

Section D **Riparian Functions**

Issue: How well do current riparian protection practices on forestland provide for and maintain large wood inputs and stream temperatures necessary to maintain and recover salmonids?



Forest Practices Advisory Committee on Salmon and Watersheds

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I. Current Scientific Findings

Riparian Functions

Large wood, shade (stream temperature), microclimate, streambank stability, litterfall, sediment filtration, and floodplain processes are all riparian functions that are provided for by riparian forests (Naiman et al., 1998; Spence et al., 1996; FEMAT, 1993; Chamberlin et al., 1991; Sullivan et al., 1987; CH2MHill et al., 1999). While some or all of these functions may be provided for either directly or indirectly by the current forest practice rules and Oregon Plan voluntary measures, large wood and stream temperature are the primary functions that the rules and measures are designed to address. For this reason, this paper focuses almost exclusively on these two issues. This section of the paper provides an overview of the current scientific findings and what is generally understood in terms of forest management effects upon large wood inputs and stream temperature. A later section in this report will examine the adequacy of current efforts in providing for these two functions. For additional information on other riparian functions, see the references cited above.

Large Wood

Large wood (a.k.a. large woody debris; coarse woody debris; large organic debris) is an important component of salmonid habitat (Bisson et al., 1987; Bilby and Bisson, 1998). Large wood (LW) is a key factor in the development of channel form, including off-channel rearing backwaters, side channels, and pools and riffles, that are important for salmon. The National Research Council (1996) states that "[p]erhaps no other structural component of the environment is as important to salmon habitat as large woody debris, particularly in coastal watersheds."(p. 194)

Physical processes associated with [large woody] debris in streams include the formation of pools and other important rearing areas, control of sediment and organic matter storage, and modification of water quality. Biological properties of [woody] debris-created structures can include blockages to fish migration, provision of cover from predators and from high streamflow, and maintenance of organic matter . . . The locations and principle roles of woody debris change throughout the river system. In steep headwater streams where logs span the channel, debris creates a stepped longitudinal profile that governs the storage and release of sediment and detritus, a function that facilitates the biological processing of organic inputs from the surrounding forest. When the stream channel becomes too wide for spanning by large logs, debris is deposited along the channel margins, where it often forms the most productive fish habitat in main-stem rivers. (Bisson et al., 1987)

Large wood loading of streams has been correlated to winter survival of juvenile salmonids (Bisson et al., 1987; Murphy et al., 1986) and can increase fish numbers within a given watershed. Reeves et al. (1997) found that adding LW to Fish Creek resulted in a 27 percent increase in the mean number of fish in during the period following wood placement compared to

the prior five-year period¹. Steelhead age 1+ and smolts were also significantly larger ($P < 0.05$), 12.5 percent and 4.1 percent, respectively, following wood placement compared to the period before.

Reductions in large wood will often result in habitat simplification which has been shown to reduce the diversity of fish species (Reeves et al., 1993). Habitat simplification, however, does not necessarily result in a decline in total fish populations. Certain species and age classes may increase in numbers to occupy space vacated by other species or age classes that found the habitat simplification undesirable (Schwartz, 1990). It is also possible for habitat simplification to favor no species or age classes and all groups experience a decline in productivity (House and Boehne, 1987).

Currently there is no accepted minimum criteria for what LW levels (i.e., pieces per 1000 feet) are necessary for maintaining and recovering salmonids. Despite this lack of prescriptive information, a better understanding of possible historic stream conditions relative to current conditions can be useful. The Oregon Department of Fish and Wildlife (ODFW) Aquatic Inventory project has attempted to describe both the possible historic conditions (which would include the entire range of successional and disturbance conditions), and desired future conditions for streams in western Oregon, in terms of various aquatic habitat characteristics (Thom et al., 1998). Information about the reference sites surveyed for this project were not intended to portray what stream conditions should be like for all western Oregon watersheds, but rather give a range of values from which to compare current habitat conditions in a general way. Fifty-seven reference reaches were inventoried covering 93 km of streams, most of which occurred in the Oregon Cascade Range with a few in the Coastal Range. The reference sites were described as follows:

- 4.5 percent average stream gradient
- 11 meter (36 feet) average active channel width
- Located in unmanaged watersheds and wilderness areas
- Primarily in upper portions of watersheds and federally owned
- Fire suppression may have reduced the influence of disturbance relative to historic conditions
- Stream cleaning projects may have occurred in the past along some reaches

In the summer of 1998, the ODFW selected stream reaches across western Oregon using a random and unbiased methodology and the habitat conditions of those reaches were summarized (Thom et al., 1999)². Each area of the state had 50 sample sites, with the exception of the “Southwest Washington” area that had only 35 sites. Large wood (number of pieces, number of key pieces, and volume) was one of the habitat variables inventoried and randomly selected reaches were compared to the reference sites. The ODFW inventory defines large wood as any

¹ This difference was not statistically significant, $P > 0.05$. Due to the many different factors that influence fish populations and the variability from one year to the next, a 27% increase over five years was not statistically significant in this study.

² See Appendix C for the figures and tables referenced below.

piece greater than six inches in diameter and 10 feet in length (15 cm x 3 m). Key pieces are defined as greater than two feet in diameter and 33 feet in length (60 cm x 10 m):

The reference values observed for the distribution of the number of pieces of wood in the stream channel falls within the range observed in the streams used for current conditions analysis [i.e. reference sites] (Figure 9). . . . The number of key pieces of wood differs more markedly than the number of wood pieces. These large pieces were low in all of the areas with 50 percent of the stream length surveyed in each basin having less than 1.0 piece per 100 m of stream channel (Table 8). The median value for the reference reaches is 1.8 key pieces per 100 m of stream channel (Table 8). Again, the North Coast and Willamette areas had higher levels of key pieces of woody debris than any other area (Figure 10). The Mid-Coast, South Coast, and Lower Columbia areas had the lowest number of key wood pieces with over 75 percent of the stream length in those areas having less than 1.0 key piece per 100 m of stream channel. . . . Wood volume density showed a wide range of distributions between the different areas surveyed. The general pattern was similar to the density of wood pieces, but the distributions had a much wider range (Figure 13). (Thom et al., 1999, see Appendix C for figures and tables referenced here)

The density of large riparian conifers was also examined to understand current conditions in terms of future LW recruitment. The number of conifers greater than 20 inches in diameter and within 100 feet of the stream on the random sites was compared to the reference sites.

The number of conifers observed differs markedly from the reference reaches. All of the [randomly selected] areas show low conifer numbers with over 30 percent of the stream lengths surveyed having no large conifers in the riparian zone (Figure 8). The 75th percentile occurs at less than 120 conifers per 305 m of stream length for all of the areas, while the reference reaches had a 75th quartile of 240 conifers (Table 7). (Thom et al., 1999)

While the frequency and distribution of total pieces of LW across western Oregon appears similar to that of the reference sites, there is a marked difference when it comes to total key pieces and large riparian conifers. For the largest LW there appears to be a shortage of potential key pieces of LW currently in riparian areas. Long-term supplies may or may not be at risk, depending on whether or not adequate numbers of current small conifers are retained and grow into potential key pieces of LW in the future.

A number of different factors are responsible for the lower levels of key pieces of LW and large riparian conifers in the sampled streams. In the 1800s and up through the turn of the century, splash damming was an accepted practice that resulted in extensive scouring of long stretches of some steam channels. It's estimated that close to 25 percent of the streams in Oregon were impacted by splash damming (Dave Hibbs, personal communication, 1999). Extensive dam building and an acceleration of road building into forestland during most of this century have also reduced levels of LW in the system. As LW moved into reservoirs or backed up behind stream crossing structures, it would be removed either for safety reasons or to utilize the wood,

thereby preventing that LW from continuing downstream and being utilized by the stream system. Stream cleaning also occurred in the 1970s and early 1980s because it was believed LW was a barrier to fish passage. During this period there was an effort to remove large accumulations of LW from selected streams. A significant amount of this stream cleaning occurred immediately after large storm events such as the 1964 and 1977-78 floods. Previous to any forest practice rules that require the retention of trees along streams, harvesting operations were also removing the large trees that were potential future sources of key pieces of LW. Historical harvesting practices that did not retain riparian buffers have also resulted in fewer large conifers being grown in riparian forests and upslope areas (forestlands susceptible to landslides that result in LW being transported to fish bearing streams), reducing the future supply of key pieces of LW.

There are essentially three ways in which LW can end up in streams. It can fall directly in from the riparian area, it can be delivered via a landslide or debris flow from upslope areas, or it can be manually placed in the stream. Considering riparian areas first, potential LW inputs can be expressed as a function of distance from the stream. A review of the literature shows that anywhere from 70 percent to 99 percent of the LW input potential *from adjacent riparian stands* originates from within the first 30 meters, or about 100 feet, of the riparian forest (Murphy and Koski, 1989; Van Sickle and Gregory, 1990; McDade et al., 1990; Bilby and Bisson, 1998). It is also possible, however, for 70-99 percent of the LW input potential from riparian stands to originate from within the first 50 feet of the riparian forest (Murphy and Koski, 1989). It should be emphasized that these studies did not intend to examine upslope source areas. They analyze potential LW inputs in terms of the total LW potential from riparian areas only. Large wood is defined in most of these studies as pieces with a minimum diameter of 10 centimeters (4 inches) and a minimum length of 1-1.5 meters (3.25-5 feet). The majority of larger pieces of LW, such as key pieces, originate from within a distance less than 100 feet (Robison and Beschta, 1990). The bulk of the potential *riparian area* inputs of LW comes from vegetation in close proximity to the channel, with diminishing amounts coming from distances farther from the stream (Figure 1).

The incidence of windthrow affects the frequency and distribution of LW inputs from riparian areas. An increase in windthrow can occur where riparian buffers are retained. It is generally believed that the potential for windthrow is higher for narrow buffers and decreases for wider buffers, however there is a wide range of scientific opinion on how wide a buffer needs to be before the risk of windthrow is significantly reduced. Windthrow associated with riparian buffers is also highly variable depending on vegetation, local topographic relief, and an area's susceptibility to windstorms. It could be argued that an increase in the incidence of windthrow due to narrow buffers could have a positive short-term effect on salmonid habitat by delivering LW to the stream (Spence et al., 1996). Potential negative effects of windthrow include an increase in stream temperatures due to additional solar radiation reaching the stream, increased bank erosion due to the displacement of soil by root wads, upslope erosion of fine sediments where oversteepened slopes are exposed by displaced trees, and reduced LW input potential until a future stand of large trees becomes established.

There are many factors that must be considered in determining what types of buffers are effective or ideal in maintaining or enhancing salmonid production. Botkin et al. (1995) points out that mature forests (forests older than 100 years of age) covered 50-70 percent of the Coast Range between 1850 and 1940. It is estimated that historically 15-25 percent of the forest in the Central Oregon Coast Range was in early successional stages because of disturbance by wildfire (Benda, 1994; Reeves et al., 1995). Wildfire, floods and windstorms were all important disturbance events that had a significant effect on forest characteristics. These types of disturbance also tend to leave behind significant amounts of structure in the form of snags and large wood on the ground, as compared to timber harvesting where this is not always the case. Data presented by Dave Hibbs (MOA Riparian Habitat Workshop) illustrated how the percentage of forestland in conifer versus hardwoods changed dramatically over 1000-year time periods, sometimes by a factor of fifty percent. At least for coastal forests, it appears that hardwood tree species may have been much more pervasive at certain times than was previously assumed to be the case. While the notion of mature forest conditions everywhere on the Coast Range (and the Cascades) is not consistent with what is known about historic disturbance patterns, the current disturbance pattern due to fire suppression and forest management is not consistent with historic disturbance patterns either.

