense foliage provides seclusion, large and stable branches for nesting platforms and preferred height associated with large trees. Pileated woodpecker feeding occurs but availability of nesting sites varies from moderate to high. Big game mineral licks are scattered and may be found where lacustrine deposits are exposed in calcareous glacial till and outwash. Where riparian areas occur, they receive a tremendous amount of wildlife use, particularly in summer range areas.

Silvicultural Importance - With the diverse nature of this vegetation response unit, a mosaic of seral species shares this ecological niche and has an important role, as has been described. Western larch and ponderosa pine are very fire-resistant species that have a competitive advantage over most conifer species, under natural fire regimes. In fact, the fire resistance of western larch is enhanced by its tendency to self-prune lower branches and its tolerance to defoliation. Both species are important parts of the seral community and, being long lived, are generally maintained as important stand components and are potential seed sources for many years.

The physical attributes of this landscape also define the successional role of Douglas-fir as both the indicated climax species on the warm, drier sites and a seral dominant on the moist sites with lodgepole pine, ponderosa pine and western larch. Historically, wildfire helps to maintain these species and facilitates their continued regeneration. However, Douglas-fir is unique in that it can establish on a variety of seedbeds and is not dependent on mineral soil for successful regeneration. Without disturbance, and with continued duff accumulation, Douglas-fir is the only species that continues to regenerate in any abundance. As a result, it becomes dominant in these situations and can persist through many successional stages. With that persistent nature it is not surprising that Douglas-fir has the widest range of any commercial conifer of western North America and serves an important ecological role in this vegetation response unit.

Ecosystem Health, General Trends and Management Implications
Largely due to its location and access, the composition and structure of low to mid elevation moist Douglas-fir forests has changed in recent decades through fire suppression, timber harvest, private development, livestock grazing, etc. These forests have historically experienced frequent, low severity and mixed severity fires as a predominant natural disturbance. However, over the last 60 years, human activities have essentially replaced fire as the determining disturbance pattern. Since we know that disturbance drives the development of forest structure, there are noticeable trends in this VRU that are the direct result of this interaction and which can influence ecosystem health and landscape patterns. ICBEMP scientific findings (USDA 1996) indicate that over 60% of the area within the Dry PVG that used to burn with nonlethal fires now has a mixed severity or lethal stand replacing fire regime.

As a result of fire suppression having lengthened the fire free interval, much of this landscape has not experienced fire cycles that would be considered typical. As a result, shifts in vegetative patterns, fuel loadings, and species composition have occurred in many areas. There are generally more early seral stands now, due to the frequency and scale of harvest in recent decades. In many cases, these young stands do not have the scattered large, live and dead trees that may have been historically present following a varied fire regime. These indicated trends are particularly noticeable in roaded areas that have facilitated access for fire suppression and timber management.

Fire has an important role in controlling density and species composition. Without the frequent low to moderate fires that favor western larch and ponderosa pine, scattered overstory ponderosa pine trees are not able to regenerate successfully and are being outcompeted by Douglas-fir. Growing in dense thickets and as mature overstory trees, Douglas-fir is less fire tolerant than its associates and regenerates well without site conditions created by fire. The Douglas-fir cover type on the forest is presently estimated at 16%, a marked increase from the 2% noted in historic vegetation research (Losensky 1994).

An increase in the understory of shrubs and young trees has changed wildlife habitat to favor whitetail deer and snowshoe hare. This is to the disadvantage of pocket gophers and ground squirrels that require minimal cover. Additional effects of an interrupted fire regime and conifer encroachment include a reduction in the amount and quality of forage. The shrub community is typically older, decadent and often out of reach due to its advance growth form. Flammulated owl habitat has declined due to canopy closure and the shift in species composition to Douglas-fir. Also, without ground fires fire there is a general lack of small openings or gaps that would otherwise be created. Interruption of the frequent underburning cycle has allowed the accumulation of more fine fuels and downed logs for the benefit of small mammals. However, in many areas overall habitat diversity has been reduced as forest patches are more continuous and horizontal diversity is less.

While insects and pathogens are an inherent part of the forest, recent changes in species composition, stand densities and structure have created additional concerns that relate to ecosystem resiliency and the importance of maintaining biological function. Dense multi-storied Douglas-fir are susceptible to and capable of supporting populations of western spruce budworm, resulting in severe defoliation and mortality. These same stand structures can be conducive to infection by dwarf mistletoe. In fact, partial cutting and fire exclusion only make conditions for the host species worse, in most cases. So far, these forest conditions have not led to significant increases in budworm or dwarf mistletoe problems on the Kootenai or northwest Montana. While the presence of root disease creates openings in otherwise closed canopies, a shift in species composition to Douglas-fir is creating more continuous tree mortality than may be considered desirable. Areas that contain mature

lodgepole pine stands have experienced high levels of bark beetle caused mortality due to physiological age, summer drought and overstocking.
The increased mortality, decadence and higher stand densities are accompanied by dense, continuous fuels. This increased fire hazard presents conditions resulting in increased fire intensity and a change from surface to crown fires (Monnig and Byler 1992). Without fires or associated management action disturbing portions of the landscape, the extensity and intensity of these pathogens will undoubtedly increase and result in a less resilient community. These consequences may lead to a reduction in site quality and continued shift in species composition. Where these conditions border the urban areas and important wildlife winter ranges, it becomes all the more importance to assess the risks of no action.

Nonnative plants are becoming more persistent in disturbed areas and represent an alarming trend in many areas. Many of these plants are considered noxious weeds as they have the potential to eliminate or adversely affect native flora and fauna, posing a great threat to biodiversity. The nonnative plants listed in VRU 1 would also be found in this vegetation response unit. Forests of this type are vulnerable to noxious weed infestation due to their dry, somewhat open character. Though disturbance increases susceptibility to noxious weeds, they can invade without it. Management activities within this vegetation response unit should consider strategies that do not encourage the spread of nonnative vegetation.

Desired Landscape Conditions and Silvicultural Strategies

The following habitat conditions are described as options for vegetation managers to **consider** in prescribing silvicultural treatments to shift the landscape within this vegetation response unit towards a more desirable and sustainable condition. The landscape attributes described are achievable under average conditions and are based on applied research, ICBEMP scientific findings (USDA 1996) and experience with local forest conditions. While there is considerable information presented on historic forest conditions, the emphasis is placed on sustaining the biological processes that produce these conditions. It should be noted that the extent and scale of vegetation management is dependent on project-level resource objectives with consideration of historic patch size.

Landscape Attributes - **Desired forest structures would reflect the product of frequent low to moderate severity ground fires, and occasional stand replacement events**. A mosaic of stand conditions (stocking, age class, species composition) with varied structural attributes would be present across this vegetation response unit. Management activities could perpetuate and maintain a nonuniform, relatively open community of mature western larch, ponderosa pine and Douglas-fir (VRU 2S), with lesser amounts of lodgepole pine (VRU 2N). Largely multi-storied and two-aged, these conditions would be sustained through prescribed fire and timber harvest at frequencies consistent with natural fire return intervals (15-45 yrs.). Other stand structures would be featured to a lesser extent. Stocking levels would generally be maintained at lower levels than they exist presently.

A variety of successional stages should be represented across the landscape, managed in proportions relative to the historic range of seral and climax trees species. The recommendations described below are based on the scientific findings that have been described, research of historic vegetation, the inherent fire regime, and landscape assessments completed at the district level. Within this response unit, strive to maintain 15-25% early seral, 15-35% mid seral, 10-30% mature, and 20-50% late seral. A portion of the landscape will undoubtedly be in natural openings, currently nonstocked with trees. These percentages would be dynamic and represent averages that change as

do successional pathways. It is anticipated that late seral stands with large diameter trees and generally open conditions would be managed on ridgelines, gentle slopes, and riparian areas.
It would be desirable to create small openings (2-5 ac.) within an irregularly shaped, large treatment area (20-200 ac.). This landscape-level application intends **to emulate the variation that occurs from mixed severity burns occurring within a larger stand replacement disturbance**. Often these burns occurred in dense Douglas-fir thickets that establish during fire-free periods. Overstory trees become susceptible to stand destroying crown fires when such situations develop. These openings would create an element of edge that would be beneficial to some wildlife species. Openings also support the grass, forbs, and shrubs that are largely absent under canopy cover.

Silvicultural Systems

It is anticipated that desired landscape objectives will be executed within individual stands and groups of stands. Individual treatments will vary, depending on the current vegetation conditions and whether or not they meet desired objectives. Where and when vegetation management is desirable, a cross section of silvicultural systems would undoubtedly be used to create the forest structures that are prescribed. In fact, if a skilled marking crew is given specific guidelines that include key elements to assess, landscape level objectives can be executed using a variety of treatments.

In the absence of insect and disease concerns, some healthy multi-aged stands can be managed through individual tree or small group selection on a 20-25 year re-entry schedule. This treatment might be feasible in mid to late seral stands that occur on drier sites and moderate terrain (i.e. VRU 2S). Group selection can be particularly useful in late seral stands **where the intent is to maintain or develop multi-storied structure and old growth characteristics. This condition would be similar to that resulting from frequent, low severity natural fires** that would typically occur. This system could also be used **to maintain large diameter overstory trees in an open condition**. Stocking levels can be maintained somewhere between 65 and 100 square feet of basal area. Each entry would attempt to create a new age class, retain the most valuable old growth trees and release any desirable species that would be carried for another cycle. As described previously, it will be difficult to maintain a high stocking level of shade intolerant species (PP,WL,LP) where managed openings are less than 2 acres. Having 5 entries on a 25 year cutting cycle would regenerate 20% of

the area at each entry with a conversion period of 100 years. Essentially this would create 5 age classes that are 25 years apart. A precommercial thin would occur at year 25 in the immature age classes. Commercial thinning is an option to be considered. Stands with an abundance of lodgepole pine or grand fir are not suitable for selection harvest systems. Also, where shade intolerant species such as western larch, ponderosa pine or lodgepole pine make up more that half the stand composition (singly or in combination), regeneration may not be feasible with the limited canopy gaps of individual or small group selection. In addition, where annosum root disease is active in ponderosa pine, harvest of host trees may result in increased infection and subsequent mortality. This situation can be minimized by focusing harvest of unhealthy and genetically undesirable ponderosa pine, selecting against Douglas-fir and following up with prescribed burning to facilitate ponderosa pine and western larch regeneration.

In areas with dense or overstocked clumps of Douglas-fir and ponderosa pine, **group selection may be useful as a means of creating suitable conditions for regeneration of ponderosa pine, while providing site protection,** if necessary. Individual tree selection would also protect the site but would not provide suitable growing conditions to assure regeneration of shade intolerant conifers, such as western larch and ponderosa pine. In fact, these conditions would actually favor Douglas-fir which has less stringent seedbed requirements than ponderosa pine and other shade intolerant associates. **These selection practices recognize that a mosaic of age/size classes and species were historically maintained by creeping fires that occasionally torched out trees.** However, managers need to acknowledge the higher cost of managing uneven-aged stand structures due to repeated entries, low volume removal, and increased fuels management cost. Also, some previously managed stands may not be in a condition that is suitable for selection systems.

Where stand conditions are generally poor or where insects and diseases are a concern**,** regeneration harvest treatments may be desirable and can be initiated through an irregular shelterwood system (i.e. VRU 2N**)**. Structural classes that include the understory reinitiation stage and old forest are particularly suited for this type of system. **This condition would be similar to that resulting from the historic mixed severity fires that created medium sized patches as well as infrequent stand replacement events.** A combination of shelterwood preparatory cuts and shelterwood seed cuts would likely be used to develop multiple size classes. The former would thin the stand and focus more growth on selected crop/reserve trees, while the latter facilitates the development of a young cohort under the canopy of the reserves. Shelterwood cutting in variable unit sizes and density can be used to harvest and regenerate groups of trees, similar to a group selection method. This methodology has the additional benefit of providing shade on site, conserving soil moisture and providing favorable conditions for regenerating ponderosa pine and western larch. In this case, an overstory density of 30- 40 sq.ft. of basal area would provide conditions intended to secure regeneration that may be jeopardized due to moisture stress and solar exposure on south and west exposures. Additionally, shelterwood cutting may be desirable where a fully stocked even-aged stand is desirable to meet scenic objectives or special habitat needs for wildlife. Planting will often be necessary to assure regeneration, as naturals are the result of chance combination of good seed crops and favorable weather during the growing season. Although the ability to tolerate high temperatures and low soil moistures allows ponderosa pine to occupy sites not favorable to other species, seedling survival can be quite poor and sporadic. On the Kootenai, regeneration of ponderosa pine is typically assured through planting.

The use of clearcutting and seedtree methods should be assessed on a site-specific basis. They may be entirely appropriate for management of shade intolerant species where small openings are created or on north and easterly exposures. However, clearcutting and seedtree regeneration systems may be

incompatible as the site exposure results in an environment too severe for successful tree regeneration within desired time frames (KNF 1993).

Intermediate harvest methods such as improvement cuttings and thinning from below are very important components of landscape treatments where stand regeneration is not the intent and root disease is not a concern. For example, in forest conditions at an understory reinitiation stage **it may be desirable to remove excess trees, maintain a desired stocking level and open up growing space while maintaining the large overstory component.** The stocking level would vary with the site capabilities and the management objectives, but would likely not be reduced below 60 sq.ft. basal area. Following treatment, the stands would likely be variably spaced and contain a mix of diameter classes. These intermediate treatments are very useful in modifying species composition to favor ponderosa pine over Douglas-fir. It is expected that lodgepole pine would be removed during commercial thinning entries as well as some ponderosa pine in overstocked or pole sized stands. Sanitation cutting can also be used to remove undesirable trees while retaining a fully stocked manageable stand (min. 100 tpa). Precommercial thinning in the early stem exclusion stage can effectively reduce stocking and redistribute growing space to the desirable species in the stand. A variable spacing technique that executes a best tree selection has the best chance of creating the desired landscape structure.

Fire and Fuels Management - It is important that fire be restored and maintained as a process for change on the landscape. The use of **prescribed fire is recommended as a tool for periodic reduction in fuels as well as restoring and maintaining vegetative composition and structure.** For example, prescribed fire may be used in combination with thinning to reduce undesirable understory trees (e.g. Douglas-fir thickets), and prepare the site for maintaining ponderosa pine/western larch as seral species. In many cases, slashing of saplings in advance of burning would be done to minimize the anticipated radiant heat that could damage overstory trees. As duff accumulation around individual ponderosa pine trees is generally very high, there is a mortality risk to individual trees during prescribed burns. Where it is appropriate, spring burning would moderate this hazard and is generally preferred in order to retain adequate duff and woody debris. Spring burns on northerly aspects may not meet site preparation and/or fuel reduction objectives. The time of year to conduct burning will depend on resource objectives, fuels, weather, etc. Response of understory plants to burning will vary with their tolerance to disturbance, the season of burning, and the plant's post-fire regeneration strategy. The extent of duff reduction, mineral soil exposure, overstory crown scorch, and tree mortality that results from prescribed burning is dependent upon the resource objectives, the burning prescription, etc. These results are best predicted at the project level at which they are implemented.

It is important to maintain downed woody material (>3") at a level that would sustain frequent underburning. Approximately 5-9 tons/ac. is recommended (Graham et al. 1994) on DF/ninebark sites and 12-25 tons/ac. on the DF/pinegrass sites. This amount would include the contribution of standing dead as well as down woody fuels. These recommendations are not designed to immediately replace the present forest floor but to ensure their replacement over the next 100 years or more. This is particularly important on sites with light fuels and thin duff. While prescribed burning is desirable for a number of stated reasons, it often will result in an increased density of competitive shrubs and grasses, particularly ceanothus, mallow ninebark and pinegrass.

Reforestation and Species Management - Target stands should be composed of ponderosa pine and Douglas-fir on the drier, lower elevations and western larch, lodgepole pine and some ponderosa pine on the moist, upland sites. In rare cases, portions of the forest would have grand fir and western white pine as a minor component. Areas with root disease and dwarf mistletoe would emphasize ponderosa pine and western larch. Due to the absence of fire and past selective harvest of ponderosa pine, Douglas-fir is over represented within its natural range, and is at high risk to root disease. In general, ponderosa pine would be favored in planned management activities due to its fire-adaptiveness, resistance to drought, root disease and mistletoe.

Overall, it is expected that there would be a fairly balanced mix of shade intolerant species (PP,WL,LP) and mid tolerant species (DF) in stands managed through group selection and mostly shade intolerant species in stands managed through even-aged regeneration harvests. It is unlikely that Douglas-fir will be maintained in openings where prescribed fire is applied with any frequency. At a landscape perspective it is estimated that 40% of the species composition would be ponderosa pine, 50% western larch/Douglas-fir and 10% others. Silvicultural practices that leave a heavy overstory of live, reserve trees with little or no seedbed preparation will favor a continued shift towards Douglas-fir. Natural regeneration can be used if the genetic source of parent trees is known and represents a desired seed source. Planting in group selection openings and under the shelterwood may be desirable to meet desired stocking levels. Again, when featuring the regeneration of shade intolerant species, openings should be at least two acres or more.

Recommendations from ICBEMP indicate a desired level of shade intolerant species in each seral stage: 70-80% early seral, 65-75% mid seral, 60-75% mature/old forest multi-storied, and 85-95% in mature/old forest single storied. This wide representation of shade intolerant species throughout successional development reflects the desirability of this species composition in terms of fire tolerance, greater resistance to insects and pathogens, and consistency with historic ranges.

Stands within this VRU would represent habitat types that include Psme/Phma, Psme/Phma-Caru, Psme/Caru, Psme/Vaca, Psme/Phma-Phma, Psme/Syal-Caru and Psme/Libo-Caru. Soil moisture deficits, vegetation competition and solar insolation can limit regeneration success, particularly in VRU 2S. A reduction in stocking levels to mimic low severity fire regimes can cause increased vegetative competition as shrubs such as mallow ninebark respond following prescribed burns. The regeneration strategy of ponderosa pine and western larch relies on the availability of adequate cone crops and favorable site conditions. Stockability is estimated to vary from 70 to 90% on sites typical of this VRU.

Wildlife Needs - It is desirable to emphasize silvicultural treatments that would create or maintain a mosaic of stand conditions over the landscape in relative proportion to forest conditions that experienced natural disturbances. Within this vegetation response unit silvicultural systems that create multi-aged stand structures would be common and compatible with many wildlife objectives, although implementation strategies should recognize unique situations where even-aged conditions can be maintained in small patches.

Maintain key cover areas for dependent wildlife. Maintain wildlife travel corridors to provide a more continuous level of connectivity between habitat features. Forage conditions would be improved by increasing low intensity disturbances that open the understory to more light and rejuvenate browse species and grass.

Retain existing snags, broken-topped live trees, and down logs to provide habitat for a variety of wildlife species. Natural fires, root disease in Douglas-fir and periodic bark beetle mortality create conditions that provide cavity habitat and nesting sites for raptors. The reserve tree emphasis would be a landscape consideration rather than an individual stand basis. In addition, the retention of large diameter trees is important as snag replacements and seed sources. They represent a unique component of the VRU that typically survived nonlethal fire events.

Special Considerations - Retention and planting of native vegetation is emphasized to limit the spread of noxious weeds. However, if spotted knapweed is present, mechanical site disturbance may dramatically increase its spread. Understory vegetation is maintained through implementation of site preparation techniques that consider plant phenology. This vegetation response unit would benefit from the planting of nitrogen fixing plants.

Wetland areas are particularly rare in this VRU, but nonetheless important. These areas serve a special ecological function and should be sustained.

Maintain the health, vigor, stocking, species and age class diversity of vegetation by promoting a forest resilient to insect and pathogens. The long term health and productivity of this vegetative response unit can be insured by maintaining an endemic level of insect and pathogen activity. Management strategies recognize the beneficial role of insects and pathogens in ecosystem functioning. Ideally, a mosaic of age classes and species composition is desired. Single storied, second-growth stands of ponderosa pine are very susceptible to attack by bark beetles. Maintaining good vigor through stocking control can prolong the life of some stands. A basal area less than 120 sq.ft per acre has proven effective in reducing stand susceptibility in maturing stands where epidemic conditions have not yet occurred.

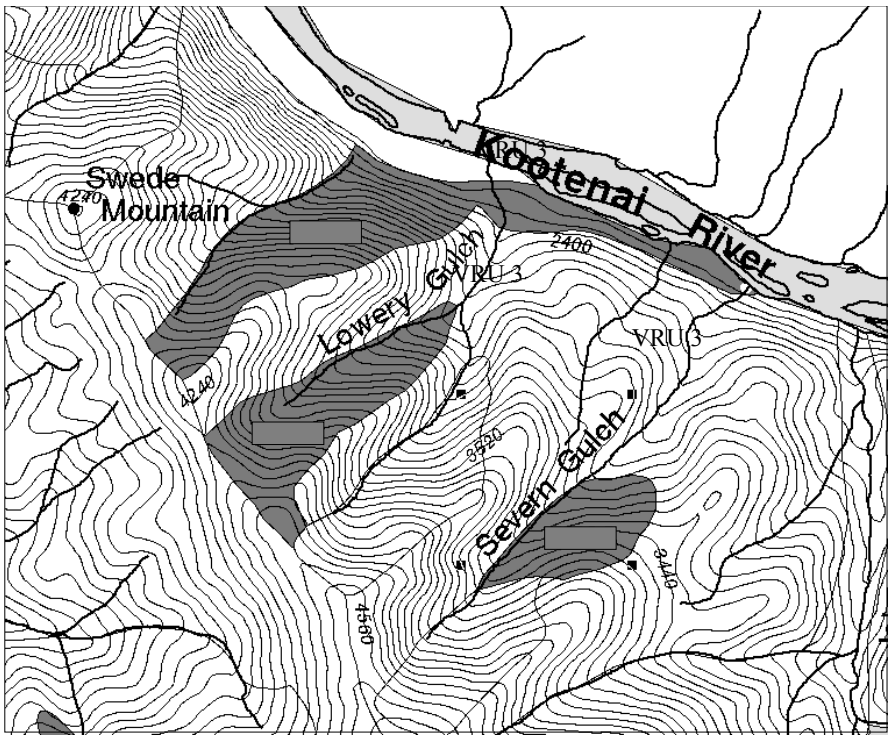
Silvicultural prescriptions should recognize that site productivity is only moderate as the nutrient holding capacity is inherently low and soils can be dry and relatively shallow. Soil compaction potential is low to moderate for the same reasons. Soil displacement can result in loss of site productivity as many sites have limited soil development and little to no loess deposits.

Vegetation Response Unit Description
VRU 3
Moderately Warm and Moderately Dry Habitat Setting

Ecosystem Setting and General Description

This vegetation response unit occupies a moderately warm and moderately dry habitat between the drier, warmer sites featuring the Douglas-fir series (VRU 1, VRU 2) and the warmer and more moist sites featuring western redcedar and hemlock (VRU 5). Being a transitional setting, this VRU includes characteristics of each. Often on moderately steep, northerly slopes and some lower valley sites, the elevation averages 3,800 feet but can range between 2,000 and 5,800 feet. Average precipitation is estimated to range from 18-30 inches, at least 70% of this is rain.

The habitat types classified within this group typically occur on the lower to mid-slope landtypes on benches and well drained slopes. Sites contain volcanic ash over glacial till or glacial outwash terraces covered by ash. Timber productivity is moderate to high as a result of loess deposits, a favorable moisture regime and a good growing season. The exception to this is where sites occur on ridge noses where loess is generally absent. Approximately 9% of the Forest is currently mapped as VRU 3 (see Map 3).



Map 3 - Typical Physical Setting for VRU 3

Vegetative Composition

Fire has been an important agent in shaping the species composition of this landscape. Characteristic low to moderate severity fires favor western larch and ponderosa pine over Douglas-fir. The less common severe fires favored the development of single species stands, especially lodgepole pine. Although characterized as a moderately warm and moderately dry grouping, this vegetation response unit contains a highly variable assemblage of habitat types (Table 5), reflective of its wide environmental distribution. The Douglas-fir habitat types and the Abgr/Libo habitat types represent the moderately cool and moist areas that transition between VRU 5 and the driest end of VRU 2. The Abgr/Xete habitat types represent cooler and drier conditions at the limit of the grand fir series. The Abgr/Clun-Xete habitat type is intermediate between warm Clun sites and the colder, drier Xete sites. The majority of habitat types within VRU 3 are from the grand fir series.

This VRU is likely near the climatic (cold) limit of ponderosa pine, where mixed stands give way to more pure stands of Douglas-fir. Also, fire history literature and modeling efforts (Keane et al. 1990) suggest that a 50 year average fire return interval is near the maximum that would allow the perpetuation of pine as a major stand component, when in competition with Douglas-fir. Across this gradient a mixture of tree species that include ponderosa pine, Douglas-fir, western larch, lodgepole pine and grand fir in both seral and climax stands is distributed. Douglas-fir is a major component of seral stands in all represented habitat types. Ponderosa pine is a major component in some Abgr/Libo-Libo habitat types (Steele 1994). Lodgepole pine is a major component in young stands of the Psme/Libo-Vagl habitat type (KNF 1993). With the exception of isolated cool sites, conditions in late summer are typically too hot and dry to support Engelmann spruce and western white pine.

This VRU has less of a maritime influence than VRU 4 which contains the Abgr/Clun types and a greater abundance of subalpine fir and spruce. The composition of western larch is relatively sporadic depending on frequency of fire disturbance, which favors its establishment and development. Grand fir is slow to establish and grow. It typically forms a subordinate layer to the seral species on the site.

Where disturbance has not recently occurred, dense thickets of Douglas-fir and grand fir occur in the understory. Ponderosa pine regeneration is generally absent under these circumstances. Associated understory plants include forbs such as beargrass, Oregongrape, false solomon's seal, western meadowrue, sweetscented bedstraw, showy aster, orange hawkweed, lupine, pussy-toes, and heart-leaf arnica. Shrubs include dwarf huckleberry, Rocky Mountain maple, common snowberry, twinflower, kinnikinnick, shiny-leaf spiraea, baldhip rose, western serviceberry, and *pachistima* (mountain-lover). Grasses include pinegrass and Columbia brome. The occurrence of any one of these plants varies from site to site, depending on the requirements of the vegetation and the environmental conditions.

Table 5 **- Habitat Types and Fire Groups within VRU 3**

Habitat Type Code	Habitat Type	Regional Habitat Group	Climatic Modifier	Fire Group Code MT	% of HG 3
290	Psme/Libo	HG 3	Mod Warm and Mod Dry	6	13
291	Psme/Libo-Syal	HG 3	Mod Warm and Mod Dry	6	12
293	Psme/Libo-Vagl	HG 3	Mod Warm and Mod Dry	6	4
510	Abgr/Xete	HG 3	Mod Warm and Mod Dry	11	17
511	Abgr/Xete-Cooc	HG 3	Mod Warm and Mod Dry	11	3
512	Abgr/Xete-Vagl	HG 3	Mod Warm and Mod Dry	6	4
515	Abgr/Vagl	HG 3	Mod Warm and Mod Dry	6	2
523	Abgr/Clun-Xete	HG 3	Mod Warm and Mod Dry	11	7
590	Abgr/Libo	HG 3	Mod Warm and Mod Dry	11	8
591	Abgr/Libo-Libo	HG 3	Mod Warm and Mod Dry	11	24
592	Abgr/Libo-Xete	HG 3	Mod Warm and Mod Dry	6	5

Disturbance Processes

Ecosystems are constantly changing in ways that are only partially predictable. Understanding the nature of ecological resiliency, stability and the impact of disturbance factors on sustainability is important to our land management efforts. Disturbance of one kind or another is a pervasive feature of forests (Perry 1994). Whether they occur from within an ecosystem (e.g. insect outbreak) or from outside it (e.g. fire, humans) these processes interact to influence the health of the forest. For example, weather influences susceptibility to insects, and insect infestation increases vulnerability to catastrophic fire. The disturbance regime is usually a complex mixture of infrequent, large events punctuated by frequent, smaller events. Although the following disturbance elements are presented individually they are not intended to be considered in isolation, but rather by their interconnectedness.

Fire Regime- The inland maritime climate that prevails on this Forest exerts a strong influence on forest development and the role of fire in this response unit. As very little of the Kootenai is categorized as VRU 3 it is important to recognize the complex nature of defining the fire regime for this transitional response unit. As displayed in Table 5, the habitat type groups that comprise this VRU include both Fire Group 6 and Fire Group 11. This is largely due to the variation in temperature and moisture across this VRU and the resultant diversity in fire regimes. The fire group is based on the response of tree species to fire and the roles they play in forest succession (Fisher and Bradley 1987).

The historic fire regime of a given ecosystem can be characterized by the average fire frequency, fire severity, and fire size (Perry 1994). **This vegetation response unit has been shaped by a combination of fire regimes, mainly low to moderate intensity fires.** Moist upland sites containing mixed species and pure lodgepole pine stands experienced a high percentage of stand replacement fires. This is attributed to many factors that include higher humidities leading to longer fire return intervals, higher stocking levels, drought and heavy fuels. This fire regime is very similar to that described for VRU 2N except that stand replacement fires were more common and resulted in larger openings due to higher stocking levels and increased fuel loadings in this vegetation response unit.