LW Input Potential vs. Riparian Buffer Width

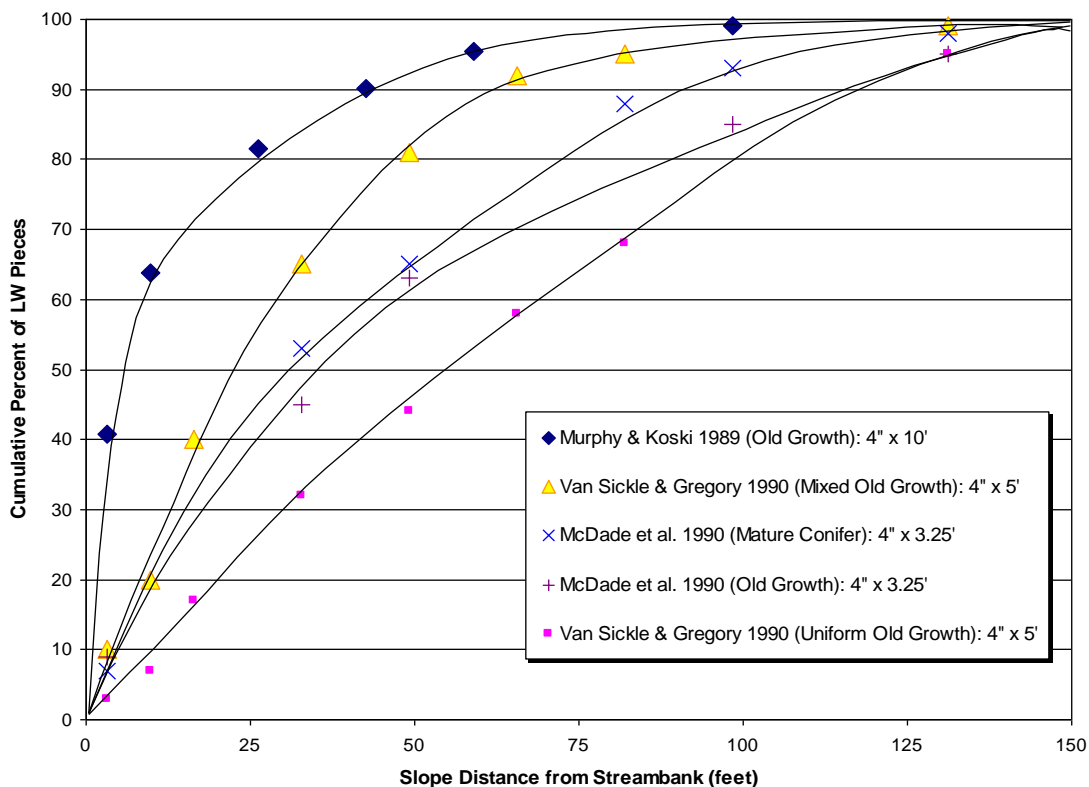


Figure 1: Compilation of current studies relating buffer width to large wood input potential. Murphy and Koski (1989) conducted their study in Alaska, the McDade et al. (1990) data is from the Oregon Cascades, Van Sickle and Gregory “mixed old growth” data is from the Oregon Cascades, and the Van Sickle and Gregory “uniform old growth” is modeled data from a hypothetical (modeled) stand.

Historically, most streams, wetlands, and lakes had some riparian overstory vegetation composed of conifer and/or hardwood trees. The processes for plant succession in riparian areas are debated and it is likely that succession follows a number of potential paths. Beavers and elk may have maintained some riparian areas, particularly along lower gradient reaches, in early (more open) seral stages. Large conifer, now often absent in some riparian areas, may have played an important role in conifer regeneration on some sites through nurse trees (Hibbs and Giordano, 1996). This role may have been relatively more important on wet coastal sites. Vegetation succession paths are likely to vary for different streams. More frequent disturbance events, including beaver activity and floods, may create more diverse conditions and a greater hardwood component on larger and lower gradient streams. Small streams in steeper terrain, however, are more likely to be more dominated by conifer due to different types of disturbance (more frequent fire) and site conditions. Since large wood originates from many different sources on the landscape, these patterns also likely influenced large wood inputs and habitat conditions.

In terms of source areas for LW, potential inputs are not limited to stream-adjacent locations. Upstream or upslope areas can also be a source of LW for fish bearing streams (Keller and Swanson, 1979; McGarry, 1994; Benda and Sias, 1998). In steep landscapes, where the occurrence of debris flows is a normal part of the disturbance regime, relatively large pieces of LW in small streams can play an important role in maintaining salmonid habitat (Swanson et al., 1987). High stream flows and debris flows are both mechanisms by which LW can be transported from relatively small stream channels downstream to larger channels.

Debris flows can periodically move very large pieces of wood from a hillslope or hollow downslope to fish bearing streams where the LW can interact with the channel and form fish habitat. In these cases, small stream channels can play a significant role in contributing key pieces of LW to downstream riparian functions. These sources of LW have been referred to as both “upslope” and “upstream” sources. For the sake of clarity, the following terminology will be used to define LW sources for this discussion.

Near-stream riparian:

Areas directly adjacent to the stream. LW is delivered simply by the tree falling directly into the stream from the adjacent streambank or hillslope.

Upstream riparian:

Near-stream riparian sources that are upstream of the reach of concern. High water and/or a debris flow transport the LW to its current location after initially falling into the stream from the riparian area.

Upslope:

Zero-order channels (zero-order channels are small unbranched draws), hollows, or hillslopes. Areas outside of the riparian area. LW is delivered by a landslide or landslide-debris flow combination that moves the wood into the stream channel from these areas.

Currently there is limited scientific information on the relative inputs from these three sources. McGarry (1994) is one of the few studies that have attempted to quantify the relative contribution

from each LW source. He found that the LW inputs in Cummins Creek, Oregon were split about 50/50 between near-stream riparian and other source areas, or what was termed “transported” and “nontransported”. McGarry (1994) did not attempt to quantify what percent of the transported LW originated from upstream versus upslope areas. McDade et al. (1990) also identified about 50 percent of the LW as originating from near-stream areas, but did not attempt to classify the origin of the other 50 percent either. Unless the debris flow and/or landslide delivering the material is inventoried before high stream flows are able to transform the deposits and relocate the LW downstream, it is difficult to determine what pieces of transported LW originated from upslope versus upstream areas. Both of these studies (MacGarry, 1994; McDade, 1990) utilized a single-season data collection method, representative of conditions for a snap-shot in time.

Despite the limitations of the data, some qualitative statements can be made in regards to LW sources. In terms of upslope sources, the relative importance of potential LW from zero-order channels and hillslopes to a given stream reach becomes less and less the larger the channel network is above that reach. The larger the channel is along a given reach, the greater the percentage of potential LW originates from near-stream and upstream riparian sources. This will vary, however, depending on the topographic characteristics and landslide/debris flow potential. An area where debris flows rarely occur and where the slopes are relatively mild will have virtually all of the LW originating from near-stream and upstream riparian sources. An area that has frequent landslide/debris flow activity and relatively steep slopes, on the other hand, may have a significant portion of the LW potential in upslope sources originating from the zero-order channels and hillslopes. Benda and Sias (1998) conducted a modeling exercise where they estimated that the overall contribution of LW by debris flows is limited to about 10-15 percent of the overall wood budget. While this may imply that mass wasting plays a relatively minor role in the long-term wood budget of a given watershed, “wood from debris flows can overwhelm all other sources to a channel or valley floor locally in time and space, and therefore dominate in the shorter-term (decadal – human lifespan).” (Benda and Sias, 1998)

Where shallow rapid landslides are rare or do not occur, the dominant available mechanism for transporting LW downstream is stream flow. For this population of streams, the hydrologic regime will determine what sizes of LW will be stable and hydrologically functional in the channel. Bilby (1985) found that length and diameter of stable large wood in a stream is in part a function of channel width, where smaller pieces of LW can be stable in smaller streams. Other research has found that the amount and distribution of LW will vary with channel size. Smaller channels contain more abundant amounts of randomly distributed LW, while larger streams more easily transport LW, resulting in fewer pieces and reduced aggregation of LW (Bilby and Bisson, 1998). On very large, main-stem channels, LW tends to form accumulations at the head of gravel bars and along the edge of the channels. These accumulations are important for maintaining spawning areas and creating off-channel habitats (Sedell et al., 1982).

Stream Temperature

Stream temperature is an important component of fish habitat and has a direct effect on the growth and survival of salmonids. The effect of changes in stream temperature on fish varies between species and within the life cycle of a given species (DEQ, 1995). Critical life stages that

occur during the warmest months in the summer are of particular concern. For the chinook salmon, juvenile rearing, adult holding and adult migrations all occur during the summer months. Juvenile rearing also occurs in the summer for the coho salmon, and migration occurs in the late summer and early fall. Spawning and within-stream migration occurs in the summer and fall for the bull trout. Preferred temperature ranges for these species and particular life stages are shown in Table 1.

Table 1. Optimum and lethal limit temperature ranges for coho, chinook and bull trout (from DEQ 1995).

<i>Fish Species</i>	<u>Coho</u>	<u>Chinook</u>	<u>Bull Trout</u> ³
<i>Preferred juvenile temperature range</i>	54-57°F	50-60°F	39-50°F
<i>Adult migration, holding, or spawning</i>	45-60°F	46-55°F	39-54°F
<i>Lethal limit</i>	77°F	77°F	NA
<i>State water quality standard</i> ⁴	64°F	64°F	50°F

The various physiological and ecological processes of salmonids that are affected by temperature are well documented. Listed below are some of the more important processes (from Spence et al. 1996).

- Decomposition rate of organic materials
- Metabolism of aquatic organisms, including fishes
- Food requirements, appetite, and digestion rates of fish
- Growth rates of fish
- Developmental rates of embryos and alevins
- Timing of life-history events including migrations, fry emergence, and smoltification
- Competitor and predator-prey interactions
- Disease-host and parasite-host relationships
- Development rate and life history of aquatic invertebrates

Exposure to temperatures above optimum levels has the potential to negatively affect salmonid survival and recovery. As stream temperature increases, the ability of water to hold dissolved oxygen decreases (MacDonald et al., 1991). Increases in stream temperature also raise the metabolic rate of salmonids, which can enlarge demands on the available food supply. Primary productivity can be augmented as a result of increases in light reaching the stream where nutrients are limiting, which can add to the available food supply for salmonids (MacDonald et al., 1991; Murphy and Meehan, 1991). However, decreased levels of dissolved oxygen may also lead to appetite suppression in salmonids (Jobling, 1993; in Spence et al., 1993).

³ The optimal temperature for rearing and the lethal limit may actually be different from the values listed in Table 1. Preliminary results of on-going research by Dr. Bob Danehy concludes that the optimal rearing and lethal limit are closer to 54-58°F and 69°F, respectively (Bob Danehy, personal communication.)

⁴ See Appendix E for more information on state water quality standards and rules.

The presence of cool-water refugia can help salmonids avoid areas with adverse stream temperatures and help sustain a population of sensitive species (Bilby, 1984; Sedell et al., 1990). When ambient stream temperatures are too warm, sensitive aquatic species can inhabit these patches of cool water habitat. Deep pools, cool springs, hyporheic flow, and the junction of cooler tributary streams are all examples of cool-water refugia. Matthews et al. (1994) and Nielsen et al. (1994) found that stream temperatures are stratified in deep pools (3 to 9 feet), in pools with large gravel bars at the upstream end, and in shallow pools (1.5 feet) with subsurface seepage. Differences in temperature ranged from 7.0 to 8.0°F between the stream surface and stream bottom in these areas.

There are several factors that make up the heat balance of water, which determine how the temperature of a stream will change as it flows downstream. Net radiation, evaporation, convection, conduction, and advection all contribute to the net rate of gain or loss in stream temperature as it moves through a forest (Brown 1983). Stream temperatures also can fluctuate significantly over both space and time. Seasonal and daily cycles produce a high degree of variability in stream temperatures. Spatial variables such as latitude, proximity to the ocean, stream order, and distance from watershed divide can all affect differences in stream temperatures as well (Beschta et al., 1987; Sullivan et al., 1990). Heat inputs result from solar radiation, conserved solar radiation in the form of channel substrate heat loading (conduction), and air temperature that is greater than the water temperature (convection). Heat losses occur from evaporation, air temperature that is less than the water temperature (convection), channel bed conduction if the bed is cooler than the water column, and surface water/ground water interactions. Over any stream length heat will be retained as it flows downstream in the water column only if the heat inputs are greater than the heat losses.

During the summer months, when stream temperatures are at their highest, the combination of direct solar radiation, a decrease in discharge, and the relative number of tributaries have the greatest effect on stream temperatures changes in the downstream direction (Beschta et al., 1987). Of these three factors, forest management can have the greatest effect on direct solar radiation. Solar energy is also the largest component of energy available to warm stream water (Chamberlin et al., 1991). The more forest canopy that is removed that reduces shade, the more energy reaches the stream translating into a potential increase in stream temperature. While shade cannot physically cool the stream down, it can prevent further heating of the stream. In the case where significant groundwater inputs or tributaries are contributing relatively cool water, shading can have the appearance of cooling. In fact what is occurring is that shade is preventing further heating so that other processes (e.g., evaporation; groundwater mixing; convection) have a chance to cool the stream.