The fire free interval for low severity, **nonlethal underburning** is estimated at 25-50 years. On these drier, more open sites numerous fire-resistant western larch, Douglas-fir, and ponderosa pine remain following these events. Fire scar sampling data from the Meadow Creek landscape assessment (KNF 1997) suggest a mean fire return interval of 31 years for nonlethal fires. An exception is demonstrated in research in Abgr/Libo on the Bitterroot NF (Arno 1995) show a mean interval of 13 years, maintaining a long lived and multi-aged overstory of ponderosa pine, despite competition from grand fir and Douglas-fir. This frequent fire regime reduced fuels more often and reduced the site susceptibility to fire regimes of a higher intensity. Low intensity, frequent surface fires were an important agent in controlling species composition and density, particularly at low elevations and on southerly aspects.

Moderate severity**, mixed lethal fires** occurred at mid to upper elevations on north slopes every 70 to 250 years on cool and wet sites and every 30 years on warm and moist sites. Losensky found that where lodgepole pine dominated stands, these fires occurred on the average of 77 years. The greater likelihood of mixed severity fires burning on moist sites is perhaps because the drier sites (having nonlethal fires) are receptive to burning for a longer time period each year. The nature of these moderate severity fires resulted in large canopy gaps and mosaic conditions that included patches of even-aged stands, with surviving groups and individual trees. Multiple age classes also resulted, as the tendency of these mixed severity fires was to underburn trees as well as to flare up and torch out crowns. The presence of western larch is a good indicator of a moderate severity fire regime that occasionally opens up enough growing space for larch establishment.

Stand replacing fires were patchy and occurred within the range of 100 to 250 years in varying environmental conditions, but primarily in cool/wet sites and warm/moist sites. Often, these fires originated in overstocked stand conditions or draws with heavy fuels due to long fire-free intervals. Also, dense understory trees create a fuel ladder that often carries fire up into the crowns and through the stand. Fires occurring on steep slopes or wind prone areas can contribute to this occurrence. Following lethal fires, the vegetative conditions often result in a nonuniform distribution of even-aged stands containing scattered overstory western larch and Douglas-fir. Historic vegetation research (Arno et al. 1995) in a Abgr/Libo site on the Bitterroot NF did not indicate a

stand replacement fire having occurred in the last few centuries. This may be attributed to the gentle topography and evidence of frequent low to moderate intensity fires which minimize fuel accumulations.

Fuels and Nutrient Cycling - Fuel loadings are highly variable due to the wide range of fire return intervals and forest types within this response unit. Much of the downed fuels results from insect and disease caused mortality, accumulated deadfall, periodic natural thinning, and blowdown. The amount, distribution and flammability of these fuels largely determines the severity of fire. Dead woody material on the ground serves a number of ecological functions that include: protecting the soil from surface erosion, a site for nitrogen fixation, storage for energy and some nutrients. Ideal moisture conditions make downed material a favorable microsite for the growth of young trees, as well.

Research by Losensky (1993) in grand fir types of Idaho estimated historic fuel loadings of 13-30 tons per acre in Fire Group 6. Other studies (Fisher and Bradley 1987) display quite a range but averaged 14 tons per acre. While there is considerable variation, the tendency of habitat types within this group to be overstocked and contain understory thickets results in high hazard fuel conditions in many cases.
In Fire Group 11, fuel loadings were estimated to average 25 tons per acre in both studies. Despite the relatively high fuel loadings, fire hazard in group 11 is normally low to moderate, under normal conditions, due to fairly high humidity on the moist sites.

The nutrient cycle occupies a key position in ecosystem processes and can be directly affected by disturbances, both natural and human-caused. Dense thickets of fire intolerant grand fir and Douglas-fir are susceptible to fast moving crown fires, which can reduce the longevity and function of coarse woody debris (Dumroese, pers. comm). The dense, nutrient rich crowns are ideal settings for lethal fires to occur, with resultant mortality and nutrient loss. Where heavy residual fuels remain, second burns can occur and lead to soil damaging results. Natural decomposition rates are higher in this VRU due to the increased site moisture.

Insects and Disease - Disturbance caused by insects and disease occur almost everywhere and to varying degrees. This is largely due to the nonuniformity of tree distributions and the sites containing host species. Indigenous pathogens certainly are natural and necessary and perform important functions in natural ecosystems (Hagle 1993a). Management efforts intended to suppress disturbance from insects and disease have the potential to reduce biodiversity and ecosystem health. Our perception and acceptance of this role has changed in recent years with an acknowledgment that endemic levels of insects and disease are a desirable level to manage for.

Some insects and pathogens may attack only healthy host trees. Others affect only host trees that have been weakened by stress from some other disturbance. Stress induced pathogens eventually kill these weakened trees, thereby releasing growing space and nutrients to the replacement vegetation. Drought prone areas not only are more susceptible to root disease but are also prone to Douglas-fir beetle outbreaks. Mature patches of lodgepole pine are also a primary host for bark beetles, particularly where they are low in vigor. Endemic levels of dwarf mistletoe commonly appear in stands containing scattered, large diameter western larch and Douglas-fir.

While Douglas-fir survived frequent fires, they often did not attain great longevity, perhaps as a result of decay hastened by fire injury (Arno et al. 1995). Also, resin deposits often contribute to the

enlargement of old fire scars during subsequent fires (Fisher and Bradley 1987). Where grand fir survive the effects of fire, they typically have severe heart rot that has entered through fire scars.

In some cases, the conditions brought about by human influence are having undesirable effects. For example, fire exclusion has increased stocking levels and shifted some areas to more Douglas-fir and grand fir which favors root disease. This condition can also exacerbate mortality from the fir engraver beetle in grand fir. In some areas, previous harvest entries have caused basal wounding in residual trees resulting in an increased level of heart rot in mature grand fir, western larch and, to a lesser extent, Douglas-fir.

Weather - The key determinant of fire severity is probably weather (Johnson and Larsen 1991). In particular, droughts set the stage for small fires to become large ones. Historic records confirm this by noting that the most extensive fires in North American forests occur during dry periods (Clark 1988). The most severe drought occurs in areas with low winter and spring rainfall. Occasional east winds may cause a drying trend and in fire season lead to critical burning conditions (Barrett 1995).

Wind can be a major force in this vegetation response unit, creating gaps of various sizes by blowing down trees that are adjacent to existing openings or currently affected by root disease. February and March are the two months that have the most distinct possibility of wind damage on the Kootenai. The susceptibility to blowdown has a lot to do with crown support of adjacent trees, as this influences the amount of crown sway.

Occasional thunderstorms occur during the summer, accompanying late afternoon convection buildups. These storms can bring sporadic and intense rain or simply dry lightning. The latter storm type is a significant hazard causing at least 70% of the forest fires on the Kootenai. Stream runoff peaks in the spring, with rapid snowmelt from mountain watersheds. When snowmelt coincides with the high spring runoff, floods may occur as stream banks are full. Many areas of the forest have also experienced damaging floods resulting from heavy rains falling on a snowpack. In addition, some areas become prone to blowdown following rain on snow events when soils are supersaturated and tree roots are not secure.

At a different level, cold air drainage in narrow mountain valleys leads to dew formation during the night in areas where cold air pools. The influence of this microclimate can be important in reducing transpiration stress and in helping seedling survival on flat ground. However, the same conditions can cause frost related regeneration problems. While Douglas-fir is particularly vulnerable to foliar damage from frost, lodgepole pine is considered one of the most frost hardy species.

Successional Pathways

Vegetation that exists following a fire is largely dependent on the severity of the event, the vegetation that existed prior to the disturbance, the seed stored on the site, survival of seed trees, and the degree that natural regeneration is successful. While the nature of fire is important to plant community establishment, these accompanying factors are largely responsible for post-fire succession. The diagram below (Figure 3) represents a conceptual basis for illustrating the successional trends that are described for Fire Group 6 (Fisher and Bradley 1987). Different scenarios are inevitable and include conditions where ponderosa pine and western larch are seral

dominants, where Douglas-fir is a seral dominant throughout succession, and where lodgepole pine and Douglas-fir are co-dominant serals.

In the event that a severe, stand replacing fire occurs in a hypothetical stand in this VRU, a mix of shrubs, forbs, and grass establish on the site. In time, seral species such as western larch, lodgepole pine, ponderosa pine and Douglas-fir become established as a single cohort. Relic overstory trees are scattered throughout the landscape. Low intensity fires that occur during early seral stages can act as a thinning agent, in many cases converting overstocked stands of pole size and larger trees to a more open condition. Intermediate sized western larch, Douglas-fir and ponderosa pine are usually favored in these circumstances. Ponderosa pine is a bit more fire-resistant than larch at this point. Lodgepole pine and Douglas-fir may be significantly reduced or eliminated if they in are densely stocked conditions. These maintenance fires 'prune' lower tree branches, reduce understory competition and rejuvenate browse and forage plants. A long interval between underburns will allow a tall understory to develop, which has a high probability of crowning (Davis et al. 1980).

Although the growth of residual Douglas-fir and lodgepole pine can be significantly reduced for at least two years after wildfire (Peterson 1991), it is possible that the thinning effect of the maintenance fires will eventually increase growth on the residual trees (Oliver and Larson 1990). Where fire has access to the canopy, heavily stocked pole-sized stands have a high crown fire potential (Davis et al. 1980). A high intensity fire will kill almost all trees in this mid-seral development stage. This could result in a shift back to the herb/shrub phase or facilitate the development of dog-hair lodgepole pine stands from serotinous cones. If an area experiences a double burn within a relatively short interval, the site may revert to a brushfield. Neither western larch or lodgepole pine will likely survive such fires in the pole stage.

Mature**,** mixed species stands that experience fires of low to moderate intensity are naturally thinned, favoring western larch and ponderosa pine, with patches of other species where fires are less intense or excluded. In the larger diameter classes, western larch exhibits greater fire resistance than ponderosa pine. In studies that monitored growth response following prescribed underburning (Reinhart and Ryan 1988), individual tree growth was not reduced despite some fire damage. However, overall stand growth was reduced as projected growth was distributed among fewer, larger trees. If the overstory remains relatively intact following a fire, the new cohort will develop as predominantly shade-tolerant species, including grand fir (Larson 1982). This understory reinitiation begins the formation of a multi-aged structure, characteristic after low to moderate severity fires and/or the break-up of overstory canopies. In the unlikely event that Douglas-fir is of both the climax species and the dominant seral, frequent low to moderate intensity fire can maintain these conditions by cleaning out competing open understories.

If these mature stands experience a lethal fire, tree mortality is very high and the vegetative conditions are replaced by early successional plants and scattered overstory relics, individually or in clumps. Western larch has light winged seeds, which can easily blow onto a burned site from adjacent stands or from lightly scorched cones in the fire-killed stands. If present on the site, lodgepole pine will develop from serotinous cones in the area. Often, lodgepole pine will dominate under these conditions, particularly towards the center of large burns (Cooper 1991). Both lodgepole pine and western larch have exceptionally fast juvenile height growth and, along with other species developing at the same time, create different strata over time.

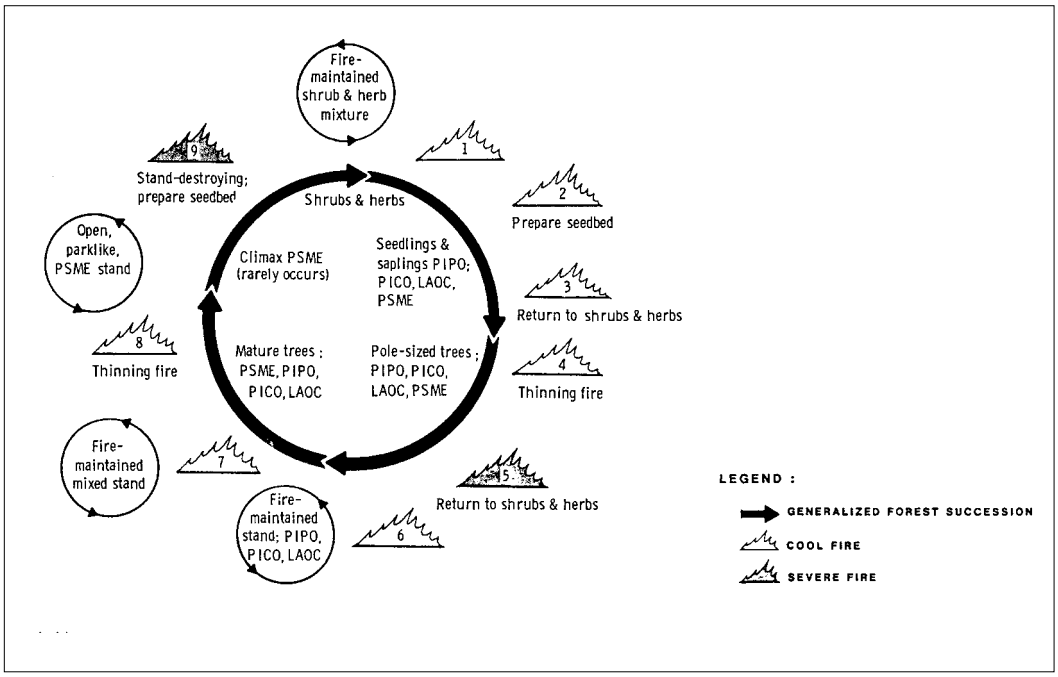


Figure 3 - Generalized Forest Succession in Fire Group 6

Vegetative Structure

Landscape structure is essentially formed by an arrangement of patches, corridors and everything in between (matrix). How the landscape functions has a lot to do with the nature of disturbance, successional development of landscape structure, and the flow of energy and nutrients through these landscape structures. The size and distribution of a particular habitat is very important in consideration of species richness, for example. The actual historic patch size is not well known but would vary from small openings to larger, even-aged patches resulting from mixed lethal to lethal burns. Underburning likely occurred across large expanses of open, park-like areas. Investigations following the 1994 fire season (KNF 1994) estimate patch size at somewhere between 5 and 50 acres for commonly occurring nonlethal and mixed severity fires. Research in Bristow Creek indicate an historic patch size of 20-200 acres. Vegetative diversity would likely be inherently high given the amount of edge represented by relatively small openings and their irregular shape.

This response unit is a mix of open stands, brushfields, well stocked mixed conifer and dense lodgepole pine stands. These forest conditions are the result of primarily low to moderate intensity wildfires that left varying amounts of fire-tolerant overstory trees throughout the landscape. The open stands of Douglas-fir, western larch and ponderosa were historically maintained by underburning which tended to clean out the understory. Multi-storied conditions were generally maintained by the mixed lethal fires which facilitated the development of an all-aged condition. Patches of even-aged, single storied stands were also the product of moderate intensity fires that created medium sized canopy gaps. These forest structures and fire regimes occurred mostly in the drier portions of this landscape.

On the more moist sites, where fire return intervals were longer, periodic lethal fires also occurred. These large scale crown fires occurred under varying conditions that included dense understory thickets, root disease pockets, following bark beetle infestations and reburns. This fire intensity

resulted in most trees killed and the development of essentially even-aged and single storied stands. The extensive areas of lodgepole pine are largely attributed to this fire regime. Within these intense burn areas, it is conceivable that islands of unburned trees remained.

Historic stand structures varied but were an average density of 80-120 sq.ft. of basal area (Steele 1994), and likely higher in riparian areas. Tree densities varied from 15-30 tpa, where ponderosa pine overstory was prevalent to as much 60 tpa in the cooler, more moist habitat types. Fire history research on the Bitterroot NF (Arno et al. 1995) indicate that vegetative conditions around 1900 in the Abgr/Libo habitat types was multi-aged, represented by a very broad distribution across most age classes, averaging 90 sq.ft. of basal area. Ponderosa pine occurred in all size classes (approximately 40 tpa), dominating the diameter classes above 17 inches. Douglas-fir and grand fir (approximately 15-20 tpa) were exclusively in the small and medium size classes as intermediate and co-dominant crown classes. This research shows a stark contrast with conditions in 1993 that have a stocking level of 135 sq.ft. of basal area, in Douglas-fir and grand fir trees less than 11 inches in diameter (>250 tpa), as well as most of the original overstory of ponderosa pine. Recent conditions also display that Douglas-fir is aggressively moving into the mid-seral class that ponderosa pine dominated in the historic scenario. The absence of Douglas-fir in larger size classes may be attributed to mortality from root disease or bark beetles.

Age Class Diversity

Age class proportions represent successional stages that vary in their distribution through time, depending on the disturbance mechanisms. Each successional stage provides distinct ecological conditions that fulfill the requirements of many terrestrial species. Age class distributions are but one of many important landscape attributes that provide the framework for developing desired future vegetative conditions. In the Forest Plan (KNF 1987) the management direction in this regard was to maintain diverse age classes of vegetation for viable populations of all existing native, vertebrate wildlife species. These forestwide goals also direct that we maintain old growth timber (habitat) in sufficient quality and quantity to maintain viable populations of old growth dependent species and to maintain habitat diversity representative of existing conditions. The future forest envisioned in this direction was a broad distribution of age classes, evenly distributed throughout the forest.

Table 6: **Age Class Distribution**

Age Class	Pre-1900 Condition	Existing Condition
0-40	15-25%	25%
41-100	20-40%	40%
101-150	15-35%	23%
150+	15-40%	12%
nonstocked	5-10%	0%

Table 6 provides an estimate of historic **(pre-1900)** age class proportions for this landscape setting. It is based on forest conditions predicted from modeling age class proportions that would result from the average stand replacement interval in VRU 3. Research by Losensky and Lesica are too broad to apply to this particular vegetation response unit. While broader in scope, findings from ICBEMP,

applicable to the dry end of the grand fir habitat types, indicates an historic seral stage distribution of 10-20% early seral forest conditions, 30-40% mid seral, 10-20% multi-storied mature and old forest and 20-30% single storied mature and old forest. This study estimated that up to 15% of this group may be in nonstocked openings.

The existing condition information in Table 6 is based on stand year of origin data for Habitat Group 3 taken from the Timber Stand Management Record System (TSMRS). Approximately 7% of the stands in this grouping do not have complete inventory information and are not represented in this age class distribution.

Ecological Function and Habitat Features

This vegetation response unit is a transition between the relatively open landscape of the warm, drier environments (i.e. VRU 2) containing dispersed openings and mosaic conditions, and the cooler moist sites (i.e. VRU 5) with contiguous areas of dense, similarly structured stands. This habitat diversity is important to many wildlife species who utilize this area for a variety of functions, including cover and browse. These habitat features contribute to the biological diversity of the landscape as a whole.

Landscape Linkages - Adjacent riparian areas provide a valuable forested linkage between different types of habitat. Wildlife may seasonally use these areas as cover between unforested areas and also as sources of food and water. Overall, the forest composition in this landscape provides suitable connectivity for many wildlife species such as wolves, grizzly bear, lynx, fisher and wolverin**e.**

Old Growth and Interior Habitat - Structural diversity varies from low in commonly occurring single layered forest conditions to moderate in multi-storied stands. Both conditions occur and are controlled by fire, site conditions and seed source. Stands with old growth characteristics are not evenly distributed in this VRU and make up a very small portion of the functional old growth habitat across the Kootenai.
Long fire-free interval on these moist sites enable the old growth conditions to persist. The exception is sites with predominantly lodgepole pine, a seral species. The commonly occurring large, even-aged patches do function as interior habitat and provide habitat for neo-tropical migratory birds, big game security and travel for many species.

Wildlife Habitat - Big game use is high as this habitat generally provides excellent cover. Openings within this habitat are generally small and hiding cover is provided by shrub thickets and the overall density of the trees. Thermal cover is well distributed in much of these dense, mixed conifer and lodgepole pine stands.

This response unit is important summer range for bighorn sheep, elk, whitetail and mule deer. Some winter range occurs on the low elevation areas and open ridges of this landscape where solar exposure is higher. Forage areas vary from gaps in the canopy to larger, natural openings that may border riparian areas or meadows. Vegetation that is important wildlife forage occurs in this VRU. Oregongrape has a high protein content and is valuable winter forage for whitetail deer. Bears and other wildlife eat the berries as well. The leaves and twigs of the Rocky Mountain maple are important winter food for big game. Small mammals eat the seeds, buds and flowers. Huckleberry is an important early summer browse for elk, mule deer and whitetail. Bears consume the berries, an important food source. The abundance of common snowberry provides an important food source for

wildlife, particularly by deer in the summer and fall. Elk have been known to utilize this where little else is available. *Pachistima* (mountain-lover) is considered to be an important forage for elk, deer and moose although palatability and nutritional value is low. Heart-Leaf arnica is an important browse for elk. The flowers are preferred by some ungulates.

Some of the drier portions of this VRU, that often function as winter range, contain browse such as pinegrass which is an early growing season forage for deer, elk and black bear. Elk sedge is important forage for elk during the spring and summer. During the winter and early spring elk, bighorn sheep, moose and deer utilize western serviceberry. The berries of kinnikinnick are important to bears in spring and fall. The plant is moderately important winter browse for mule deer, elk, bighorn sheep and moose. When other forage is not available, is utilized year-round by deer and elk. Both grizzly and black bear eat the berries. Where fires occur, they have an effect on wildlife habitat by opening up stands, reducing understory competition and rejuvenating plants to increase availability of palatable browse.

Snag levels vary from low in areas regenerating, to a single age class following stand replacement fires, to fairly high where mixed-severity fires retain diverse structural components. Dead trees are used for feeding, nesting, roosting and resting depending on their physical characteristics. Snags provide a lifeline for many plants, birds, mammals, and invertebrates. Black-backed woodpecker occupy mixed conifer, grand fir and lodgepole pine stands for reproduction and feeding purposes. The abundance of western larch, Douglas-fir and ponderosa pine in most areas provides reasonable habitat options for cavity-dependent species.

Dead trees or portions of trees lying on the forest floor perform a variety of functions. For example, woodpeckers eat insects that inhabit downed logs, and mammals use logs for foraging, cover and reproduction. In general, this VRU provides moderate habitat for small vertebrate animals, reptiles, amphibians, and invertebrates. Fairly low levels of downed trees and woody debris exist due to the nature of this fire regime. However, dense shrub thickets, draws, and heavily treed areas provide small mammal habitat as well. During fire-free intervals or following incidents of tree mortality higher levels of habitat suitability exist. Blowdown does occur but is not as significant as neighboring landscapes with shallow soils or in settings more susceptible to windthrow.

Rare Elements and Specialized Habitat - Diversity and uniqueness of this landscape varies but is generally low in areas of primarily single storied and even-aged stands. These contiguous areas offer refuge for some species of wildlife such as owls and bears. Specialized habitat may also be present where unique vegetation occurs within springs, wallows and nonforest natural openings. For example, some areas may be very suitable as prime calving and fawning habitat. They are usually located on gentle topography containing hiding cover and forage within a reasonable distance to water.

Silvicultural Importance - As previously described, this vegetation response unit is an important transitional landscape between very different habitats. It is dry enough to support ponderosa pine and yet mesic enough for western larch and Douglas-fir. Where moisture levels permit successful establishment, growth and development of grand fir seedlings, the Douglas-fir/western larch cover type transitions into the grand fir zone. Given adequate moisture, grand fir actually has greater competitive ability than does Douglas-fir (Barrett 1995).

For the most part, the absence of dense understories results in reduced fire hazard, even in well-stocked stands (Fisher and Bradley 1987). However, these moist sites can support a dense stocking

of overstory trees with low-lying dead branches and the potential for crown fires does exist. Fire's role in preparing an adequate seedbed is slightly different in this landscape as Douglas-fir is not dependent on mineral soil for successful regeneration. The persistence of Douglas-fir can be managed through prescribed fire by reducing its understory stocking, opening up the stand and creating conditions favoring the establishment of western larch and ponderosa pine.

Ecosystem Health, General Trends and Management Implications

Fire exclusion and some forms of vegetation management have resulted in a general shift from primarily species tolerant of a fire-adapted ecosystem to a greater proportion of fire-intolerant species. Interruption of the natural fire cycle has also created higher stocking levels and homogenous high fuel conditions across much of the landscape. Historically, this condition was primarily associated with cool and moist areas, canyons, north slopes and other protected refugia. This condition is leading to a change from predominantly stand maintenance fires of low through moderate intensity to more frequent occurrences of stand replacement fires of high intensity. The shift to less controllable fire regimes is not only more dangerous and costly to suppress, but is potentially more damaging to the ecosystem. As this vegetation response unit is often in a lower elevation setting, this concern is elevated in the urban interface where people and homes are at greater risk.

Both fire exclusion and selective removal of overstory fire resistant trees have advanced succession and resulted in increased understory and stand basal area density. This condition has also reduced nutrient availability to the site, as the levels of carbon and nutrients tied up in woody material are higher in recent decades. In places, this is resulting in reduced growth and declining vigor of many forest areas. Without prescribed fire and fuels management, loss of ponderosa pine from this VRU is virtually assured due to successional replacement.

Suppression of fires and a resulting shift in species composition can also result in serious insect and disease problems. On the dry end of this VRU many ponderosa pine types have converted to fire intolerant thickets of Douglas-fir. This change in forest structure creates conditions whereby Douglas-fir is more susceptible to western spruce budworm, which can cause severe defoliation and mortality. Infection and tree mortality from root disease and dwarf mistletoe is also a concern. On sites where fire-resistant species are being replaced by shallow-rooted, thin-barked species there is the potential for a large loss of shallow fine roots following a surface fire. This increases the susceptibility to stress and direct entry of root and stem pathogens. Fire-resistant species have lower susceptibility to long term soil damage from fire as roots are deep and bark is thick. As much of this VRU has a lodgepole pine component, high levels of mountain pine beetle infestation may be partially attributed to the reduction in mixed lethal fires.

As described, higher stocking levels and greater incidence of tree mortality and decadence have lead to higher fuel loadings and increased ladder fuels, in many instances. The consequences of a change from surface to crown fires may lead to reduction in site quality and species composition that may last for many decades (Monnig and Byler 1992). Higher intensity fires have a high potential for soil heating, death of tree roots with subsequent tree and shrub mortality. Many changes occur to soil organisms as a result of fire. The higher the intensity, the more damaging the effect (Kuennen 1994). These effects can be beneficial and/or detrimental, depending on the intensity and duration. Reburns can create reduced plant reproductivity and vigor by altering mycorrhizae, microbes and invertebrates contained within the soil.

In general, the present age class proportions appears to be fairly consistent with historical conditions, although the desired distribution and location on the landscape may not. The exception appears to be a greater amount of early seral stands today. Historically much of the landscape would have been comprised of more ages of trees and a less homogenous distribution. Some areas of native grasslands, shrublands, and old forest conditions have declined in total area and shifted in distribution since historic times. Many native species of fungi, lichen, plants, invertebrates, and vertebrates are associated with these types. Overall species richness is likely to be similar to historic conditions, although the relative proportions would differ. Presently, encroaching understory trees may be outcompeting other vegetation for light, water, and nutrients. An increase in human activities has facilitated the establishment of nonnative plants.

Some of the managed plantations are experiencing damage from bears and squirrels, particularly in western larch. Research findings have not sufficiently addressed this problem to enable a comparison of existing animal damage in managed forests with that of early seral stands that result from natural fires.

Desired Landscape Conditions and Silvicultural Strategies

The following habitat conditions are described as **options** for vegetation managers to **consider** in prescribing silvicultural treatments to shift the landscape within this vegetation response unit towards a more desirable and sustainable condition. The landscape attributes described are achievable under average conditions and are based on applied research, ICBEMP scientific findings (USDA 1996) and experience with local forest conditions. While there is considerable information presented on historic forest conditions, the emphasis is placed on sustaining the biological processes that produce these conditions. It should be noted that the extent and scale of vegetation management is dependent on project-level resource objectives with consideration of historic patch size.

Landscape Attributes - **Management activities conducted in VRU 3 can create and maintain forest conditions intended to compliment the processes and results of frequent low to moderate intensity ground fires, and occasional stand replacement events.** A mosaic of stocking levels, age class distribution and species composition would exist representing varied structural attributes. VRU 3 would likely appear as a mix of open stands with large diameter overstory, and well stocked stands of mixed conifer and lodgepole pine.

On low elevation south slopes, management activities can create and maintain a nonuniform, relatively open community of mature western larch, Douglas-fir, and ponderosa pine. Largely single storied and multi-aged, these conditions would be sustained through prescribed fire and timber

harvest at frequencies **consistent with nonlethal, low severity burns** within the range of the historic fire return intervals. Other stand structures would be featured to a lesser extent depending on topography and resource objectives. Stocking levels would generally be maintained at lower levels than presently exist, due to reduced understory composition.