Many studies have documented increases in stream temperature due to timber harvesting. The degree of impact varies with particular practices and stream characteristics. Harvesting to the edge of the stream without leave trees or riparian buffer strips is consistently shown to increase mean, maximum, and diurnal fluctuation of stream temperature (Levno and Rothacher, 1967; Meehan, 1970; Feller, 1981; Hewlett and Fortson, 1982; Holtby, 1988). Maintaining riparian vegetation has been shown to be successful in minimizing or eliminating increases in stream temperature associated with harvesting (Brazier and Brown, 1973; Kappel and DeWalle, 1975; Lynch et al., 1985; Amaranthus et al., 1989). When examining the potential influence of

harvesting near streams on stream temperatures, it is important to account for 'natural' heating in the downstream direction that is commonly observed (Sullivan et al., 1990; Zwieniecki and Newton, 1999). Increases in stream temperatures that might occur in the downstream direction whether or not vegetation is removed can be difficult to separate out from potential harvesting effects on stream temperatures (Dent and Walsh, 1997).

The width of the riparian vegetation alone, however, does not dictate the amount of shade provided to a given stream reach. Canopy density, canopy height, stream width, and stream discharge are all interrelated and determine the effectiveness of the riparian buffer width (Brazier and Brown, 1973). For example, a stand of dense vine maple and salmonberry over a small stream might provide close to 100 percent shading for that stream in the middle of summer. It would not matter how much riparian vegetation was retained beyond the width occupied by these two species in terms of increased shade. For a medium or large stream in eastern Oregon, on the other hand, that has a widely-spaced stand of Ponderosa Pine it may not be possible to obtain 100 percent shade no matter how wide of a buffer is retained. Because of the complex interactions between all of the factors that determine effective shade about a stream, buffer width alone is not always a reliable determinant of effective shade.

Angular canopy density (ACD) is an effective means of providing a direct estimate of the shading effects of riparian vegetation (NCASI, 1999). ACD is a measurement of the canopy density at an angle coincident with the sun when the most significant solar heating occurs. ACD is expressed as a percentage, where 100 percent represents no sunlight reaching the stream or forest floor. Considering small streams only, Figure 2 demonstrates the relatively high variability of buffer width as a determinant of effective shade. For example, 75-90 percent shading can be achieved with a buffer width of anywhere from 30 to 145 feet. Looking at it a different way, a 50-foot buffer width might provide anywhere from 18-80 percent shading.

Natural disturbance regimes historically played a significant role in the temporal and spatial distribution of forest-types across the landscape (Swanston, 1991). The historic distribution of forest-types is important in understanding the temporal and spatial distribution of effective shade along riparian areas across the landscape. While significant areas of 'old growth' are likely to have occurred along riparian areas historically, variability in the intensity, timing, and location of disturbance events created a diverse mosaic of riparian vegetation characteristics. Wildfire, windthrow, debris torrents, and major floods periodically reset riparian forests and changed the characteristics of riparian vegetation. The result of the natural disturbance events in terms of effective shade is that while relatively high levels of shade may have been present in some areas or at one moment in time, lower shade levels are likely to have occurred in other areas or at another moment in time. Understanding the natural or climactic variability in stream temperatures brought about by natural disturbance regimes is an important first step in understanding how forest management may be altering stream temperatures and thus influencing salmonid populations. If harvesting near a stream results in temperature changes that are consistent with the range of natural variability, both spatially and temporally, of the temperature regime, then such effects may be unimportant (Beschta et al., 1987). However where the opposite is true, harvesting effects on the maintenance and recovery salmonids may be significant.

II. Watershed-Scale Effects

Natural Variability

The historic condition of riparian forests in which salmonids evolved and thrived was significantly influenced by natural disturbance (fire, insects, disease, windthrow, landslides, and floods). A high degree of spatial and temporal variability was present at both small and large scales. Fire disturbance has received increased attention in recent years, perhaps because it is arguably the disturbance-type that has been most influenced by human activities across the landscape (Agee, 1998). More recently, increased attention has been given to the effects of landslides and flooding in how they influence the physical and biological characteristics of riparian areas and associated aquatic species.

The spruce and Douglas fir forests of the Oregon Coastal Range and Cascade Range were historically subjected to infrequent (every 175-250 years), high-intensity fires, while the pine forests of eastern Oregon experience frequent (every 10-30 years) low-intensity fires. Portions of both eastern and western Oregon also experience a moderate-intensity fire regime, where semi-frequent (every 30-175 years) fires would result in a patchwork of stands of various ages (Agee 1998). High intensity fires tend to “reset” the landscape by killing all live vegetation resulting in even-aged forests. Low intensity fires tend to burn mostly understory vegetation leaving the larger trees unimpacted, resulting in a forest of widely spaced larger trees with a relatively open understory (Agee, 1998).

Decades of fire suppression has increased the frequency and intensity of insect and disease disturbance in eastern Oregon, where relatively dense stands of pine and mixed conifer forests have become stressed due to increased competition for limited resources. As a result, these forests can be more susceptible to high-severity fire and insect and disease outbreaks than was historically the case. For low-severity fire regimes, Agee (1998) suggests that a combination of underburning and thinning to modify the fuel loads in the system can result in a forest that more closely resembles a natural pattern. In areas where moderate-severity fire regimes were historically present, harvesting techniques that utilize partial cuts, small patch cuts with snag retention, and a system of reserves will result in a forest structure that more closely resembles the historic pattern than either even-aged management or a no-harvest reserve system that does not recognize natural disturbance processes (Agee, 1998). Management options that influence fire behavior in forests adapted to high-severity fire regimes are relatively limited. Severe weather appears to be the controlling factor in these forest-types, thus large stand-replacement fires are probably going to occur regardless of the fire suppression activities or harvesting methods that are employed (Agee, 1998).

An investigation of forest succession following a high intensity fire is presented by Tappeiner et al. (1997). In this study, the diameters and diameter growth rates for the first 100 years of old-growth stands on the Oregon Coast were compared to 50-70 year-old second-growth stands. It was observed that the regeneration of old-growth forests do not necessarily follow the scenario of a stand replacement disturbance followed by an even-aged forest. The ten old-growth study sites

that were examined showed that the development of these forests occurred over a prolonged period where the trees grew at a low density with little self-thinning. It is suggested that where the management objective is to speed development of old-growth characteristics, thinning may be needed in dense young stands. As few as 40-49 trees per acre were observed in the early stages of some old-growth stands that were examined:

Density of young-growth stands in this study was greater than that of old stands [when the stand was younger than 100 years], and diameter growth rates of individual trees were much less, even in the thinned stands. Our stand simulations also indicated that young stands with even as few as 250 trees/ha [about 100 trees/ac] will develop along a different pathway than the old stands. (Tappeiner et al., 1997)

Riparian functions and the maintenance of riparian forests have important implications in terms of disturbance regimes and watershed-scale effects. Riparian forests can provide important functions that include the delivery of large wood to streams, corridors for wildlife, and stream temperature protection for threatened and endangered fish. There is evidence, however, that riparian areas maintained as reserves where management is excluded can become corridors for severe wildfire (Segura and Snook, 1992, *in* Agee, 1998). However, there is limited data available to evaluate the susceptibility of different riparian community types to severe fire (Agee, 1998). Disturbance plays an important role in the ecology of both upland and riparian forests. Management prescriptions that do not consider the role of disturbance and historical patterns of forest succession may result in riparian forests that differ significantly from what occurred in the past.

Forest Management

Large Wood

Watershed-scale effects can be an issue for small Type N streams and on steep hillslopes with the potential to deliver LW via debris flows and landslides. Currently, the rules do not address the issue of potential LW inputs from upslope sources (i.e. source areas that do not require riparian buffers). In watersheds where periodic debris flows and landslides are an important part of the natural disturbance regime, the possibility exists for a significant percentage of these source areas to be harvested and potential LW inputs removed. Therefore, different harvesting patterns will result in different watershed-scale effects in terms of potential upslope sources of LW. For those forestlands that are not characterized by steep slopes, where small Type N streams do not have the potential to deliver LW to Type F streams, watershed-scale effects due to habitat foregone by the lack of recruitment of LW are unlikely to occur.

The hardwood conversion option also presents an opportunity for watershed-scale effects to be an issue. If within a certain watershed there are a significant number of operations that take advantage of this option, while in another watershed this option is generally not being used, a watershed-scale effect could be observed as a result of the hardwood conversions. The effect would likely be a short-term loss in potential LW and possible temperature effects, in return for

an anticipated long-term gain once conifers can be re-established. It should be noted that the potential LW lost is of nondurable hardwoods that persist for a significantly shorter period of time in the channel as compared to the conifers. Currently, however, landowners are rarely exercising this option.

Stream Temperature

Under ‘natural’ conditions, summertime stream temperatures generally tend to increase in a downstream direction and approach the mean basin air temperature at some distance from the watershed divide.

Because stream discharge (and water depth) increases in a downstream direction, the capability of incoming solar radiation to increase summertime stream temperatures also tends to diminish downstream. Further, as small shaded streams combine to form larger streams with intermediate levels of shading, and these in turn combine to form relatively wide and mostly unshaded rivers, the relative importance of stream-adjacent vegetation for providing shade becomes a less significant component of a stream’s energy balance. . . . [T]he harvesting of streamside vegetation and its ability to increase summertime stream temperatures is generally most critical for small- to intermediate-sized (perhaps 3rd to 4th-order) streams (Sullivan and Adams, 1990; in Beschta et al., 1995).

The potential for watershed-scale effects to occur depends on the combination of the degree of impacts from harvesting and the size of the stream that is impacted. Caldwell et al. (1991) concluded that there is a 150-meter “zone of concern” (about 500 feet) downstream of the smallest perennial streams where there is a potential for a cumulative effect to occur. As long as there is at least a 150-meter shaded reach between these streams where the canopy has been removed, there is a minimal risk of a cumulative downstream temperature impact (Caldwell et al., 1991). Temperature increases that result from harvesting near larger streams generally require a longer distance under canopy to return the “equilibrium temperature”, but this will depend on the magnitude of the increase and the thermal dynamics of the downstream reach (e.g., existing shade, channel morphology, groundwater inflows, hyporheic zones).

Beschta et al. (1995) offers another perspective on the relevance of the tendency for temperatures to increase in the downstream direction and potential harvesting effects.

The tendency for water temperatures to increase in a downstream direction may seemingly imply that the effects of timber harvest are not of significance in relation to the naturally occurring downstream increases, or that temperature increases can be tolerated in smaller tributaries because they are less likely to contain fish. However, if the temperatures in headwater streams were to be elevated by reductions in riparian shading, warmer waters may occur along intermediate sized reaches of a stream network and perhaps shift the preferred habitat of thermally sensitive fish and other aquatic species towards the steeper tributaries.

While there is merit to this hypothesis, there are currently no studies that have been effective in either confirming or disproving it. The ODF monitoring program has been collecting stream temperature data at both the reach and basin scale over the past few years that may help evaluate this hypothesis. Final results from data collected for a number of stream temperature-related projects that will help address the adequacy of the rules in terms of meeting water quality standards will be available by 2001.

Other Land Uses

Figure 3 is a flow chart illustrating the many pathways by which all land uses can influence stream temperature changes and what processes need to be considered. Urban and agricultural lands generally do not require riparian buffers of the type that are prescribed for forestlands under the current water protection rules. Riparian prescriptions on urban lands vary throughout the state, depending on city and county development practices. Under SB1010 that was passed in 1993, the Oregon Department of Agriculture requires that landowners' activities be conducted in a manner that will adequately address water quality limiting factors. However, no guidance or BMPs are prescribed by the ODA that instructs the landowner on how to comply.

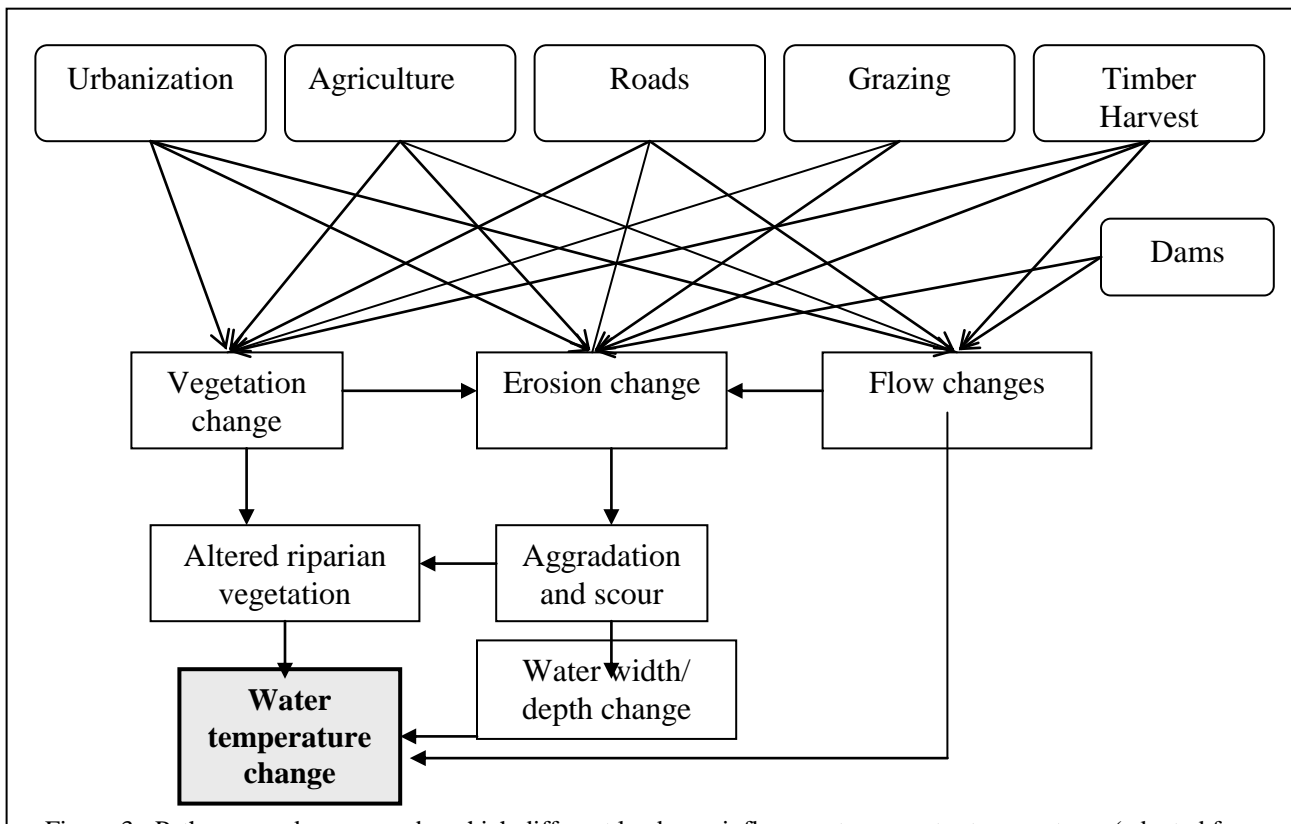


Figure 3. Pathways and processes by which different land uses influence stream water temperatures (adapted from Ziemer 1998).

Removal of LW from the stream is sometimes required for public safety and infrastructure considerations. Large wood originating from upland forests can work its way downstream, collecting against bridges and other stream crossing structures. When LW becomes backed up

behind these structures, it can cause damage associated with lowland flooding in urban, agricultural, and residential areas. The structural integrity of the crossing can also be at risk when LW is held back during high water. There is a potential issue here about how upstream activities in forestlands may affect downstream landowners. Where LW and migrating organic dams move downstream into agricultural and urban environments, there can be a conflict between what might be good for fish versus what might have negative impacts upon landowners and the general public.

Where the effective shade is reduced for streams adjacent to other land uses, the potential watershed-scale effects are essentially the same as what would occur on forestlands. Where there are combined land uses, such as grazing and timber harvesting in areas of eastern Oregon, it can be difficult to sort out the relative contributions to stream temperature effects.

III. Objectives of the Current Measures and Rules

Oregon Plan Objectives

Appendix B contains the interim objectives under the Oregon Plan for “instream roughness” (large wood) and temperature (“temperature biological objectives”). There are no explicit interim objectives for streambank stability (root strength), litterfall, microclimate, sediment filtration, and floodplain processes.

FPA Objectives

Statutes

ORS 527.710

(8) If based upon the analysis required in section 15 (2)(f), chapter 919, Oregon Laws 1991, and as the results become available, the board determines that additional rules are necessary to protect forest resources pursuant to ORS 527.630, the board shall adopt forest practice rules that reduce to the degree practicable the adverse impacts of cumulative effects of forest practices on air and water quality, soil productivity, fish and wildlife resources and watersheds. Such rules shall include a process for determining areas where adverse impacts from cumulative effects have occurred or are likely to occur, and may require that a written plan be submitted for harvests in such areas.

ORS 527.765 Best management practices to maintain water quality.

(1) The State Board of Forestry shall establish best management practices and other rules applying to forest practices as necessary to insure that to the maximum extent practicable nonpoint source discharges of pollutants resulting from forest operations on forestlands do not impair the achievement and maintenance of water quality standards established by the Environmental Quality Commission for the waters of the state. Such best management practices shall consist of forest practices rules adopted to prevent or reduce pollution of

waters of the state. Factors to be considered by the board in establishing best management practices shall include, where applicable, but not be limited to:

- (a) Beneficial uses of waters potentially impacted;
- (b) The effects of past forest practices on beneficial uses of water;
- (c) Appropriate practices employed by other forest managers;
- (d) Technical, economic and institutional feasibility; and
- (e) Natural variations in geomorphology and hydrology.

- (2) The board shall consult with the Environmental Quality Commission in adoption and review of best management practices and other rules to address nonpoint source discharges of pollutants resulting from forest operations on forestlands.

ORS 527.770 Good faith compliance with best management practices not violation of water quality standards; subsequent enforcement of standards.

A forest operator conducting, or in good faith proposing to conduct, operations in accordance with best management practices currently in effect shall not be considered in violation of any water quality standards. When the State Board of Forestry adopts new best management practices and other rules applying to forest operations, such rules shall apply to all current or proposed forest operations upon their effective dates.

Administrative Rules

OAR 629-635-100 - Water Protection Rules; Purpose and Goals

- (3) The purpose of the water protection rules is to protect, maintain and, where appropriate, improve the functions and values of streams, lakes, wetlands, and riparian management areas. These functions and values include water quality, hydrologic functions, the growing and harvesting of trees, and fish and wildlife resources.
- (4) The water protection rules include general vegetation retention prescriptions for streams, lakes and wetlands that apply where current vegetation conditions within the riparian management area have or are likely to develop characteristics of mature forest stands in a "timely manner." Landowners are encouraged to manage stands within riparian management areas in order to grow trees in excess of what must be retained so that the excess may be harvested.
- (5) The water protection rules also include alternative vegetation retention prescriptions for streams to allow incentives for operators to actively manage vegetation where existing vegetation conditions are not likely to develop characteristics of mature conifer forest stands in a "timely manner."
- (6) OARs 629-640-400 and 629-645-020 allow an operator to propose site-specific prescriptions for sites where specific evaluation of vegetation within a riparian management area and/or the condition of the water of the state is used to identify the appropriate practices for achieving the vegetation and protection goals.
- (7) The overall goal of the water protection rules is to provide resource protection during operations adjacent to and within streams, lakes, wetlands and riparian management areas so that, while continuing to grow and harvest trees, the protection goals for fish, wildlife, and water quality are met.

- (a) The protection goal for water quality (as prescribed in ORS 527.765) is to ensure through the described forest practices that, to the maximum extent practicable, non-point source discharges of pollutants resulting from forest operations do not impair the achievement and maintenance of the water quality standards.
- (b) The protection goal for fish is to establish and retain vegetation consistent with the vegetation retention objectives described in OAR 629-640-000 (streams), OAR 629-645-000 (significant wetlands), and OAR 629-650-000 (lakes) that will maintain water quality and provide aquatic habitat components and functions such as shade, large woody debris, and nutrients.

OAR 629-640-000 - Vegetation Retention Goals for Streams; Desired Future Conditions

- (1) The purpose of this rule is to describe how the vegetation retention measures for streams were determined, their purpose and how the measures are implemented. The vegetation retention requirements for streams described in OAR 629-640-100 through OAR 629-640-400 are designed to produce desired future conditions for the wide range of stand types, channel conditions, and disturbance regimes that exist throughout forestlands in Oregon.
- (2) The desired future condition for streamside areas along fish use streams is to grow and retain vegetation so that, over time, average conditions across the landscape become similar to those of mature streamside stands. Oregon has a tremendous diversity of forest tree species growing along waters of the state and the age of mature streamside stands varies by species. Mature streamside stands are often dominated by conifer trees. For many conifer stands, mature stands occur between 80 and 200 years of stand age. Hardwood stands and some conifer stands may become mature at an earlier age. Mature stands provide ample shade over the channel, an abundance of large woody debris in the channel, channel-influencing root masses along the edge of the high water level, snags, and regular inputs of nutrients through litter fall.
- (3) The rule standards for desired future conditions for fish use streams were developed by estimating the conifer basal area for average unmanaged mature streamside stands (at age 120) for each geographic region. This was done by using normal conifer yield tables for the average upland stand in the geographic region, and then adjusting the basal area for the effects of riparian influences on stocking, growth and mortality or by using available streamside stand data for mature stands.
- (4) The desired future condition for streamside areas that do not have fish use is to have sufficient streamside vegetation to support the functions and processes that are important to downstream fish use waters and domestic water use and to supplement wildlife habitat across the landscape. Such functions and processes include: maintenance of cool water temperature and other water quality parameters; influences on sediment production and bank stability; additions of nutrients and large conifer organic debris; and provision of snags, cover, and trees for wildlife.
- (5) The rule standards for desired future conditions for streams that do not have fish use were developed in a manner similar to fish use streams. In calculating the rule standards, other

factors used in developing the desired future condition for large streams without fish use and all medium and small streams included the effects of trees regenerated in the riparian management area during the next rotation and desired levels of instream large woody debris.

- (6) For streamside areas where the native tree community would be conifer-dominated stands, mature streamside conditions are achieved by retaining a sufficient amount of conifers next to large- and medium-sized fish-use streams at the time of harvest, so that halfway through the next rotation or period between harvest entries, the conifer basal area and density is similar to mature unmanaged conifer stands. In calculating the rule standards, a rotation age of 50 years was assumed for even-aged management and a period between entries of 25 years was assumed for uneven-aged management. The long-term maintenance of streamside conifer stands is likely to require incentives to landowners to manage streamside areas so that conifer reforestation occurs to replace older conifers over time.
- (7) Conifer basal area and density targets to produce mature stand conditions over time are outlined in the general vegetation retention prescriptions. In order to ensure compliance with state water quality standards, these rules include requirements to retain all trees within 20 feet and understory vegetation within 10 feet of the high water level of specified channels to provide shade.
- (8) For streamside areas where the native tree community would be hardwood dominated stands, mature streamside conditions are achieved by retaining sufficient hardwood trees. As early successional species, the long-term maintenance of hardwood streamside stands will, in some cases, require managed harvest using site specific vegetation retention prescriptions so that reforestation occurs to replace older trees. In order to ensure compliance with state water quality standards, these rules include requirements in the general vegetation retention prescription to retain all trees within 20 feet and understory vegetation within 10 feet of the high water level of specified channels to provide shade.
- (9) In many cases, the desired future condition for streams can be achieved by applying the general vegetation retention prescriptions, as described in OAR 629-640-100 and OAR 629-640-200. In other cases, the existing streamside vegetation may be incapable of developing into the future desired conditions in a "timely manner." In this case, the operator can apply an alternative vegetation retention prescription described in OAR 629-640-300 or develop a site specific vegetation retention prescription described in OAR 629-640-400. For the purposes of the water protection rules, "in a timely manner" means that the trees within the riparian management area will meet or exceed the applicable basal area target or vegetation retention goal during the period of the next harvest entry that would be normal for the site. This will be 50 years for many sites.
- (10) Where the native tree community would be conifer dominant stands, but due to historical events the stand has become dominated by hardwoods, in particular, red alder, disturbance is allowed to produce conditions suitable for the re-establishment of conifer. In this and other situations where the existing streamside vegetation is incapable of developing characteristics of a mature streamside stand in a "timely manner," the desired action is to

manipulate the streamside area and woody debris levels at the time of harvest (through an alternative vegetation retention prescription or site specific vegetation retention prescription) to attain such characteristics more quickly.

Additional administrative rules are listed in Appendix D.

IV. Description of the Measures and Rules

Oregon Plan Measures

The Oregon Plan contains several voluntary measures to supplement the conifer stocking within riparian areas and the recovery rate for LW to streams. This is accomplished during harvest operations by (1) placing appropriate-sized LW within streams that meet parameters of gradient, width, and existing wood in the channel; and (2) relocating in-unit leave trees in priority areas⁵ to maximize their benefit to salmonids while recognizing operational constraints, other wildlife needs, and specific landowner concerns.

The measures include the following:

ODF 8S: Riparian Conifer Restoration

Forest practice rules have been developed to allow and provide incentives for the restoration of conifer forests along hardwood-dominated RMAs where conifers historically were present. This process enables sites capable of growing conifers to contribute conifer Large Wood Debris (LWD) in a timelier manner. This process will be modified to require an additional review process before the implementation of conifer restoration within core areas.