On mid to upper elevation north slopes it would be desirable to **create small openings** (<5 to 10 ac.) **within a large treatment area** (50-200 ac.). These irregularly shaped areas are designed to **emulate the moderate intensity, mixed-lethal fires** that created large canopy gaps within Douglas-fir thickets and other moist mixed conifer types that establish during fire-free periods. Overstory trees become susceptible to stand-destroying crown fires when such situations develop. Management activities would aim to retain a mosaic of conditions including even-aged patches and multi-aged stands with mixed species composition (WL,DF,GF,LP). Reserve trees would exist in groups and as individuals. These small openings would create an element of edge that would be beneficial to some wildlife species. Openings also support the grass, forbs, and shrubs that are largely absent under canopy cover. Treatment areas are expected to be sufficiently large enough for successful germination and development of western larch seedlings.

It may be desirable on some of the more productive sites to create larger treatment areas that accelerate the development of early seral stands. Conditions that may be suitable for regeneration harvest include stands that have a high degree of decadence or disease, overstocked with undesirable species, etc. Intended to be patchy and nonuniform (50-100 acres) in distribution, **these conditions would be similar to that created by stand replacement fires.** Managed stand structures would largely be single storied in lodgepole pine and two storied in mixed conifer. While existing conditions don't always offer the opportunity to leave a variety of species that other treatments do, retaining scattered Douglas-fir and western larch overstory is usually an option. Rotation lengths could vary from 100 to 250 years depending on featured species and overarching objectives.

Within VRU 3 it may be desirable in some riparian areas and open ridges to **defer** harvest treatments based on the need to manage for interior habitat. These are site specific considerations that require additional evaluation.

A variety of successional stages should be represented across the landscape, managed in proportions relative to the historic range of seral and climax tree species. The recommendations described below are based on a consolidation of desired attributes from district landscape assessments correlated with research of historic vegetation and ICBEMP scientific findings (USDA 1996). The desire to include this landscape attribute in describing future conditions is also consistent with forest plan direction to maintain diverse age classes in order to sustain habitat diversity for a variety of terrestrial species. Within this response unit, strive to maintain 15-25% early seral, 20-40% mid seral, 15-35% mature, and 15-40% late seral. Natural openings that are currently nonstocked with trees would very likely be a part of this landscape setting as well. These percentages would be dynamic and represent averages that vary by the scale of their application, as do successional pathways. Relatively open, single storied, late seral conditions would be expected on ridgelines. Multi-storied late seral conditions would be more easily managed on gentle slopes and riparian areas.

Silvicultural Systems - All even-aged silvicultural systems are feasible to apply in VRU 3. However, the resulting vegetative conditions will vary with the degree that desired landscape objectives are met. Shelterwood cutting may be particularly beneficial where objectives such as site protection, scenic quality, and/or special wildlife habitat needs are desirable. **Uniform shelterwood harvest**

methods are appropriate on low elevation, south slopes that favor the creation of small canopy gaps with a relatively open understory. This methodology **simulates nonlethal underburns** and has the additional benefit of providing shade on site, conserving soil moisture and providing favorable conditions for regenerating ponderosa pine and western larch. Planting will often be necessary to assure regeneration, as naturals are the result of chance combination of good seed crops and favorable weather during the growing season.

On mid to upper elevation sites, a group shelterwood may be used to feature small groups of reproduction surrounded by shelterwood 'strips'. These larger canopy gaps are desirable to regenerate stands or patches like those from mixed severity burns. Patch clearcuts can be used to achieve a similar purpose depending on the scale. An **irregular shelterwood method** may be initiated to maintain two age classes in a less uniform distribution with the idea of retaining the overstory longer. Although maintained under the competition of overstory trees, this variation would create a broader age distribution in the understory. A seedtree with reserves would have similar effectiveness with fewer overstory trees. Structural classes that include the understory reinitiation stage and old forest are particularly suited to this type of system. Conditions that may warrant these regeneration harvest methods include poor stand health, insects and disease concerns, etc.

On moderate to high productivity upland sites, where it is desirable to replace stand conditions with a stand initiation structural stage, clearcut/seedtree with reserves regeneration harvest may be entirely appropriate. The location of the treatment areas would be less uniform and more patchy in distribution than existing regeneration harvest units, which have generally been located in homogenous blocks across the landscape. Some uniform lodgepole pine stands may be uniquely suited for replacement with a mixed composition of conifer species. Many of the moist, upland sites in VRU 3 experience a longer fire return interval, which is conducive to development of species less adapted to frequent fires.

Uneven-aged systems such as group selection are useful where site protection is desirable and are biologically sound alternatives to systems that manage for even-aged stand structure. Group selection could be used in areas **designed to be consistent with a mixed lethal fire severity regim**e which killed individuals and groups of trees, and created a mosaic of age and size classes. This silvicultural system is useful where even-aged conditions exist but additional age classes and storied conditions may be desired. In contrast, applying individual tree selection would likely result in reduced genetic quality and potentially increase the level of root and stem diseases. Individual tree selection is generally not recommended in these habitat types as it is counter to natural processes that would have reduced the stocking and development of Douglas-fir and grand fir. There could be exceptions where drier sites occur as intrusions within this VRU and contain a higher proportion of seral species. Unless used in combination with other treatments, individual tree selection would not create large enough canopy gaps to successfully regenerate western larch, a very important component of this landscape. Managers need to acknowledge the higher cost of managing uneven-aged stand structures due to repeated entries, low volume removal, and increased fuels management cost.

Intermediate treatments such as sanitation/salvage, improvement and thinning remain as viable options for managing forest conditions where root disease is not a concern and stand replacement is not the desired result. Sanitation/salvage cutting is recommended where removal of dead, damaged or high risk trees is undertaken to improve stand health, recover value and maintain a stocked stand. It is not a means of reducing root disease activity on a site unless the trees left or regenerated on the site are root disease tolerant species. As this VRU has a great deal of grand fir and Douglas-fir, salvage cutting may often not be feasible. In addition, thinning from below is

recommended where understory development is undesirable and a large diameter fire resistant overstory is being maintained through prescribed burning. For example, in forest conditions at an understory reinitiation stage it may be desirable to remove excess trees, maintain a desired stocking level and open up growing space while maintaining the large overstory component. The stocking level would vary with the site capabilities and the management objectives, but would likely not be reduced below 80 sq.ft. basal area. Following treatment, the stands would likely be variably spaced and contain a mix of diameter classes. These intermediate treatments are very useful in modifying species composition to favor ponderosa pine and western larch over Douglas-fir. It is expected that lodgepole pine would be removed during commercial thinning entries as well as some ponderosa pine in overstocked or pole sized stands. Sanitation cutting can also be used to remove undesirable trees while retaining a fully stocked manageable stand. Precommercial thinning in the early stem exclusion stage can effectively reduce stocking and redistribute growing space to the desirable species in the stand. A variable spacing technique that executes a best tree selection has the best chance of creating the desired landscape structure.

It is anticipated that desired landscape objectives will be executed within individual stands and groups of stands. Vegetative treatments will vary, depending on the current vegetation conditions and whether or not they meet desired objectives. Where and when vegetation management is desirable, a cross section of silvicultural systems would undoubtedly be used to create the forest structures that are prescribed. In fact, if a skilled marking crew is given specific guidelines that include key elements to assess, landscape level objectives can be executed using a variety of treatments.

Fire and Fuels Management - **It is desirable to restore fire to its important ecological role. The use of fire is recommended as a tool for restoring and maintaining vegetative composition and structure. It is also prescribed as a primary means of managing fuels with or without accompanying tree harvest.** For example, on sites where western larch and/or ponderosa pine are dominant seral components and where Douglas-fir is large enough to be fire resistant, fire can be used to reduce fuels, remove undesirable understories, and avoid risk potential from catastrophic crown fires (e.g. moist DF habitat types). These light intensity burns have the added benefit of reducing overall competition for growing space, preparing the site for natural regeneration of shade intolerant species, and initiating a nutrient flush for seedlings. Where ladder fuels pose a risk to the manageable overstory, it may be necessary to slash understory trees prior to burning. Depending on the stocking levels, underburning will likely follow a thinning of some type. Without any harvest, a prescribed burn of a moderate intensity would create openings in the stand due to tree mortality. On the other hand this would create favorable conditions for regeneration of western larch and lodgepole pine.

Prescribed fire in the warm, moist grand fir types is not recommended unless initiated as a part of fuel treatment and site preparation that would follow regeneration harvest. In general, intermediate harvest in this type would retain many fire intolerant species that are not likely to survive fire. Even low intensity underburns would likely damage or kill species such as grand fir, sub-alpine fir or spruce. The extent of duff reduction, mineral soil exposure, overstory crown scorch, and tree mortality that results from prescribed burning is dependent upon the resource objectives, the burning prescription, etc. These results are best predicted at the project level at which they are implemented.

The time of year to conduct burning will depend on resource objectives, fuels, weather, etc. Response of understory plants to burning will vary with their tolerance to disturbance, the season of burning, and the plant's post-fire regeneration strategy. Spring burning is recommended where it is desirable to achieve moderate duff and woody debris reduction to meet site productivity needs. **It is**

important to maintain downed woody debris (>3") at a level averaging 10-20 tons per acre (Graham et al. 1994). The amount of woody debris retained will vary somewhat with the habitat needs and may be higher or lower depending on the site. For example, the low end of this range may be more applicable to Douglas-fir types and the high end to the grand fir types. The recommendations include the contribution of standing dead as well as down woody fuels, not to immediately replace the present forest floor but to insure their replacement over the next 100 years or more. This material is important for sustaining site potential, creating small mammal habitat, and ensuring adequate nutrient cycling.

Reforestation and Species Management - In general, a desired species composition in VRU 3 could approximate 40% western larch, 20% Douglas-fir, 20% ponderosa pine, and 20% lodgepole pine. During fire free intervals, portions of the forest would have grand fir and western white pine as a minor component. This wide representation of shade intolerant species, throughout successional development, reflects the desirability of this species composition in terms of fire tolerance, greater resistance to insects and pathogens, and consistency with historic ranges. These proportions are expected to vary across the Forest where some species are less represented. Recommendations from ICBEMP indicate a desired level of shade intolerant species in each seral stage: 70-80% early seral, 65-75% mid seral, 60-75% mature/old forest multi-storied, and 85-95% in mature/old forest single storied. These are broad references applicable at a coarse scale of resolution for the Dry Potential Vegetation Group.

Areas with root disease and dwarf mistletoe should emphasize western larch and ponderosa pine. Effective fire suppression coupled with past selective harvest of large, overstory western larch and ponderosa pine has resulted in Douglas-fir being over represented within its natural range. This situation has increased the risk for root disease. In general, western larch and ponderosa pine would be favored in planned management activities due to their resistance to drought and root disease. The latter is also favored where dwarf mistletoe is a concern. Overstocked lodgepole pine stands, at risk to mountain pine beetle mortality can be managed to emphasize a more balanced mix of species.

Overall, it is expected that there would be a fairly balanced mix of shade intolerant species and mid tolerant species in stands managed through group selection. Shade intolerant species would be featured in all even-aged silvicultural systems during stand initiation. Additional species would exist as the site conditions change and forest succession progresses. Silvicultural practices that leave a heavy overstory of live, reserve trees (e.g. shelterwood) with little or no seedbed preparation favor Douglas-fir. Natural regeneration can be used if the genetic source of parent trees is known and represents a desired seed source. Planting in group selection openings and under a shelterwood may be desirable to assure western larch and ponderosa pine regeneration as well to meet desired stocking levels.

Stands within this VRU would represent habitat types that include Abgr/Libo, Abgr/Libo-Libo, Abgr/Xete, Psme/Libo, Psme/Libo-Syal, Abgr/Clun-Xete. Other habitat types would exist to less extent. It is expected that regeneration will be successful on most sites as soil moisture deficits, vegetation competition and solar insolation are not expected to be problematic. However, tree regeneration can become subject to mortality as a result of root disease, soil compaction, drought, etc. Although ponderosa pine and western larch regeneration relies on available cone crops and favorable site conditions, it's regeneration strategy is likely to be successful. Stockability is estimated to vary from 80 to 95% on sites typical of this VRU.

Wildlife Needs - It is desirable to emphasize silvicultural treatments that would create or maintain a mosaic of stand conditions over the landscape in relative proportion to forest conditions that experienced natural disturbances. The silvicultural systems recommended for use in VRU 3 would create or maintain variable sized openings, nonuniformly distributed stands that are both even-aged and uneven-aged, and a variety of structural stages. These mosaic conditions are expected to be compatible with many wildlife objectives that promote the maintenance of varied age classes and habitat diversity. Landscapes analyzed at a project level will identify special habitat requirements that may necessitate the use of other management options or other vegetation management techniques.

Some key habitat conditions that can be provided for include:
Maintaining key cover areas for dependent wildlife. Maintain wildlife travel corridors to provide a more continuous level of connectivity between habitat features. Riparian areas and ridges are likely to be featured sites for specialized habitat needs.

Improve forage conditions by increasing low intensity disturbances that open the understory and rejuvenate browse species and grass.

Retain existing snags , broken-topped live trees, and down logs to provide habitat for a variety of wildlife species. Natural fires, root disease in Douglas-fir and periodic bark beetle mortality create conditions that provide cavity habitat and nesting sites for raptors. The reserve tree emphasis would be a landscape consideration rather than an individual stand basis. In addition, the retention of large diameter trees is important as snag replacements, seed sources, and to represent a unique component of this VRU that typically survived a variety of fire regimes.

Special Considerations - Retention and planting of native vegetation is emphasized to limit the spread of noxious weeds. However, if spotted knapweed is present, mechanical site disturbance may dramatically increase its spread. Understory vegetation is maintained through implementation of site preparation techniques that consider plant phenology. This vegetation response unit would benefit from the planting of nitrogen fixing plants.

Although most riparian areas may be characterized within a Valley Segment Response Unit, occasional wetlands may occur within this VRU. These areas serve a special ecological function and should be managed accordingly.