ODF 19S: Additional Conifer Retention along Fish Bearing Streams in Core Areas

This measure retains more conifers in RMAs by limiting harvest activities to 25 percent of the conifer basal area above the standard target. This measure is only applied to RMAs containing a conifer basal area that is greater than the standard target.

ODF 20S: Limited RMA for Small Type N Streams in Core Areas

This measure provides limited 20-foot RMAs along all perennial or intermittent small Type N streams for the purpose of retaining snags and downed wood.

ODF 21S: Active Placement of LW during Forest Operations

This measure provides a more aggressive and comprehensive program for placing LW in streams currently deficient of LW. Placement of LW is accomplished following existing ODF/ODFW placement guidelines and determining the need for LW placement is based upon a site-specific stream survey.

⁵ The Executive Order replaced the concept of “core areas” with “priority areas”. See (1)(f) of the Executive Order (p.5).

ODF 22S: 25 Percent In-unit Leave Tree Placement and Additional Voluntary Retention

This measure has one nonvoluntary component and two voluntary components:

- 1) The State Forester, under statutory authority, will direct operators to place 25 percent of in-unit leave trees in or adjacent to riparian management areas on Type F and D streams.
- 2) The operator voluntarily locates the additional 75 percent in-unit leave trees along Type N, D or F streams, and
- 3) The State Forester requests the conifer component be increased from 50 percent to 75 percent.

ODF 61S: Analysis of "Rack" Concept for Debris Flows

OFIC members will conduct surveys to determine the feasibility and value of retaining trees along small type N streams with a high probability of debris flow in a "rack" just above the confluence with a Type F stream. The rack would extend from the RMA along the Type F stream up the Type N stream some distance for the purpose of retaining trees that have a high likelihood of delivery to the Type F stream.

ODF 62S: Voluntary No-Harvest Riparian Management Areas

Establishes a system to report and track, on a site-specific basis, when landowners voluntarily take the opportunity to retain no-harvest RMAs.

DEQ measures include the following:

DEQ2S - Development of 303(D) List and Identification of Priorities for Total Maximum Daily Loads (TMDL) Development

- Summary of Measure: Under Section 303(d) of the Clean Water Act, Department of Environmental Quality (DEQ) recently revised its list of water quality limited waterbodies and has developed a priority list for TMDL development over the next two years. DEQ prioritized its 1994/96 list of water quality limited waters to address limiting factors for salmonid recovery. The presence of threatened or endangered species within a given watershed is a criterion for Priority 1 ranking of waterbodies for TMDL action. DEQ will update the 303(d) list and TMDL priority list again in April 1998 and every two years thereafter (or at an alternative frequency identified by EPA). The updates to the list include an analysis of all water quality data available to the Department, and over time should provide a comprehensive list of all watersheds in Oregon where water quality standards are not being met.
- Goal: To have all waters of the state achieve water quality standards within a reasonable time frame.
- Objective: Identify waters that do not meet water quality standards, prioritize and target waterbodies and address water quality concerns through the development and implementation of Total Maximum Daily Loads and Management Plans.

DEQ6S - Implement Antidegradation Water Quality Standard

- Summary of Measure: DEQ will implement its antidegradation water quality standard in steelhead ESUs to address degradation of water quality that is currently cleaner than parameter specific water quality standards would allow. DEQ will ensure that point source discharges are subjected to antidegradation review as permits are issued for new or increased discharges, and will work with ODF, ODA and other state and federal natural resource agencies to ensure the antidegradation standard is implemented for nonpoint sources.
- Goal: Ensure that water quality and beneficial uses are protected on agricultural lands and forestlands, and that high-quality waters are protected from degradation.
- Objective: The development of water quality management plans for the steelhead ESUs that meet the requirements of the Coastal Nonpoint Pollution Control Program and the State's water quality antidegradation policy. DEQ's objective is to provide ODA, ODF, USFS, BLM and local management agencies the technical assistance they need to successfully complete water quality management plans and to ensure that these plans contain the appropriate water quality objectives and are likely to achieve those objectives.

The ODF voluntary management measures are implemented within priority areas. Several of the measures utilize in-unit leave trees and are applied in a "menu" approach to the extent that in-unit leave trees are available to maximize their value to the restoration of salmonid habitat. The choice of menu measures is at the discretion of the landowner, but one or more of the measures is selected.

The measures can be described as either active restoration measures, or passive restoration measures that provide long-term LW recruitment. Voluntary measures ODF 8S and 21S are active restoration activities. ODF 8S restores hardwood-dominated riparian areas back to a conifer-dominated condition, where appropriate, using a site-specific plan. Site-specific plans require additional consultation with the ODFW to minimize potential damage to the resource. They often result in conditions that are more protective of the resources than would occur without the site-specific plan. ODF 21S addresses LW placement if stream surveys determine there is a need. Measures ODF 19S, 20S, 22S, and 62S provide future LW recruitment through additional riparian protection. This additional protection is accomplished by retaining in-unit leave trees, snags, and downed wood within and along RMAs, and by changing the ratio of in-unit leave trees to 75 percent conifer.

The following application priority has been developed for harvest units containing more than one stream type. The list establishes the general priority for placement of in-unit leave trees.

- 1) Small and medium Type F streams.
- 2) Nonfish bearing streams (Type D or Type N), especially small low-order headwater stream channels, that may affect downstream water temperatures and the supply of large wood in priority area streams.

- 3) Streams identified as having a water temperature problem in the DEQ 303(d) list of water quality limited waterbodies, or as evidenced by other available water temperature data; especially reaches where the additional trees would increase the level of aquatic shade.
- 4) Potentially unstable slopes where slope failure could deliver large wood.
- 5) Large Type F streams, especially where low gradient, wide floodplains exist with multiple, braided, meandering channels.
- 6) Significant wetlands and stream-associated wetlands, especially estuaries and beaver pond complexes, associated with a salmon core area stream.

FPA Standards and Rules

The Water Protection Rules identify seven geographic regions and distinguishes among streams, lakes, and wetlands. The rules further distinguish each by size and type. Stream size is distinguished as small, medium, or large, based on average annual flow. Stream type is distinguished as fish use, domestic use, or neither. Table 2 lists the required RMA widths based on stream size and type.

Table 2. Riparian Management Area widths for streams of various sizes and beneficial uses (OAR 629-635-310).

	Type F	Type D	Type N
<i>LARGE</i>	100 feet	70 feet	70 feet
<i>MEDIUM</i>	70 feet	50 feet	50 feet
<i>SMALL</i>	50 feet	20 feet	Apply specified water quality protection measures, and see OAR 629-640-200

Generally, no tree harvesting is allowed within 20 feet of all fish bearing, all domestic-use, and all other medium and large streams unless stand restoration is needed. In addition, all snags and downed wood must be retained in every riparian management area. Provisions governing vegetation retention are designed to encourage conifer restoration on riparian forestland that is not currently in the desired conifer condition. Future supplies of conifer on these sites are deemed desirable to support stream functions and to provide fish and wildlife habitat. The rules provide incentives for landowners to place large wood in streams to immediately enhance fish habitat. Other alternatives are provided to address site-specific conditions and large-scale catastrophic events.

The goal for managing riparian forests along fish-use streams is to grow and retain vegetation so that, over time, average conditions across the riparian landscape become similar to those of mature, unmanaged riparian stands. This goal is based on the following considerations (Lorenson et al., 1994):

- (1) Mature riparian stands can supply large, persistent woody debris necessary to maintain adequate fish habitat. A shortage of LW currently exists in streams on nonfederal forestlands due to historic practices and a wide distribution of young, second-growth forests. For most streams, mature riparian stands are able to provide more of the functions and inputs of LW than are provided by young second-growth trees.

(2) Historically, riparian forests were periodically disturbed by wildfire, windstorms, floods, and disease. These forests were also impacted by wildlife such as beaver, deer, and elk. These disturbances maintained a forest landscape comprised of riparian stands of all ages ranging from early successional to old-growth. At any given time, however, it is likely that a significant proportion of the riparian areas supported forests of mature age classes. This distribution of mature riparian forests supported a supply of large, persistent woody debris that was important in maintaining quality fish habitat.

The overall goals of the riparian vegetation retention rules along Type N and Type D streams are the following:

- Grow and retain vegetation sufficient to support the functions and processes that are important to downstream waters that have fish;
- Maintain the quality of domestic water; and
- Supplement wildlife habitat across the landscape.

These streams have reduced buffer widths and reduced basal area retention requirements as compared to similar sized Type F streams. In the design of the rules, this was judged appropriate based on a few assumptions. First, it was assumed that the amount of large wood entering Type N and D channels over time was not as important for maintaining fish populations in downstream reaches. And second, it was assumed that the future stand could provide some level of “functional” wood input over time to support nutrient and sediment storage processes. The validity of these assumptions needs to be evaluated over time through monitoring.

With the exception of small Type D and N streams, basal area targets are established and used for any type of management within the RMA⁶. These targets were determined based on the data that was available at the time, with the expectation that these targets could be achieved on the ground. There is also a minimum tree number requirement of 40 trees per 1000 feet along large Type F streams, and 30 trees per 1000 feet along medium Type F streams⁷. The specific levels of LW inputs that the rules are designed to achieve vary by stream size and type. Given the potential LW that is functional for a given stream, a combination of basal area targets, minimum tree retention, buffer widths, and future regenerated stands and ingrowth are used to achieve the appropriate LW inputs for a given stream.

The expectation is that the 20-foot no-harvest area on all but small Type N streams, combined with the shade provided by trees left outside of the first 20 feet for basal area requirements when an RMA is managed to the standard target, will be sufficient towards maintaining stream temperatures consistent with ‘natural’ conditions. In the design of the Water Protection Rules, shade data was gathered for 40 small nonfish bearing streams to determine the shade recovery rates after harvesting. One to two years after harvest, 55 percent of these streams were at or above pre-harvest shade levels due to understory vegetation regrowth. Most of these streams had

⁶ Small Type D streams require a 20-foot no-harvest RMA. Type N streams do not require an RMA.

⁷ The leave tree requirements for Type D and N streams are 30 live conifers per 1000 feet for large streams and 10 for medium streams.

a bankfull width averaging less than six feet, and most shade was provided by shrubs and grasses within 10 feet of the bank. Since 1991, there has also been a 120-acre limit on a single clearcut size, which is assumed to result in a scattering of harvested area across a watershed over time. In the development of the rules, it was assumed that this, combined with the relative rapid shade recovery along smaller nonfish bearing streams, would be adequate in protecting stream temperatures and reduce possible cumulative effects. The monitoring program is collecting data to test these assumptions, evaluate the effectiveness of the rules, and evaluate whether or not water quality standards for temperature are being achieved.

The ODF is also the designated management agency (DMA) for water quality management on nonfederal forestlands. To improve the coordination between the ODF and the DEQ, the two agencies signed a memorandum of understanding (MOU) in June of 1998. The purpose of the MOU is to guide coordination between the ODF and DEQ regarding water quality limited streams on the 303d list. An evaluation of rule adequacy will be conducted (also referred to as a “sufficiency analysis”) through a water quality parameter-by-parameter analysis. This statewide demonstration of forest practices rule effectiveness in the protection of water quality will address the following specific parameters and will be conducted in the following order:

- 1) Temperature
- 2) Sediment and turbidity
- 3) Aquatic habitat modification
- 4) Bio-criteria
- 5) Other parameters

By statute, forest operators conducting operations in accordance with the ODF best management practices (BMPs) are considered to be in compliance with Oregon’s water quality standards. Also, the 1994 Water Protection Rules were adopted with the approval of the Environmental Quality Commission as meeting water quality standards. However, there are several provisions within the Forest Practices Act and rules that call for rule re-evaluation as needed at the state, regional, and watershed scale. The statewide sufficiency analysis initiated by the MOU is such a re-evaluation process.

Currently, the two agencies are working cooperatively in the continued development and refinement of the stream temperature simulation model developed by the DEQ. This model will eventually be used to calculate TMDL values for all 303d listed streams. In addition, these analyses will address attainment of the state anti-degradation policy. These sufficiency analyses will be reviewed by peers and other interested parties prior to the final release. They will also be designed to provide background information and techniques for watershed-based assessments of BMP effectiveness and water quality assessments for watershed with forest and mixed land uses.

V. Evaluation of the Measures and Rules

Voluntary Measures

Evaluation of the Oregon Plan voluntary measures is limited since the Plan has only been in effect for a short while. It is very difficult to assess the effectiveness of measures that have not yet been given a chance to work. An evaluation at this point would be little more than speculation and opinion. Therefore, the Oregon Plan measures must be examined in light of what they attempt to achieve, and some assessment of risk must be determined in terms of how likely the current measures are to achieve the stated goals. It is likely that the Oregon Plan measures will result in additional LW primarily in priority areas, and also to some degree in other areas. It is uncertain as to exactly how much LW will be added under these measures. This must be evaluated through implementation and effectiveness monitoring over time.

The Oregon Plan Watershed Restoration Inventory (1998) does provide some statistics on LW placement activities that occurred in 1996-97. Of the total instream restoration activities reported, 45 percent (n=206) of them were LW placement activities. Forty-four percent of these LW placement activities included placing logs into structures with boulders and rootwads, while the other 56 percent were the placement of LW alone.

The bulk of the voluntary measures that directly address stream temperature issues are implemented by the DEQ. However, the ODF does have measures ODF 8S, ODF 19S, and 20S that are indirectly related to the stream temperature issue. The Oregon Plan Watershed Restoration Inventory (1998) reports that there were 204 riparian restoration projects completed under measures ODF 19S, 20S, and 22S that treated in excess of 73 miles of stream channel. It was noted that this is an underestimation of total stream miles treated because, depending on the activity, seven percent to 20 percent of the projects did not report the extent of the riparian corridor treated.

The following tasks have been completed under DEQ2S (Development of 303(D) List and Identification of Priorities for TMDL Development):

- Task 1: Maintain and update the 303(d) list of waters that do not meet state water quality standards by April 1, 1998, and every two years thereafter.
Deliverables: Updated list for U.S. Environmental Protection Agency approval with a focus on priority coastal basins. The 1998 303(d) list resulted in a 13 percent increase of listed temperature water quality limited stream miles (entire State) (1533 miles added for a total of 12,102 miles). This results in a 26 percent increase of listed stream segments (entire state) between data evaluated in 1994/1996 compared to data evaluated in 1998 (253 stream segments added for a total of 940 segments). More than one quarter of those stream miles listed for temperature occurred on private forestlands.
- Task 2: Develop process for prioritizing and targeting waterbodies on the 303(d) list.
Deliverables: Document describing a process to prioritize and target waterbodies on the 303(d) list for TMDL development.
- Task 3: Prioritize the list and target water bodies for development of TMDLs.
Deliverables: Prioritized waterbodies with a list of targeted waters for which TMDLs will be developed prior to the next listing cycle (April 2000). The following tasks

- under DEQ6S (Implement Antidegradation Water Quality Standard) are ongoing and progress is being made in each area. ODF and DEQ are fully engaged in this process.
- Task 4: Provide technical assistance to ODF in monitoring, evaluation and development of forest practices rules to protect water quality and beneficial uses and to implement antidegradation policies.
Deliverables: Technical assistance provided to ODF.
 - Task 5: Provide financial assistance to ODF for monitoring and evaluation of forest practices effectiveness to protect water quality.
Deliverables: Final reports for two Section 319 funded projects: 1) the evaluation of riparian buffer effectiveness for stream temperature protection; and 2) forest road best management plans for erosion control.
 - Task 6: Provide technical assistance to ODF in the development of water quality management plans.
Deliverables: Technical assistance provided to ODF.

Current Rules

Large Wood

Since the Water Protection Rules were enacted in 1994, there has not been enough time to observe significant changes in riparian characteristics on the ground. Given this fact, how can we determine if under these rules LW levels are in fact increasing towards what would exist under mature conifer forests? Initial monitoring results can help evaluate the validity of some of the assumptions built into the rules, and in turn allow us to evaluate the potential effectiveness of the current rules given the adequacy of these assumptions.

Under the current water protection rules, are the RMAs “likely to develop characteristics of mature forest stands in a timely manner?” Two issues must be addressed in answering this question. The first has to do with the adequacy of the RMA widths, and the second with the adequacy of the RMA management prescriptions.

Historically, periodic disturbance occurred across the forested landscape. While it is likely that many riparian areas had mature or old-growth conifer stands, there were other recently disturbed areas with very young stands, grass, or brush. A 100-foot (30-meter) buffer width will generally capture 70-90 percent of the LW input potential from riparian forests (this does not consider upslope sources) (Bilby and Bisson, 1998). While this represents an average value at a landscape level, it should be noted that different size streams provide different degrees of riparian functions. While the largest streams, on the one hand, have the capacity to move very large pieces of large wood, the smallest streams do not normally move the larger wood during high flows. They may be dominantly used by resident fish species, in which relatively small wood normally functions in step-pool formation. In considering on-site effects of LW, smaller trees can provide both stable and functional-size wood for small streams. For example, a small stream with an active channel width of 2 or 3 feet will interact well with a 20- or 30-foot long piece of wood that is 6 to 10 inches in diameter.

Historically, however, large diameter trees were present along all sizes of streams to a greater or lesser degree. Large diameter trees, therefore, have been a component of the wood supply and aquatic structure in small streams. These larger pieces of wood, while being relatively immobile as compared to smaller LW, provide for some functions that may not be supported by small diameter wood. These functions include storing large volumes of sediment and mitigating steep channel gradients by creating large steps in the channel profile (Montgomery et al., 1996). During high flow events the larger pieces are also more stable than the smaller pieces. If the stream is in an area where debris flows occur, there is the potential for larger pieces to be transported some distance downstream from where the wood was first deposited (Robison et al. 1999).

During a recent riparian aquatic habitat workshop, a number of studies were referenced that examined buffer width versus potential LW inputs. In general, the findings show that nearly all of the potential LW from *stream-adjacent sources* originates from within 60 to 130 feet of the stream (see Appendix A). The law of diminishing returns dictates that the majority of potential LW comes from relatively close to the stream, and the potential inputs rapidly diminish at distances beyond 60 to 130 feet. Close to 100 percent of the potential LW originates from within this distance from the stream. To achieve the entire 100 percent of potential LW, the buffer would need to extend an additional 100-150 feet, or to about one site-potential tree height.

The Water Protection Rules require an RMA between 50 to 100 feet on all streams except small, Type D and N. Small Type D streams require a 20-foot RMA. Small Type N streams do not have an RMA (they do require the protection of the bed and banks and water quality). The inner 20-foot RMA is a no-harvest zone. Harvesting may be allowed within that portion of the RMA outside of the no-harvest zone depending on the existing basal area.

For riparian areas managed to achieve mature forest conditions (Type F streams), a 50- to 100-foot RMA is applied. Within the RMA, trees must be maintained with conifer basal area adequate to achieve mature forest conditions mid-way through the next rotation (in 25 years). This range of RMA widths is believed to supply between approximately 65 percent and 95 percent of the potential conifer LW of a mature forest, assuming that these zones will contain conifer stocking of a mature forest (McDade et al., 1990). There is a reasonable probability that for those streams where 50- to 100-foot RMAs of mature conifer forests are maintained, the potential LW supply from adjacent riparian stands will be close to what would exist under mature forest conditions. This is not the case for LW delivery from small Type D and N streams where RMAs are 20 feet or less.

Murphy (1995) presents an analysis of the effectiveness of current forest practice rules in a number of western states in protecting and restoring riparian aquatic habitat. Murphy performs two analyses to quantitatively evaluate and rank LW input protection among different states. Based on the RMA width alone (and assuming an unharvested, fully stocked mature conifer forest within the buffer), Murphy assigns Oregon an initial 92 percent potential LW delivery score for large Type F streams in the Oregon Coast Range. Though not stated by Murphy, the same analysis for other size streams would result in estimates of potential LW delivery of

approximately 80 percent for medium and 70 percent for small fish bearing streams. These estimates were based on the Oregon RMA widths and the McDade et al. (1990) study of LW delivery. In addressing the adequacy of the Oregon stream rules, Murphy states the following:

“Oregon's rules are based on the expectation that basal area will increase by 59 percent within 25 years, thereby achieving the level of LW sources in a mature Douglas-fir streamside forest [at mid-rotation of the second rotation over the entire watershed/landscape]. Assuming a similar growth rate (59 percent per 0.5 rotation period) in the other states, the resulting LW sources at mid-rotation [from adjacent riparian stands only along large Type F streams] would exceed 90 percent of the level in mature forests in Alaska and Oregon, but would still be far below that level in California and Washington.”

Murphy (1995) further estimated potential LW sources (conifer volume) present *immediately after* timber harvest, assuming the retention of the minimum basal area only, pursuant to the forest practices requirements of the different western states. Based upon his analysis, Murphy estimated that approximately 58 percent of potential conifer LW sources of mature forest stands would be present on large Type F streams in the Oregon Coast Range following timber harvest. Though not completed by Murphy, expanding the analysis procedure to Medium and Small Type F streams in this region results in estimates of approximately 38 percent and 15 percent potential conifer LW sources after harvest in medium and small stream RMAs, respectively (Table 3). Where stream enhancement activities and harvest to the “active management target” occurs, the potential conifer LW retained in these RMAs immediately following harvest is less.

Since the publishing of Murphy (1995), Murphy has corrected calculations of the percent of LW sources at mid-rotation in mature forests for Type F streams in Oregon. Instead of the 92 percent quoted above, Murphy estimates that the percent of LW sources present along a large Type F stream in the Coast Range at mid-rotation to be only 73 percent of the adjusted normal yield of mature forest, as assumed under the Water Protection Rules (Mike Murphy, personal communication, 1998).

The second issue that must be addressed is the adequacy of the RMA management prescriptions in achieving mature forest conditions. During the development of the 1994 Water Protection Rules, it was necessary make a number of assumptions where data was lacking. Through effectiveness and implementation monitoring, these assumptions will be tested and revised as warranted. Basal area targets were developed for the seven different georegions, and it was believed that these targets would be reasonably accurate in describing the potential of a given riparian stand in a given georegion. Another assumption was made regarding conifer stocking on small, medium, and large streams. This assumption held that hardwood species would dominate the first 20 feet of the RMA across the landscape. A third assumption was made regarding incentives for landowners to manage within the RMA. This assumption held that the hardwood conversion option would provide an adequate incentive for landowners to convert riparian stands currently dominated by hardwoods back to conifer where it is highly likely that conifer existed historically. It was also believed that the standard and active management basal area targets would provide an incentive for landowners to grow trees in excess of what must be retained so

that the excess may be harvested. A final assumption was that 25 percent and 75 percent of the LW recruitment needs on Medium and Small Type F streams, respectively, would originate from ingrowth and newly established stands following harvest. This assumption has not been validated by monitoring.

Table 3. Percentage conifer large wood sources⁸ following clearcut harvest to current FPA basal area retention standards on Type F streams.

Georegion	Target	Potential Large Wood Sources After Clearcut Harvest ⁹ (% of mature forest potential)								
		Large			Medium			Small		
		0 yrs	+25 yrs	+50 yrs	0 yrs	+25 yrs	+50 yrs	0 yrs	+25 yrs	+50 yrs
Coast	Standard	58	92	126	38	60	82	15	24	33
	Active Mgmt.	43	68	93	28	44	60	8	13	18
South Coast	Standard	57	91	124	37	59	81	15	24	33
	Active Mgmt.	42	67	92	28	45	61	8	13	17
West Cascades	Standard	59	94	129	38	60	83	13	21	28
	Active Mgmt.	43	68	94	30	48	65	6	10	13
Interior	Standard	58	92	126	37	59	81	13	21	28
	Active Mgmt.	42	67	92	29	46	63	6	10	13
Siskiyou	Standard	58	92	126	37	59	81	16	25	35
	Active Mgmt.	45	72	98	30	48	65	8	13	17

⁸ Potential conifer large wood source estimates follow the analysis procedure described by Murphy (1995).

⁹ For example, for a clearcut harvest along a large Type F stream in the Coast georegion 58 percent of the total potential LW will be left after the RMA is managed to the standard target. At mid rotation (25 years in the future), 92 percent of the total potential LW will be present (assuming a 59 percent increase in basal area every 25 years). At the end of the next rotation (in 50 years), 124 percent of the total potential LW will be present. Medium and small streams have lower levels of potential LW due in part to narrower RMAs. This is also due in-part to the fact that additional LW from in-growth and adjacent second-growth assumed to contribute 25 percent and 75 percent of the total potential along medium and small streams, respectively, is not accounted for here.

Monitoring data collected by the ODF over the last four years has provided preliminary results pertaining to the validity of some of these assumptions. As for the first assumption about basal area targets, there are initial indications that the high degree of variability in site potential within a given georegion makes the use of an average basal area target problematic. In theory, if unrealistic basal area targets are used, a very low productivity site will not allow for active management and will thus take longer to realize a ‘mature stand’ condition. A high productivity site, on the other hand, may never reach its potential (in terms of basal area and growth) because using a basal area target that is too low will result in harvesting that reduces the potential below what can actually be achieved.