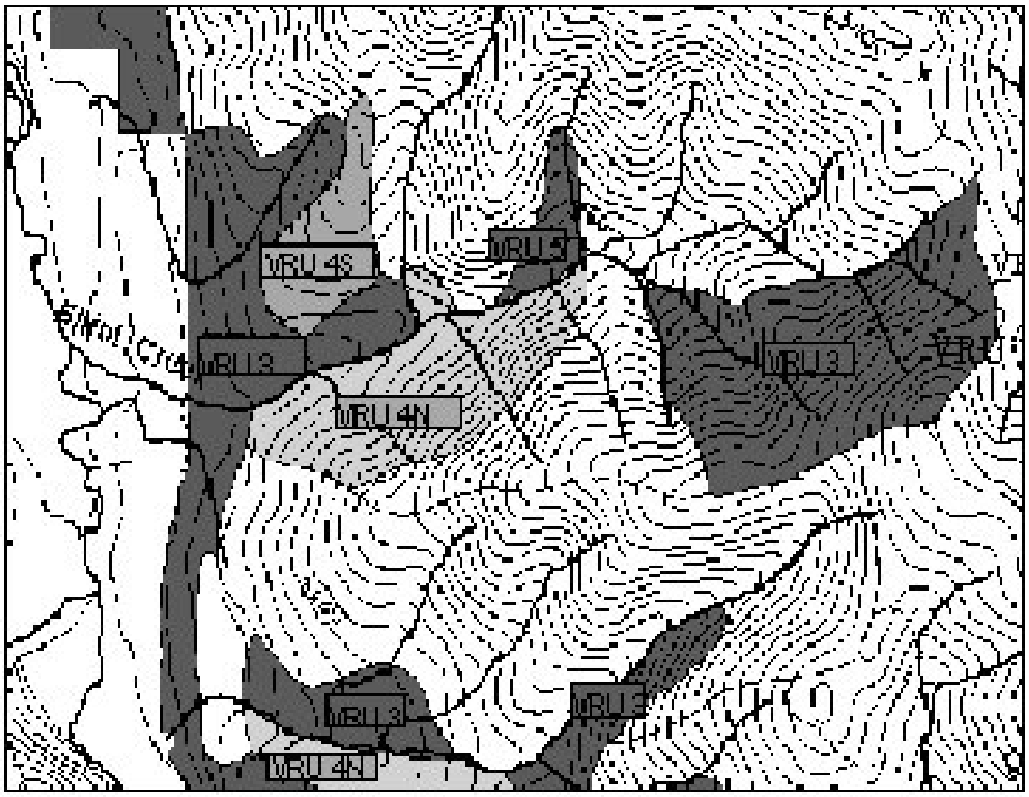
Rather than view conditions resulting from insects and pathogens as static and unpredictable, we should manage the land with a better understanding of the process of change, and manage for vegetation that has resiliency to insects and diseases. Some organisms and vegetation may exist largely because of the conditions created by insects and diseases. The long term health and productivity of this vegetative response unit can be ensured by maintaining an endemic level of insect and pathogen activity. Management strategies recognize the beneficial role of insects and pathogens in ecosystem functioning. Ideally, a mosaic of age classes and species composition is desired. Even-aged, overstocked forests of lodgepole pine are very susceptible to attack by bark beetles. Maintaining good vigor through early stocking control and improvement cutting can prolong the life of some stands. A basal area less than 120 sq.ft per acre has proven effective in reducing stand susceptibility in maturing stands where epidemic conditions have not yet occurred. Managing for a mix of species and varying age classes across the landscape are basic features to promote forest resiliency.

Vegetation Response Unit Description
VRU 4
Moderately Warm and Moist Habitat Setting

Ecosystem Setting and General Description

This vegetation response unit occupies some of the moderately warm and moist sites along lower slopes and valley bottoms (see Map 4). VRU 4 is ecologically influenced by the moderating effects of the inland maritime climate. It is typically bounded by warmer and drier upland sites (e.g. VRU 2 and 3), moderately cool and moist sites (e.g. VRU 5), and some cooler sites (e.g. VRU 7 and 9). While very limited in scope, VRU 4 contains habitat conditions that are ordinarily drier and cooler than what is suitable for western hemlock and western redcedar. This VRU is located on all aspects on the west side of forest and primarily north slopes on the east side. Slope averages 30%. Elevation ranges from 2,000-6,400 feet, mostly around 3,700 feet. Average precipitation is 30+ inches, higher in some areas around Libby.

This landscape exists on a broad range of productive landtypes that commonly feature volcanic ash (loess) deposits. The common occurrence of loess deposits largely contributes to these sites having good nutrient availability and high moisture carrying capacity. Landforms without loess deposits comprise an insignificant amount of VRU 4. Landtypes include lacustrine terraces with glacial lake sediments; alluvial terraces with sandy alluvial deposits; glacial outwash terraces; sideslopes with compacted glacial tills; and landtypes containing mixed lacustrine, alluvial and outwash deposits (Kuennen and Gerhardt 1984). Approximately 9% of the forest is currently mapped as VRU 4, 5% as VRU 4 N and the remainder as VRU 4 S.



Map 4 - Typical Physical Setting of VRU 4

Vegetative Composition

The most efficient way to maintain biological diversity in a forested landscape is to have a diverse array of stands and ecosystems with their constituent species (Hunter 1990). Unlike other vegetation response units that have been significantly influenced by the effects of fire, species composition in VRU 4 is largely the result of longer fire-free intervals and an inland maritime climate. The existence of grand fir as a predominant forest component and the indicated climax species is evidence of the moderating effects of this environment. Where grand fir development is successful, it is ordinarily attributed to the area being beyond the ecological and geographical limits of western hemlock and wester redcedar (Minore 1979), which are more shade tolerant and moisture dependent. On the Kootenai, grand fir habitat types are rare and the warm, moist sites dominated by cedar and hemlock are much more prevalent.

The nature of varying fire regimes creates ideal conditions for the development of a mosaic of seral and climax species. Habitat types and topographic settings that characterize VRU 4 are bordered by the Douglas-fir series on the drier and warmer sites, cedar and hemlock on the warm and more moist sites, and the subalpine fir series in the cooler sites. Floristically, this vegetation response unit is one of the most diverse. The exceptional species diversity is largely attributed to the climate which transitions between the Pacific maritime and the continental. Table 7 illustrates the common habitat types that comprise Habitat Type Group 4 and their relative distribution.

Situated on most aspects, the forest community is broadly distributed across the numerous benches and valley bottoms of this vegetation response unit. Grand fir is a climax dominant, consistently present during most successional stages. However, due to slower initial establishment and growth, it is usually subordinate to Douglas-fir and western larch. Douglas-fir is a major seral on all sites,

except those with saturated soils. Engelmann spruce and lodgepole pine occur on wet, colder habitat types. Western larch can be a major seral where fire has created favorable conditions, but is otherwise sporadic. Western white pine and ponderosa pine are scattered and a very minor seral component. Paper birch is occasional. Being more shade tolerant and moisture dependent, western redcedar and western hemlock are not usually reproducing successfully in VRU 4, and only appear as incidentals.

Dominant vegetation includes shrubs such as Rocky Mountain maple, redstem ceanothus, western serviceberry, thimbleberry, ocean-spray, common snowberry, baldhip rose, Utah honeysuckle, globe huckleberry, and twinflower. Dominant forbs include arrowleaf groundsel, queen's cup beadlily, starry Solomon-plume, northern bedstraw, Idaho (western) goldthread, Hooker's fairybell, trail-plant, and occasionally arrowleaf balsamroot. Lady fern and the graminoid Columbia brome are two associates.

Table 7 - **Habitat Types and Fire Groups - VRU 4***

Habitat Type Code	Habitat Type	Regional Habitat Group	Climatic Modifier	Fire Group Code MT	% of HG 4
516	Abgr/Asca	HG 4	Mod Warm and Moist		-
517	Abgr/Asca-Asca	HG 4	Mod Warm and Moist		-
520	Abgr/Clun	HG 4	Mod Warm and Moist	11	65
521	Abgr/Clun-Clun	HG 4	Mod Warm and Moist	11	25
522	Abgr/Clun-Arnu	HG 4	Mod Warm and Moist	11	4
524	Abgr/Clun-Phma	HG 4	Mod Warm and Moist	11	4
525	Abgr/Clun-Mefe	HG 4	Mod Warm and Moist	11	-
526	Abgr/Clun/Tabr	HG 4	Mod Warm and Moist	11	-
529	Abgr/Setr	HG 4	Mod Warm and Moist		-

* Note: Where habitat types comprise less than 1% of this habitat type group, a dash is indicated (-).

Disturbance Processes

Disturbance is defined as any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment (SAF 1996). Whether it is fire, flooding or forest management, the long term health of ecosystems is directly linked to the disturbance characteristics along with their frequency and intensity. Understanding the processes that shape and influence disturbance is essential to meeting our varied resource objectives. Changes on the landscape are an important mechanism for energy flow, sustaining biological diversity, forest succession, canopy gaps, etc. The following information is provided to assist in our understanding the processes that have and will influence the characteristics of this vegetation response unit. The examples presented are only a partial list of known disturbances and not intended to reflect the complete picture of disturbance ecology in VRU 4.

Fire Regime - As depicted in Table 7, the predominant habitat types within VRU 4 are in Fire Group 11. The inland maritime climate that prevails on the west side of the Kootenai exerts a strong influence on the role of fire in these forests and the development of associated forest communities. Although moist site conditions and infrequent fires predominate, the occasional periods of summer drought can create some conditions very conducive to severe fires. There is a wide range of fire free

intervals within this group due to the wide moisture gradient and the influence of surroundings stands. Fire severity varies from minor ground fire on moist sites to stand replacement fires (Fisher and Bradley 1987).

Within the Abgr/Clun habitat type in the Swan Valley a mean fire return interval (FRI) was estimated at 100-200 years between stand-replacing fires (Antos and Habeck 1981). A later study in the same valley (Freedman and Habeck 1985) estimates a 30 year interval between fires, very likely an extreme example for these forest conditions. A fire history in Rathdrum Prairie of Idaho (Zack 1996), that includes a grand fir and Douglas-fir cover type, indicates a mean FRI for lethal fires at 149 years and a mean FRI of 55 years for all fires (lethal, mixed, nonlethal) prior to 1880. This study occurred in mountainous terrain with varying aspects, and a range of elevations and slope.

There are numerous other fire studies that can be examined for information on fire regimes and return intervals comparable to a typical landscape in VRU 4. **Looking at these studies in total it is evident that the historic fire severity was nonuniform, including both mixed severity types on an average of every 30-85 years (VRU 4S) with less frequent lethal fires occurring on an average frequency of 200 years (VRU 4N)**. Nonlethal underburns also occurred at varying intervals on the drier exposures sometime between the more common fire events. It is important to highlight that mixed severity fires can range from low intensity, creeping fires that kill primarily shade tolerant trees to severe stand replacing fires that create favorable conditions for seral tree growth and regeneration. In terms of stand structures and species composition, a regime of mixed severity fires promotes highly diverse landscapes because of widely varying fire frequencies, severities, and spread patterns (Barrett 1996).

Fuels and Nutrient Cycling - Fuel loadings for studies in a range of habitat types within Fire Group 11 averaged 25 tons per acre and duff depths from 2 to 4 inches (Fisher and Bradley 1987). This mean is also characteristic of stands sampled in the Abgr/Clun habitat type with a range of fuel loadings from 13 to 38 tons per acre. Moist sites such as these typically have some of the highest fuel loadings due to accumulated deadfall and natural thinning. The humidity of the sites tends to reduce microbial activity due to anaerobic conditions, but decomposition of organic matter still occurs. Nutrient cycling through the litter and back to the plants occurs more readily than cooler or drier sites. All size classes of fuels are higher in Fire Group 11 than any other group. The bulk of the fuel loading is older, rotten material of a larger size class. Depending on the nature of the tree density and canopy closure, the presence of understory fuels is quite variable.

Insects and Disease - With the very high species diversity present, there is an increased level of potential exposure to insects and pathogens. In addition, with relatively long fire free intervals the increased development of shade tolerant species presents additional opportunities for insects and pathogens that prefer these host species. Diseases can cause abnormal growth or development of trees and predispose areas to attack by other agents. Insects can create conditions somewhat similar by chewing, sucking, boring, or mining portions of the particular host trees. In some cases, such as a cone worm, the feeding habit of this pest can stop development of cones and result in infertile seed. Trunk rots, primarily Indian paint fungus, can be common on most moist sites containing grand fir, subalpine fir and western hemlock. Most common in slow growing dense forest conditions, the fungus often remains inactive within branchlet stubs for many years but has the potential for infections to reactivate from mechanical injury. Laminated root rot and armillaria root rot are the primary root-rot pathogens. The latter fungus is the most common type causing mortality in centralized areas and in scattered, individual trees. While its primary host is grand fir, Douglas-fir, lodgepole pine, and ponderosa pine, the fungus can impact all conifers. Laminated root rot is most

common in grand fir and Douglas-fir; western hemlock and subalpine fir are less susceptible. It also causes tree mortality in large or small central areas. The conditions brought about by both root disease pathogens often sets the stage for later attack by bark beetles.

Weather - Unusual weather patterns act as a disturbance in a stand (Oliver and Larson 1990) by influencing plant growth and development of species composition. Short term weather events can result in wind damage on a very local level. This disturbance occurs in most terrestrial ecosystems and can be a major force in creating gaps as trees are blown down. In VRU 4, trees exposed on ridges, on sites with a high water table, or affected by root disease are particularly vulnerable to wind-caused damage. As these events are not easily predicted and are sporadic, there have been few measurements of their frequency and severity. However, site specific locations within this landscape are more prone to wind-caused damage and their risk can be generally determined by land managers familiar with the area.

Drought is not considered a concern on most areas delineated as VRU 4. Moisture and temperature conditions are extremely favorable for promoting vegetative growth and diversity. When drought does occur, it can increase the fire hazard by rapid drying of fuels and increased tree mortality as a result of foliage desiccation.

Snow damage is a common occurrence due to the density of many stands and the resulting stem breakage. Ice storms have been known to occur during the late fall and early spring as warm, moist air produces rain that falls through a subfreezing layer of air at the ground level. When this freezing rain attaches to branches or limbs it can result in considerable breakage. Rain on snow events can occur as heavy rains penetrate snow depths in upland areas and carry sediment into flooded areas.

Successional Pathways

The following illustration (Figure 4) and descriptions characterize forest community development for an area with the attributes of VRU 4, within the context of Fire Group 11 (Fisher and Bradley 1987). It includes pathway descriptions that are somewhat similar to VRU 5, an associated VRU. It is important to recognize that forest community succession on these moist sites is governed by more than the characteristics of a particular fire event. More depends on the potential seed source, existing species composition, and time since stand initiation. The time elapsed until a distinct overstory develops is primarily a function of the rapidity of tree regeneration following disturbance. Many sites within this response unit are prime candidates for shrubfield development following stand replacement fires or management activities that do not include site preparation and prompt reforestation.

In the event that a stand replacing fire occurs, succession begins with a dominant shrub or herb field that essentially occupies the available growing space. Within a given 'burn' there would be areas containing scattered surviving overstory trees, patches of unburned areas and conditions resulting from mixed severity fire effects. The duration of this 'brush' phase can be prolonged if reburn occurs and conifer seed availability is diminished. In time, seedlings and saplings initiate development on these moist, productive sites. Grand fir can be a major recolonizer following stand replacement fires on moist sites (Cooper, et al. 1991). The initial survival and growth of grand fir seedlings is favored by a moderate overstory shading. However, under full sun its slower initial establishment and growth result in grand fir being subordinate to Douglas-fir, western larch, and Engelmann spruce.

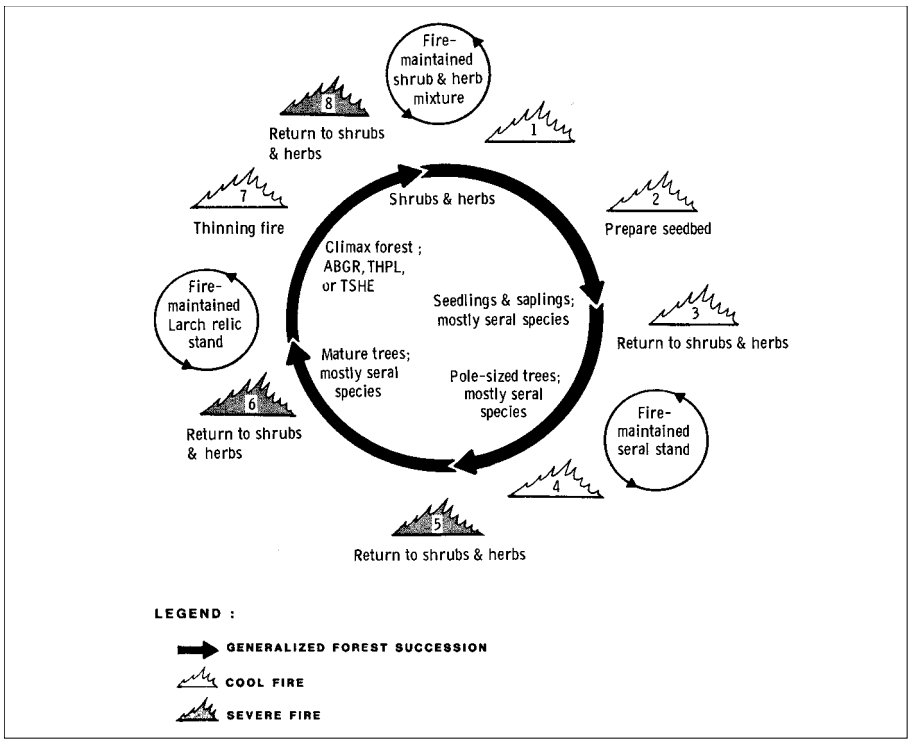


Figure 4 - Generalized Forest Succession in Fire Group 11

Fire history studies indicate that low to moderate fires do occur periodically between this stand initiation stage and less frequent lethal fires which may occur during a late seral forest condition. When occurring within the closed stem exclusion stage, shade intolerant seral species have an advantage due to their relative fire-resistance. Being one of the few species able to successfully reproduce beneath a full canopy, grand fir is generally well represented during the stem exclusion stage. When severe fires occur in these conditions the forest community is again replaced with early seral conditions and stand initiation resumes with an shrub/herb stage. If the replaced stand has a surviving seed source in the form of relic overstory or serotinous lodgepole pine cones, seedling development occurs fairly well.

This simplified expression of succession illustrates how difficult it is for a given area to develop conditions conducive to dominant seral or climax grand fir. Despite a relatively long interval without significant fire disturbance, grand fir is ordinarily not the realized climax species. Fire tolerant species are generally long lived and maintain the site in a seral condition. However, if mixed severity fires do not occur, a long fire free interval will enable the theoretical climax stage to develop. This condition can also take place despite low intensity underburns, which can occur even on moist sites.

Endemic root disease plays an integral role in shaping forest succession by killing trees in large open patches and causing scattered, individual tree mortality. Forest structural change occurs as species composition and stand densities are altered. As root disease patches seem to be perpetually in early successional stages, young trees may never grow beyond the seedling and sapling stage. Even after stand replacement fires, root pathogens appear to remain in place as regeneration establishes, although potentially being prevented from achieving a climax stage. Although permanently established, endemic root disease is often distinguished as having little variation in severity within a particular area. In addition, there is often little expression of root disease outside the discrete patches of mortality.

Vegetative Structure
A natural disturbance regime of primarily mixed severity fires with infrequent lethal fires, in addition to mortality-caused root disease, created a mosaic of horizontal and vertical forest structure across this landscape. The characteristic distribution and diversity of forest communities within VRU 4 was less than uniform, varying by topographic position and habitat type. Large valley bottoms were often composed of fairly open grown, mature western larch with younger lodgepole pine, Douglas-fir and grand fir understories. Upland sites had a mixed species composition with a narrow age class distribution and few canopy strata. Tree stocking levels varied across the landscape and with time, but may have ranged from an average of 150-200 sq.ft. of basal area and 30-50 overstory trees per acre (Steele 1994) to over 200 sq. ft. in riparian areas.

Mixed severity fires tended to create more multi-aged and storied conditions as creeping fires flared up, killing trees and creating canopy gaps. At times, some of these resulting patches may have been as much as 20-75 acres in mosaic burns. Stands within VRU 4S had greater vertical structure as more trees survived these moderate-severity fires. Even-aged stands developed following lethal, stand replacing fires. Characteristic of VRU 4N, these fires resulted in a number of scattered, relic overstory trees (i.e. DF,WL) and irregular unburned patches in protected areas. Numerous snags were created as a result of both fire regimes. Patch size following large fires varied by habitat type but was fairly large, averaging 100-300 acres. However, depending on fuel conditions, weather, and insect and disease conditions, the potential existed for larger patch size. In fact, fire history studies in the Clark Fork River Corridor (Barrett 1991) indicate a mean patch size of 437 acres, with a range of 5 to 2,000 acres.

Root disease pathogens create openings in otherwise closed canopies. This provides a unique stand structure not created by any other means. Where root disease has been a factor, forest conditions are generally discontinuous. The distribution of root pathogen colonies results in patches of tree mortality anywhere from less than an acre to an average of five to ten acres, and occasionally larger. These discrete areas are more continuous, where age and density of host trees is fairly uniform.

Age Class Diversity
The changes in forest community succession following disturbance has been generally described. Forest conditions are not ageless, immutable features of the landscape (Hunter 1990). While plants are influenced by disturbance, changes in the microclimate, and competition for resources, wildlife populations change largely in response to changes in the plant community and the general habitat characteristics. Because of this, managing forests for diversity requires managing the patterns of succession that determine the structure and composition of the landscape. Since age is an index of the successional stage of an area it is a useful attribute in setting objectives for desired conditions and designing silvicultural treatments to maintain a given age class distribution. Having a broad range of age classes will likely result in a greater number of wildlife species than if any one successional stage were featured. The intent is that diversity of habitat characteristics be represented across the landscape, not necessarily within each individual stand.

The proportion of successional stages present in a setting such as VRU 4 would have varied over time. Historic age class distributions (**pre-1900)** displayed in Table 8 are based on a synthesis of research of historic vegetation in the Douglas-fir/western larch cover type for Lincoln County, Montana (Losensky 1997), studies in old growth forests of western Montana (Lesica 1995), ICBEMP scientific findings (USDA 1996), and results predicted from modeling age class proportions that would result from the average stand replacement interval.

Table 8 - **Age Class Distribution**

Age Class	Pre-1900 Condition	Existing Condition
0-40	15-25%	25%
41-100	20-40%	44%
101-150	15-35%	21%
150+	10-40%	7%
nonstocked	5-10%	3%

The fire regime in this VRU does facilitate the development of old growth characteristics in many areas. Relatively long fire free intervals and mixed severity fires are typical disturbance events for VRU 4. This is supported by the historic vegetation research that documented an average of 21% of the representative cover types in late seral conditions, both multi-storied and single storied (Losensky 1994). Based on fire history research in Fire Group 11 for northern Idaho and western Montana (Lesica,1995) it was estimated that an average of 26% of the grand fir, cedar, and hemlock cover types were in an old growth structural stage prior to European settlement. Findings from ICBEMP for moist habitat types indicate an historic distribution of 15-25% in mature and multi-storied old forest, 5-10% mature and single storied old forest.

The **existing age class** proportions in Table 8 are based on stand year of origin data for Habitat Group 4 taken from the Timber Stand Management Record System (TSMRS). Approximately 20% of the stands in this grouping does not have complete inventory information and are not represented. When conducting a diagnosis of vegetation conditions across the landscape, it may be useful to keep in mind any significant departures from historic levels. Where important changes are noted, priorities can be set for restoration activities and an understanding of trade-offs and risks associated with whatever vegetation management is proposed to achieve the target conditions.

An assessment can be made based on a comparison of the age class distribution for historic and present conditions. The proportion of early to mid-seral stands is currently at the upper end or slightly higher than reference conditions, largely attributed to active vegetative management . Mature/late seral conditions are less represented for the same reason. As one would expect, stocking levels are significantly higher in most 'middle-aged' stands as a result of mixed severity fires that would have somewhat reduced this intermediate age class. Nonstocked areas are less, likely due to fire exclusion and encroachment by conifers into otherwise natural openings. These are comparisons of general proportions of seral stages, without the context of where they occur on the landscape.

Ecological Function and Special Habitat Features

Major processes regulate or influence the structure, composition and pattern of ecosystems. Many of these processes have been described (e.g. producing, cycling, storage of resources) as well as the relative importance of their biological role. The following information describes, at a coarser scale, the habitat features of VRU 4 that may serve a distinctive role in contributing towards the biological diversity of the overall landscape. While this VRU is not well represented on the Forest, it is nonetheless important to species that utilize its unique habitat components.

Landscape Linkages - The diversity of vegetative composition and wildlife habitat is high in VRU 4, resulting in substantial use by big game and non-game species. With respect to wildlife, there is not a lot of functional difference between the south and north aspects in this VRU. As a whole, this VRU is an important link between summer and winter range and provides habitat for reproduction.

Old Growth and Interior Habitat - As described, this landscape has the potential to provide many old forest features within fairly large, contiguous interior habitat. This habitat can also contain prime sites for sensitive plant species. Current conditions indicate that many areas are in an early seral condition as timber management has been a focus on these highly productive sites. Future silvicultural practices may be able to advance structural development in young stands through stocking control that emphasizes nonuniform techniques and retention of a varied composition of crop trees.

Wildlife Habitat - This VRU is important thermal cover for wildlife, particularly along riparian areas. The presence of shrubs and dense canopy cover offer weather protection for a number of species by reducing snow depths. Escape cover from predators is also provided in the multi- storied conditions afforded by this habitat.

This habitat is utilized by most wildlife species, particularly as summer range. Early successional stages of most sites can produce high quality browse for elk and deer. Low elevation areas with solar exposure provide transitional winter range for deer and moose. Winter range value in VRU 4 is negligible due to lack of low elevation, south slopes in this landscape. Domestic livestock also utilize some areas within this landscape as transitional forage habitat. The fire regimes in VRU 4 historically favor a more closed canopy which often shades understory browse species. This is particularly true during the stem exclusion stages of forest development. Where sunlight does penetrate the canopy or where early seral communities exist in managed forests, forage plants are more available to wildlife. In addition, root disease creates openings in otherwise closed canopies. This provides a unique stand structure not created by any other means. These openings create habitat for forage that may prove to be very valuable to wildlife survival. Many riparian areas continue to provide forage for deer during later successional stages, as palatable forage becomes available.

Pinegrass serves as an important early season forage for black bear, deer and elk where it occurs. Elk sedge is important spring and summer forage for elk and also utilized by bear, sheep and deer. Western serviceberry is a key forage for most big game species during winter and early spring. *Pachistima* (mountain-lover) is important forage for elk, deer and moose despite its low palatability and nutritional value. Common snowberry is often utilized by deer in the summer and fall. When nothing else is available, elk are also apt to browse on snowberry. Huckleberry is an important early season browse plant for elk and deer on summer ranges. Bear feed on the berries, an important food source.

This VRU typically has an abundance of snags for cavity nesting species, particularly in western larch, Douglas-fir and ponderosa pine. The structural diversity in this landscape enables this habitat requirement for dependent wildlife to be easily attainable on most sites. Specialized birds such as the black-backed woodpecker utilize snags and downed logs as feeding and reproduction habitat within grass/shrub forest settings.

With the amount of dead, dying and downed woody debris available, this VRU provides good, diverse habitat for a number of small game and non-game species. Dead and downed trees provide a food base for insect-seeking birds. Some mammals use the logs for foraging, cover and reproductive

habitat. Recurrent blowdown, root disease killed trees and storm breakage enhances the suitability of VRU 4 as favorable small mammal habitat.

Rare Elements and Specialized Habitat - The diversity in stand structure, species composition and topographic position offer some unique features. Many sites within VRU 4 provide interior habitat that is used for security by many big game species, as well as neotropical migratory birds, pileated woodpecker, etc. Some habitat conditions in VRU 4 are desirable as calving or fawning areas. Areas with downed logs and low shrubs are particularly useful for concealing young from predators. Mature, relatively closed canopies are important reproductive habitat where succulent forage is nearby.

Silvicultural Importance - This VRU has the distinction of being very diverse and bordered by very different landscape conditions. It is dry enough for ponderosa pine to be present, cool enough for occasional subalpine fir, moist enough for western white pine and spruce, yet generally outside the bounds of western hemlock and western redcedar. The blend of nonuniform mixed severity and infrequent lethal fires creates differing conditions that afford this vegetative diversity.

As a dominant seral and potential climax species, grand fir tolerates partial shade and is a successful invader of small openings and shrubfields. Following disturbance, it is fairly persistent at reproducing until the canopy closes. In time, competition can restrict grand fir to a role as an understory component. Mature grand fir can handle low to moderate severity fires due to its bark characteristics. However, because of its shallow roots, low and dense branches, and highly flammable foliage it is more often susceptible to severe fire injury and death. Vulnerability to fire varies a lot with the site and stand density which can significantly influence the outcome.

It is important to recognize the potential prevalence of root disease in this vegetation response unit. Whether causing small canopy gaps or disturbing large areas and resulting in major structural change, root disease in this ecosystem plays an integral role.

Ecosystem Health, General Trends and Management Implications

In comparison with the drier types, the influence of fire control on vegetation in many cooler, moist landscapes such as VRU 4 has been less significant due to the inherently long fire free interval. Findings in ICBEMP indicate that fire regimes in mesic forests have not changed much since 1900. Warm and moist sites such as VRU 4 are characterized as having mixed severity and infrequent stand replacement fires within a range that is similar to recent, historic levels. On a broadscale, this situation is not likely to change significantly within the near future. Other research (Barrett 1996) indicates that although severity patterns in the stand replacement fire regime have remained unchanged throughout the fire suppression era, many landscapes now have more uniformly aging mosaics in the absence of fires. Theoretically, continued fire suppression would promote larger stand replacing fires than during the presettlement era as forest homogeneity increases. As a result, overall landscape diversity could be reduced for some time due to less age class diversity and more fuels continuity.