It also appears the second assumption regarding hardwood species dominating the first 20 feet of the RMA may not be valid, particularly for small, confined channels. A preliminary look at the monitoring data indicates that variability is prevalent across all sizes of streams, and that this assumption appears to hold true for the large streams. For many of the medium and small streams, however, there are indications that a higher percent of conifer trees exists in the first 20 feet of the RMA than was assumed to be the case. This has resulted in the potential for the total basal area requirement to be met in the first 20 feet of the RMA. Where this is, in fact, the case, the actual retention will be significantly less than assumed and it may not support the expected range of functions (including shade and LW) at the level that was assumed.

Finally, there is a possibility that incentives for landowners to actively manage RMAs to “develop characteristics of mature forest stands in a timely manner” may be inadequate. About 60 percent of the 52 RMA sites surveyed by ODF monitoring crews were not harvested down to the basal area target (Liz Dent, personal communication, 1999). These findings also show that the estimates made by Murphy (1995) discussed above are not valid for 60 percent of the RMAs sampled since more basal area was retained than the minimum. It should be noted that data was not collected to understand why the landowner stayed out of the entire RMA on these sites. Possible reasons include that the stocking levels were too low for harvesting within the RMA to be an option, or that the landowner chose not to manage for their own reasons. More specific information is needed in order to determine *why* 60 percent of the sites were not harvested down to the minimum basal area target.

Hairston-Strang and Adams (1997) found similar results in their survey of private landowners managing within the RMAs, where only 21 percent actively managed within the RMA to the basal area standard targets. The hardwood conversion option also does not appear to be used very often by the landowner (Liz Dent, personal communication, 1999). This may be because some hardwood-dominated riparian areas do not have enough merchantable timber to make the operation profitable (i.e., unfavorable market conditions). Also, landowners might be wary to exercise this option out of fear that they may inadvertently commit a violation in trying to implement this option. If the lack of management within the majority of RMAs is the result of inadequate incentives for landowners, the rules may not be adequate in achieving the goal of developing characteristics of mature forest stands in a timely manner. Additional information is needed, however, before the reasons for the lack of active management can be determined.

For small Type N streams, vegetation retention is required on a portion of the perennial streams in all georegions except the Coast Range and the Cascades. In eastern Oregon, some vegetation retention is required on all perennial streams. Where required, vegetation retention on these streams consists of a 10-foot understory vegetation and nonmerchantable conifer buffer requirement. All other small Type N streams do not require an RMA or vegetation retention (outside of what is necessary to protect the bed and banks) under the current rules. In terms of structural LW, small Type N streams can only provide for inputs to salmonid habitat if they are of the type where debris flows occur that move larger material downslope to Type F streams. Under the current rules that do not require an RMA, these streams are not contributing LW inputs in this manner. The current rules assume that the newly regenerated stand will likely provide some level of smaller LW inputs over time, but this assumption has not been validated. The

significance of a lack of larger LW in these streams is uncertain, but nonetheless a reduction from this potential source does exist.

Another concern is in regards to the opportunity for LW originating from the RMA to fall into the stream. Currently, outside of the first 20 feet of the RMA, a landowner is able to harvest the largest trees within an RMA where management is an option, and harvest rotations can be as short as 50 years⁸. This creates the possibility that the LW with the highest potential and value in terms of fish habitat might be harvested before enough time has elapsed for it to fall into the stream. The current rules provide no assurances that trees retained beyond the first 20 feet of the RMA will have the opportunity to fall into the stream, or that a certain minimum number of the trees will fall into the stream. It is likely, however, that some level of LW inputs will occur even if it cannot be quantified.

There is also the issue of potential LW inputs from sources other than near-stream areas. By its very definition, upstream riparian sources are maintained where RMAs are established above a given stream reach. Upslope sources of LW are currently not maintained where a harvest operation occurs in the potential source area. The potential for delivery of upslope LW only exists, however, in areas with steep slopes that are prone to landslides and/or debris flows that enter the channel. Exactly what proportion of LW originates from each of the three source areas for a given stream reach depends on the make-up of the channel network and the extent of the RMAs. Because of the scientific uncertainty, determining the adequacy of the current rules in terms of LW supply from these three sources must be determined qualitatively using professional judgement.

Finally, information received on the eastern Oregon field tour (FPAC tour, August 1999) indicates that a single basal area target for all of eastern Oregon may be inappropriate. Stocking level recommendations provided by Fred C. Hall (Senior Plant Ecologist, USDA Forest Service, Pacific Northwest Region) show that eastern Oregon forestlands have a very wide range of different site productivity classes. The lowest site class is for a typical juniper site (<20 cubic feet/acre/year) and the highest is for a relatively high productivity, mixed-conifer site comparable to westside forests (120-164 cubic feet/acre/year). Using a single basal area target will result in the more productive sites being understocked and the less productive sites being overstocked, potentially contributing to forest health problems prior to the next harvest entry. Having basal area targets for eastern Oregon that are tied to narrower site class ranges may be a more appropriate approach for managing the RMAs towards a mature forest condition. (see Appendix F for a more detailed discussion)

Stream Temperature

The ODF has an ongoing stream temperature monitoring program. The focus is on monitoring the effectiveness of RMA prescriptions and riparian conifer restoration (RCR) in maintaining stream temperatures. A report on the results from 1995 monitoring data has provided some new information on how the rules are performing in terms of impacts to stream temperatures (Dent

¹⁰ So long as the basal area and minimum tree number requirements are met.

and Walsh, 1997). The monitoring sites included in this study are mostly medium and large streams (under ODF stream classification).

Results from this monitoring project are limited by a lack of pre-harvest data and by variability among the sample sites. Differences in elevation, harvest methodology, and georegion as well as data collection problems, especially with canopy cover, contributed to a highly variable sample population. However, consistent, if not significant, increases in stream temperature below harvested reaches indicate that the forest protection rules may not always provide adequate protection to meet water quality standards. (Dent and Walsh, 1997)

Temperatures were recorded continuously over the summer of 1995 on thirteen stream reaches and at a number of points throughout the Brush Creek watershed. Five of the reaches were managed RMAs and eight of the reaches were RCR sites (a.k.a., hardwood conversions). For each reach, temperature probes were placed in the stream above the harvest unit, immediately below the harvest unit, and downstream of the harvest unit under an unmanaged canopy.

The water quality standard for seven-day moving average of maximum (64°F) was exceeded more often downstream of harvested units than upstream. On all streams, the standard was exceeded only 9.4 percent of the time. However, only three of the thirteen streams never exceeded the water quality standard. (Dent and Walsh, 1997)

Two types of statistical analyses were conducted on the 1995 data set with contradictory results. One test was a repeated-measures Analysis of Variance (ANOVA) of the residuals that showed no statistical effect of the harvest units on stream temperature. Residuals were used to remove the influence of the 'natural' tendency for stream temperatures to increase in the downstream direction in relation to the distance from divide. A repeated-measures ANOVA was also carried out on the raw data (instead of using residuals). This method is a statistical test of the raw data that also has the ability to remove the influence of the 'natural' tendency for stream temperatures to increase in the downstream direction. This second test did show a statistically significant effect from harvesting. Those reaches sampled higher in the basin did show a corresponding decrease in temperature 500 feet downstream, while those reaches sampled lower in the basin did not show a decrease in stream temperature 500 feet downstream of the treatment reach.

All but one of the stream reaches Dent and Walsh (1997) examined were medium and large streams (by ODF classification) where either an RMA or RCR prescription was applied. What about small Type N streams that receive little or no canopy cover retention under the current rules following an adjacent harvest operation? Caldwell et al. (1991) and Robison et al. (1995) provide some information as to the performance of the current rules in terms of temperature effects from harvesting to the edge of small Type N streams. Caldwell et al. (1991) examined the

extent of temperature increases on “Type 4” streams (comparable to the category of small streams in Oregon) on downstream waters⁹.

In cases where a single stream channel changed from a Type 4 to a Type 3 water type, short response distances were seen, in response to changes in the riparian shading levels. Maximum equilibrium temperatures were quickly established dependent on the downstream conditions once the water entered the Type 3 (shaded) reach. The response distance was typically 150 meters or less with no effect on temperature from the harvested Type 4 stream downstream of the response distance. . . . The response of the Type 3 [the downstream receiving stream] never exceeded 0.5°C [1°F] change in temperature attributable to the incoming Type 4 stream. Reasons include the typical small size of the Type 4 tributaries in relation to the Type 3 receiving streams, and the relatively cool temperatures seen in some Type 4 reaches despite total removal of overstory canopy. (Caldwell et al., 1991)

This study also observed that several of the Type 4 stream reaches monitored for temperature exceeded the Washington water quality standards, and harvested streams were as much as 2-8°C higher than for streams at similar elevations with mature forest canopies. Despite these increases, the elevated temperatures in many of these streams still remained well below the water quality standards. However, there were examples in both harvested and forested Type 4 streams where the temperature standard was exceeded.

Robison et al. (1995) conducted a similar study on stream temperature response on small Type N streams in the Oregon Coast Range and Interior georegions. As with Caldwell et al. (1991), Robison et al. also observed stream temperatures that exceeded the water quality standard in forested stream reaches. There were a total of eight monitoring sites that evaluated stream temperature flowing through clearcut sites.

In general, maximum water temperatures for streams flowing out of clearcut units were below 60°F. Two clearcut unit streams had maximum water temperatures greater than 60°F [one of which exceeded 64°F]. For most of the clearcut units, there was significant cooling below the unit as the streams re-entered the forest canopy. This finding is consistent with previous temperature monitoring on small headwater streams. (Robison et al., 1995)

Based on current ODF monitoring results and other studies, the following general conclusions can be made regarding forest harvesting and stream temperature as it pertains to the water protection rules. For small, headwater streams, while stream temperatures increase after harvest, there is the potential for temperature increases due to canopy removal to diminish within 500 feet downstream of the harvest activity (Caldwell et al., 1991). For stream reaches through managed RMAs and RCRs on medium and large streams, Dent and Walsh (1997) found that 90 percent of

⁹ Since this study was published, surveys of Type 4 streams in Washington are showing that a substantial number of them are actually fish bearing streams. Thus, they may in fact be more comparable to small Type F streams in Oregon.

the time those streams that were monitored had temperatures at or below the 64°F temperature standard. Dent and Walsh (1997) do not separate out the proportion of the temperature increase that is attributable to a partial decrease in shade versus the proportion that is attributable to inherent downstream increases in stream temperatures. Additional analysis is needed to determine how these increases compare to the 'natural' rate of temperature increase in the downstream direction. Further study of the effects of RMA prescriptions and RCRs on stream temperatures with pre-harvest data and a basin-wide perspective is needed to more adequately evaluate the effectiveness of the rules. The analysis of additional temperature monitoring data will be available in the spring and summer of 2000, that may help address some of the unresolved issues.

Other Riparian Functions

Other riparian functions besides large wood and stream temperature (shade) include microclimate, streambank stability, litterfall, sediment filtration, and floodplain processes. It is generally assumed that these other functions will be provided for, to some extent, by the Water Protection Rules. It should be noted that this assumption is based on qualitative information and has not been evaluated through monitoring.

For streams that require an RMA, the understory and overstory vegetation within the 20-foot no-harvest zone, plus any additional overstory trees beyond the first 20 feet left for basal area requirements, will provide some protection for microclimate, litterfall, streambank stability, and sediment filtration. Floodplain processes will also be provided for where the effective width of the RMA is equal to, or greater than, the floodplain. Rules that are currently designed to protect wetlands can also provide protection of floodplain functions when these wetlands are adjacent to streams. When braided channels and islands occur within the annual high water mark or within the effective RMA, the current rules will provide some level of protection as well.

In some cases, other riparian functions may receive less than optimal protections under the current rules. For example, on small Type N streams that generally do not require any retention of overstory vegetation, there is a relatively higher level of risk that other riparian functions will not be provided for immediately following harvesting, where those functions depend on the presence of overstory vegetation. Also, where the floodplain extends well beyond the effective RMA width only a portion of those floodplain functions that depend on overstory vegetation will be provided for. Evaluating the performance of the rules in terms of providing these other riparian functions will take continued effectiveness monitoring.

Independent Multidisciplinary Science Team (IMST) Recommendations

The IMST made a total of 19 recommendations in its forestry project report of September 14, 1999. Six of their recommendations are directly, or indirectly, related to riparian functions. These recommendations are listed below, followed by the issue paper options that address the recommendations.