At a finer scale, current species diversity has continued to move towards a greater proportion of mid tolerant and shade tolerant species. In particular, grand fir and Douglas-fir are well represented due to selective removal of many seral overstory trees and fire suppression that has virtually eliminated the mixed severity fires. In general, age distribution has slanted more towards mid seral age classes

as a result of further understory development. In time, these young multi-strata conditions will develop old forest characteristics.

As past timber management activities have focused on the more productive sites (e.g. VRU 4), there is a disproportionate amount of the landscape in homogenous, uniform patches. In time, stand development will provide greater habitat diversity as a result of understory reinitiation that would occur following stocking control and some forms of intermediate treatment. Within a few decades, many even-aged plantations within VRU 4 (and adjacent VRU 5) will have more similarity with adjacent untreated areas as stand structures develop additional characteristics. Additional shade tolerant species will contribute towards multi-storied conditions as an intermediate crown class.

Analysis in Beaver Creek (KNF 1997) presents evidence of major change in stand structure, in a similar vegetation response unit, since the last major fire. This analysis concludes that pre-1910 periodic disturbances in all but the south aspects would have produced stands of varying age and fuel characteristics. The 1910 fire eliminated this structure and a single, homogenous age class replaced it. On the drier, south slopes of this type, stand density has changed from more open stands with moderate shrub understory to denser stands with much less herbaceous understory as a result of less light penetration and reduced moisture availability. Periodic natural fires reduced the shrub and litter layer, thinned understory conifers and created some small openings.

In many areas, root disease appears to have increased in intensity since European settlement. Species composition, forest structure, and stand density have resulted in some unhealthy conditions due to contemporary management. Where more frequent fire occurs, the presence of root disease appears to be lessened. Stands with mature, high risk lodgepole pine have experienced considerable mortality as a result of bark beetle infestation. In the near future, lodgepole pine stands at risk will likely be those currently in a closed stem exclusion stage, typically of low vigor.

Snag habitat and downed woody debris have increased in mature stands as decadence occurs and older age classes develop. Historically, late seral multi-layer forested types were in moist areas such as bottoms and benches, maintained by succession and disturbance regimes. Currently, forest practices and fire exclusion have resulted in this condition being more represented on the drier, upland slopes (USDA,1996).

The amount and diversity of nonnative vegetation has increased in recent decades, particularly along roads, operational landings, and areas of recreation use. Some species of note include common St. John's-wort, orange hawkweed, spotted knapweed, etc.

Desired Landscape Conditions and Silvicultural Strategies

The following habitat conditions are described as **options** for vegetation managers **to consider** in prescribing silvicultural treatments to shift the landscape within this vegetation response unit towards a more desirable and sustainable condition. The landscape attributes described are achievable under average conditions and are based on applied research, ICBEMP scientific findings (USDA 1996) and experience with local forest conditions. While there is considerable information presented on historic forest conditions, the emphasis is placed on sustaining the biological processes that produce these conditions. It should be noted that the extent and scale of vegetation management is dependent on project-level resource objectives while considering historic patch size.

Landscape Attributes - Activities in VRU 4 could **create and maintain forest conditions that simulate ecological processes and the results of nonuniform mixed lethal fires and long interval stand replacement events**. Vegetation management would be designed to not increase root disease levels over existing conditions. Ecosystem-based prescriptions could be designed to create a mosaic of stocking levels, age class distribution and species composition, representing varied structural attributes and habitat characteristics. Adaptive management in VRU 4 could maintain the diversity of these moist sites and manage largely for nonuniform landscape features, a departure from traditional practices. The landscape would be composed of mixed species stands with varying structural development. There would be well stocked even-aged and multi-aged stands, some fairly open stands composed of large diameter trees, protected areas with no recent evidence of disturbance, brushfields or nonstocked areas, etc. Openings could vary from small gaps created by root disease to large patches resulting from regeneration harvest.

As many plants and animals are associated with different stages of succession, **balancing the age structure of the overall landscape** can provide diverse habitat while meeting the need for forest products. In fact, the Forest Plan (KNF 1987) provides overall management direction to maintain a variety of age classes in order to maintain habitat diversity for dependent species. It would be

desirable to create less uniform age and size classes. While many areas on the Forest have been converted to early seral stages, the majority of the matrix is of similar origin. It has been suggested (Bunnell,1995) that the best prescription for maintaining biological diversity and sustainable ecosystems is to imitate as closely as possible the natural stand age distribution. It is recommended that we manage within a range that represents a relative historic age and size class distribution, as well as a representative species composition. In many areas, particularly VRU 4N, management will likely be focused within mid-seral and mature stands that have undesirable densities of understory. This would involve silvicultural techniques to remove the mid-seral component of Douglas-fir and grand fir.

Based on a consolidation of desired seral stages from local assessments, scientific findings, and historic research, long term management in VRU 4 is recommended in the following ranges: 15-25% in early seral, 20-40% mid-seral, 15-35% mature, and 10-40% late seral. Natural openings and brushfields, currently nonstocked with trees, will occur within this setting to a varying degree. These are general estimates representing a dynamic ecosystem that changes along different pathways. These proportions are recommended for the landscape level and will shift in proportion and distribution the way natural disturbances do. It is recommended that stands managed or reserved for old growth characteristics be located in riparian areas, valley bottoms, or on benches. These old growth stands would be primarily multi-storied, although single storied conditions would also be maintained where appropriate.

In summary, treatment within stands and communities should emphasize **maintaining the vertical and horizontal distribution and diversity of forest conditions that natural processes create**. This would include the maintenance of both even-aged and multi-aged structures, containing mixed and single species stands. These conditions would be distributed nonuniformly, at the indicated proportions, ranging from highly diverse multi-storied structures in valley bottoms to more homogenous single and two storied conditions in upland areas. Stocking levels would tend to be higher in the former setting, consistent with long fire return intervals.

Silvicultural Systems - Where vegetation management is used as the mechanism to move towards achieving desired landscape conditions, most silvicultural systems can be utilized. This vegetation response unit is characterized by very productive sites that are well suited to habitat manipulation. **In general, intermediate harvest methods (e.g. improvement, thinning, salvage), even-aged silvicultural systems and group selection can be utilized to achieve most objectives within the framework of the characteristic fire regime**. Where root disease is a concern, intermediate harvest treatments that leave host species is not recommended. If vegetation management is an objective in riparian areas, individual tree selection may be utilized to some extent. Selection systems as repeated entries may not be appropriate in root disease-prone areas since management of multiple age classes and regeneration to primarily host species only worsens the conditions.

Where the objective is to replace a mature stand with mostly shade intolerant species while retaining some structure, a clearcut or seedtree cut with reserves may be used. Consistent with the mosaic nature of patches **created by mixed lethal and lethal burns**, the arrangement and frequency of these treatments would emphasize less uniformity. Recommended primarily on productive north and east slopes, this silvicultural treatment would leave fire adapted western larch and Douglas-fir overstory for seed, snag replacement, and relic representation. Natural and artificial regeneration of seral species are appropriate. Shelterwood harvest is useful on sites where regeneration may be difficult, additional shade is necessary (e.g. VRU 4S), or visual enhancement is an objective. This procedure would retain desirable species in uniform and nonuniform distribution, depending on the

objectives. To meet the desired level of overstory trees, it is conceivable that some western white pine, grand fir and spruce may be left. This treatment will naturally regenerate Douglas-fir and grand fir. Where an irregular shelterwood provides sufficient openings, western larch can develop. If overstory is retained indefinitely as reserves, some growth and development effects will occur to developing cohorts as a result of competition for light and moisture. This condition would have the most impact on western larch. Where it is desirable to attain two or more age classes of Douglas-fir with some larch and grand fir, a combination of shelterwood cutting and group selection can be used. This system may be useful on dry sites where groups of otherwise healthy advanced regeneration of Douglas-fir is present. This treatment might be similar to the conditions resulting from light intensity burns which regenerated small patches of trees within the surrounding overstory.

Initially, multi-storied mid-seral stands might receive a high priority for treatment to meet overall landscape objectives of a better balanced age distribution and less horizontal patch homogeneity. **Silvicultural practices could be directed towards reducing the level of mid tolerant and tolerant species (e.g. GF, DF) and retaining the seral dominants that are not successfully reproducing under current conditions**. Where root disease is not significant, understory thinning of the intermediate crown classes, followed by burning is entirely feasible. In all cases, if the objective is to manage areas containing root disease, treatments should retain species that are less affected (e.g. WL). Where it is appropriate, commercial thinning can be utilized to reduce stand density, focus growth on selected trees, and initiate forage habitat in small openings. Creating long term forage in most vegetated conditions of this VRU requires active management that minimizes canopy closure in order to prolong the presence of understory vegetation.

It is important to realize that vegetation management can intensify the presence of root disease. This happens as a result of rapid colonization of the stumps and roots following the removal of infected trees and basal wounding. The resulting stumps subsequently serve as the food base for root pathogens to infect and kill other neighboring trees. The inherently high rates of infection and potential for increase due to reactivation of dormant infections by mechanical injury are major factors arguing against uneven-aged management on most of this VRU. Any silvicultural activity that may incur wounding of host trees should not take place. Advanced grand fir and Douglas-fir understory developing beneath an overstory should be replaced with a regeneration harvest. In some cases, practices such as sanitation-salvage cutting can result in high tree mortality that can inhibit the site capability to regenerate for many decades.

Thinning in young stands on hazardous sites can take place to increase tree vigor and air flow in nonsusceptible crop trees. Where indian paint fungus is active, defective trees should be removed during thinning. Severely affected stands should be considered for replacement. Thinning should be delayed in young stands with extensive root disease in order for potential crop trees to develop resistance. In some cases, thinning may not be an option in areas with extensive infection as mortality will undoubtedly continue and create understocking.

<u>Fire and Fuels Management</u> - Management for forest health considerations and **to maintain the natural fire frequency and intensity in prescribed fire management** is recommended. Fuels management would be designed to resume and maintain a mixed lethal fire severity regime while indirectly reducing potential for lethal, high severity fires. These efforts would also enable the development of less homogenous vegetative conditions than those already present. The time of year to conduct burning will depend on resource objectives, fuels, weather, etc. Response of understory plants to burning will vary with their tolerance to disturbance, the season of burning, and the plant's post-fire regeneration strategy. Some harvest of intermediate and mature fire intolerant trees may be

necessary prior to burning. Some species such as grand fir, western white pine and Engelmann spruce will very likely be damaged or killed without intermediate harvests. In particular, when burning occurs under dry conditions, low fuel moistures can result in basal scarring which creates favorable food bases for decay organisms.

Many of the moist sites within VRU 4 are vulnerable to soil compaction during site preparation or fuels reduction activities. Proper selection and timing of equipment use (i.e.: excavators) and/or use of prescribed fire can usually alleviate these concerns. **Silvicultural activities and fuels management should maintain an average of 15-30 tons per acre of coarse woody material (>3" dia.) with the intent of maintaining site productivity (Graham et al. 1994) as well as providing specialized habitat for small mammals.** The amount of woody debris retained will vary somewhat with the habitat needs and may be higher or lower depending on the site. While downed woody material is often quite available on these moist, productive sites, decomposition is fairly rapid. The recommendations include the contribution of standing dead as well as down woody fuels and are not designed to immediately replace the present forest floor but their ensure their replacement over the next 100 years or more.

Reforestation and Species Management - Consistent with other landscape attributes, **target stands should reflect a species composition that is representative of an historic range.** VRU 4 contains a significant number of habitat intrusions with a varying range of species. Western larch and Douglas-fir are well represented in historic records (50-60%), with lodgepole pine, grand fir, western white pine, etc. The representation of ponderosa pine would have varied significantly across the forest (20-30%). Presently, successful reproduction of ponderosa pine and western larch is less evident due to changed habitat conditions and more understory competition. Silvicultural activities should look for opportunities to favor these important species where it is appropriate. Where these fire tolerant, long-lived species are not available, other moist site mid tolerant and tolerant species would be managed for.

Reforestation in root disease-prone areas should utilize species least affected, using local seed source, well adapted to the site. Since all conifers are potential host to Armillaria this can be a challenge. However, western larch is one of the least susceptible conifers. Where laminated root rot is a concern, more options may be available. Species such as Engelmann spruce, western larch, lodgepole pine, western white pine, and ponderosa pine are not considered host species.

The habitat types within VRU 4 have and would support western white pine. However, much of this landscape is also susceptible to white pine blister rust infection. Reforestation efforts should utilize rust-resistant stock and maintain a mixed species stand composition. To increase genetic diversity, retention of some live western white pine overstory should be considered. These relics possess a degree of blister rust resistance and the value of their longevity and ecological role is not entirely understood.

Wildlife Needs - Snag habitat should be maintained at levels compatible with drainage-wide recommendations and habitat requirements. In some areas, large trees may be deficient and should be retained to provide for carbon and nutrient storage, habitat for terrestrial and aquatic species, long term site productivity, and for soil microbes that assist in decomposition.

Where old growth forest character is the desired objective, candidate stands should be located in settings representative of their functional purpose (e.g. valley bottoms, riparian areas, benches).

There would be opportunities to enhance the development of old growth character in mid-seral stands through intermediate treatments.

This landscape should be managed for its continued contribution in providing valuable habitat for small mammals and cavity nesting birds. The presence of root disease, the diversity of vegetation, and the amount of standing dead, down, and rotten logs provide good opportunity for this.

Identify and feature the isolated, low elevation areas used as winter range (e.g. VRU 4S). Maintain what limited quality forage is available on north slopes in small openings, canopy gaps, early seral stands, riparian areas, etc. Maintain the use of known and potential wildlife reproductive habitat by retaining cover between these areas and forage openings. Maintain thermal cover, particularly along riparian areas, by retaining shrubs and dense canopy cover where snow depth may be restrictive (e.g. VRU 4N).

Special Considerations - It is expected that managing a landscape with diverse attributes will contribute greatly towards sustaining endemic levels of insects and disease. Management objectives would be the primary driver in developing silvicultural strategies to conduct vegetation management in root disease areas. Some areas with advanced root disease may not be suited for active vegetation management. These areas may be better as reserves, maintained for the unique habitat that they provide (e.g. forage openings).

Retention and planting of native vegetation is emphasized to limit the spread of noxious weeds. However, if spotted knapweed is present, mechanical site disturbance may dramatically increase its spread. Understory vegetation is maintained through implementation of site preparation techniques that consider plant phenology.

Maintain habitat for viable sensitive plant populations. Portions of this VRU are particularly suitable for such species as moonworts and howellia. Ground disturbing activities can jeopardize their status.