Recommendation 2:

ODF should develop a policy framework to encompass landscape (large watershed) level planning and operations on forests within the range of wild salmonids in Oregon.

Riparian Issue Paper Option(s)

Option #41, all (partially addresses this recommendation)

Recommendation 3:

Treat nonfish bearing streams the same as small, medium, and large fish bearing streams when determining buffer-width protection.

Riparian Issue Paper Option(s)

Option #26, method 8

Option #62, method 5

Recommendation 4:

Provide increased riparian protection for the 100-year floodplains and islands.

Riparian Issue Paper Option(s)

Option #63, method 3

Recommendation 5:

Increase the conifer basal-area requirement and the number-of-trees requirement for RMAs, with increases in these requirements for medium and small streams regardless of fish presence.

Riparian Issue Paper Option(s)

Option #26—methods 1, 2, 3, 5, and 6

Recommendation 6:

Complete the study of the effectiveness of the OFPA rules in providing large wood for the short- and long-term.

Riparian Issue Paper Option(s)

Option #30—method 2

Recommendation 13:

Retain trees on "high risk slopes" and in likely debris torrent tracks to increase the likelihood that large wood will be transported to streams when landslides and debris torrents occur.

Riparian Issue Paper Option(s)

Option #38, all methods

VI. Possible Additional Measures and/or Rules

Option #20: Active Placement of Large Wood

Objective:

Provide additional large wood (LW) to streams by actively placing the wood in areas where it will provide the greatest benefits to salmonids.

Description:

It is widely believed that current levels of LW in many streams are significantly lower than what occurred historically. Where riparian areas are generally lacking in large diameter trees the active placement of key pieces from off-site sources can be critical to the creation of habitat functions in the short-term. In order to accelerate the rate of large wood inputs that is occurring under the current rules and measures, additional large wood should be actively placed in the appropriate streams.

Methods/Approaches:

- 1) Place LW along fish bearing streams during an adjacent harvest entry. (This is currently part of an Oregon Plan for Salmon and Watersheds (OPSW) voluntary measure, ODF 21S.)
- 2) Place LW along Type N and D streams prone to debris flows that are likely to deliver the wood to fish bearing streams downstream.
- 3) Place LW upslope of Type N and D streams prone to debris flows that are likely to deliver the wood to fish bearing streams downstream (i.e. in small draws and hollows)

Benefits:

This would provide more LW input in the short term and accelerate the creation of new salmonid habitat in streams where there is currently a LW deficit.

Costs:

If the additional LW is taken from the RMA, it may affect the long-term LW input potential of the RMA. If the additional LW is taken from the adjacent harvest unit outside the RMA, there will be a financial cost to the landowner. (The 1999 OPSW restoration guide recommends that the LW come from outside the RMA.) For LW that is not placed directly in Type F streams there will be a time lag between when it is placed and when it is utilized for fish habitat. If this time lag is too long, the LW may be at a stage of decomposition where it can no longer provide the same level of function as a “fresh” piece of LW.

Option #22: Manage RMAs for Shade

Objective:

Establish management prescriptions for RMAs that will provide sufficient shade to achieve and maintain state water quality standards for stream temperature.

Description:

Shade is an important riparian function that regulates the amount of solar energy reaching the stream surface. The more forest canopy that reduces shade that is removed, the more energy reaches the stream translating into a potential increase in stream temperature. While shade cannot physically cool the stream down, it can prevent further heating of the stream. To protect streams from adverse temperature increases that may violate water quality standards, the current rules use a combination of a 20-foot, no-harvest area and basal area retention targets adjacent to streams. It is assumed that the shade produced by the Water Protection Rules will maintain stream temperatures within water quality standards. Current monitoring data has shown that there is the potential for short-term stream temperature increases after harvesting under the current rules, particularly with riparian conifer restoration blocks (RCRs). This option proposes using a more prescriptive and direct approach to achieve shade levels necessary to maintain water quality standards.

Methods/Approaches:

Shade management prescriptions could be employed on a small sub-set of streams (e.g. reaches where RCR is conducted), a combination of specific stream types, or on all streams. Listed below are some specific approaches that have been deliberated by the Committee.

- 1) Establish basal area and tree retention prescriptions that provide adequate shade sufficient to meet temperature standards for all streams. A method of relating shade to basal area and tree retention would need to be developed that can accurately determine the RMA characteristics necessary to achieve adequate shade. (The Department of Environmental Quality (DEQ) is currently developing such a method, referred to as a “shade calculator.”)
- 2) Use a shade standard to manage RMAs as was done previous to the 1994 rule changes. A shade standard based on an “effective shade” target, the percent of pre-operation shade, or no shade reductions below a predetermined threshold could be used.
- 3) RCR prescriptions become conditional to a site-specific plan.
- 4) Retain shade-producing vegetation on the south side of streams in RCRs.

Benefits:

The current RMA prescriptions are based primarily on a combination of basal area and tree retention requirements. Developing and utilizing a predictable relationship between these criteria and effective shade would be a relatively efficient method of managing for shade. A prescriptive approach will also provide a direct means of managing for shade, as opposed to managing primarily for mature stand conditions under the assumption that adequate shade will be provided. Site-specific plans for RCRs would avoid a one-size-fits-all approach. Where temperatures are known to be a significant problem, the RCR blocks could be custom designed to minimize temperature effects on the stream.

Costs:

Using a combination of basal area and tree retention requirements to manage for shade is dependent on an effective model, or shade calculator, that can translate RMA conditions into effective shade for all parts of the state. Although there is one in development, it would be the first of its kind and would need to be adequately tested. Trade-offs must be considered when considering the management of RMAs primarily for shade. A management option that may be ideal for creating shade may not be ideal for providing adequate riparian function in terms of large wood. In terms of using a shade standard, site-specific shade measurements are extremely variable and are problematic in the winter months when hardwoods are defoliated. Monitoring has shown that the use of a shade standard tends to be subjective and lacks consistency. The use of a shade standard was abandoned in 1994 for these reasons. Even with a site-specific plan for RCR prescriptions, there may still be a reasonable potential for temperature increases to occur in the short term. There may still be cases where a decision must be made between short-term and long-term effects. The additional effort required for a site-specific plan can also be a disincentive for active management, reducing the potential for achieving mature stands conditions in a timely manner.

Option #26: RMA Basal Area Targets and Management Prescriptions

Objective:

Ensure that basal area retention within RMAs is consistent with achieving characteristics of mature forest conditions and desirable levels of LW inputs and shade functions over time.

Description:

The Water Protection Rules were designed to provide a level of LW inputs based on some assumptions about the capabilities of riparian areas to grow wood. Preliminary monitoring data indicates that the assumptions for determining basal area targets for small and medium streams may not be consistent with what the RMAs are capable of growing along these streams. Also, preliminary monitoring data shows that 60 percent of harvest operations are not managing within the RMAs. Monitoring has also shown that some of the current RMA prescriptions may result in short-term temperature increases, however the significance of the potential temperature increases is uncertain. Action should be taken to ensure that the level of LW inputs being provided by the RMAs is consistent with the goals of the rules, which includes the goal of achieving the desired future condition in a timely manner. This option aims to increase the level of LW inputs over the short and long term to achieve this end, and to ensure that adequate shade is maintained to protect water quality by adjusting RMA basal area targets and/or RMA management prescriptions.

Methods/Approaches:

- 1) When managing the RMA for the basal area target, require that the entire basal area target be achieved within the portion of the RMA outside of the 20-foot, no-harvest buffer (i.e., the basal area in the first 20 feet could not be counted).

- 2) To address areas where the current basal area targets may not be optimizing the shade and large wood potential for a given site, re-examine the basal area targets, and the assumptions therein, and adjust them appropriately.
- 3) Develop site-specific prescriptions for the retention of trees in the RMA based upon actual conifer basal area within the RMA. Basal area targets will be set based upon a target of retaining at least 75 percent of the pre-harvest basal area within the RMA, but at a minimum, retaining at least the current standard target. The objective for the site-specific prescription is to manage the tree selection to meet the desired future condition in a timely manner. Continue to provide active management basal area credits, allowing harvesting to less than 75 percent of pre-harvest basal area if combined with stream enhancement measures (the standard target would remain the minimum). Also, change the language of the rules to require that the basal area that is removed from the RMA be distributed in such a way as to optimize the opportunity for the remaining trees to increase in basal area in a timely manner.
- 4) Use conifer regeneration corridors (CRCs) instead of the current method for actively managing the RMAs. Retain the current RMA width classifications and replace the current thinning option and basal area targets with the CRC prescription. Under this prescription, the landowner would be allowed to harvest a corridor into the RMA perpendicular to the stream up to the no-harvest buffer. The larger trees very close to the 20-foot buffer might be felled toward/into the stream to provide immediate and short-term LW inputs. The corridors would be designed such that re-entry into the same corridor would only occur after multiple rotations for the adjacent stand outside the RMA (every 200-300 years). The corridor widths would also need to be designed such that successful Douglas-fir regeneration (where appropriate) would occur. Some degree of thinning might occur into the RMA adjacent to the CRC to ensure successful regeneration. The Water Protection Rules would remain in place as the default option for those operations where the CRC is not feasible.
- 5) Create a voluntary conservation reserve program (CRP) similar to the program under the same name currently administered by the Natural Resource Conservation Service. This program leases agricultural land adjacent to streams, lakes, and wetlands and manages these lands for water quality and wildlife habitat functions. Under this program, the State would lease land within the RMA for a period of time and the State Forester would prescribe site-specific management plans. The lease period would need to be long enough to ensure that the intended habitat functions are achieved. The landowner would retain full ownership rights to the property, whereby the State would only lease the rights to manage the property over the duration of the lease. Priority would be given to lands that have high value in terms of riparian function, or that have a high potential to develop quality riparian conditions in a timely manner. The Water Protection Rules would remain in place as the default option for those landowners choosing not to use the CRP option.
- 6) Increase the minimum number criteria for trees retained in the RMA (**IMST recommendation #5**).
- 7) Increase the minimum size criteria for trees size retained in the RMA. (The objective of this approach would be to increase the potential for key pieces of LW to be grown in the RMA and delivered to the stream.)
- 8) Treat nonfish bearing streams the same as small, medium, and large fish bearing streams when determining basal area requirements (**IMST recommendation #3**).

- 9) Use a range of site classes to determine basal area targets for RMAs in eastern Oregon instead of the uniform basal area targets that are currently used.

Benefits:

Additional salmonid habitat will be created in streams over time that currently lack the complex structure large wood provides.

Methods:

- 1) Disregarding the 20-foot no-touch zone in meeting the basal area target will prevent the basal area targets from being satisfied completely within the 20-foot no-touch zone. This will result in greater effective buffer widths that provide increased LW inputs and effective shade. This will provide more assurance that key pieces of LW, beyond what exists in the first 20 feet, will be retained in the RMA and provide inputs at some time in the future.
- 2 and 3) A site-specific basal area target will be more effective at maximizing the growth potential of a given stand, allowing for more LW to be grown more quickly. Basal area targets that better reflect the growth potential will be more effective at maximizing the LW input potential of a given stand.
- 4) This will allow for conifer regeneration to occur in the RMAs. This will also preserve the integrity of the buffer widths over most of the RMA as currently prescribed under the rules. There would be no removal of trees in the majority of the length of RMA, which will eliminate the possibility of an effective buffer width that is something less than what is prescribed under the rules. The risk of windthrow may be reduced. LW will be put into the stream in the short term from dispersed locations that correspond to the spacing of the CRCs. The relative ease of harvesting a CRC as compared to a thinning will be more of an incentive for active management.
- 5) This would allow the state direct control over managing the RMAs in the most optimal manner for LW and other riparian functions. Once a lease is signed, there would no longer be a need for measures encouraging active management by the landowner, as the state would take over this role.

Costs:

Substantial cost to the landowner could be expected, due to increases in conifer retention along all stream classes.

Methods:

- 2 and 3) The 75 percent of existing basal area approach leaves the basic structure of the current rules intact and simply changes the method of calculating the basal area available for harvest. This does not change the situation for the 60 percent of the RMAs that are not being actively managed. Language requiring an even thinning of the RMA (where applicable) may be even more of a disincentive for active management, since this will require more sophisticated harvesting techniques. Readjusting the basal area targets in and of itself does not create any more of an incentive for active management within the RMA. It also may, or may not, create additional costs for the landowner, depending on how the basal area targets are changed.

- 4) There is the risk that CRCs might cause stream temperature increases depending on the design. To minimize this risk and achieve LW objectives, the CRCs will need long rotation periods where a majority of the RMA is left intact and mature forest conditions are allowed to develop over a majority of the RMA. There may be cases where this is very difficult to achieve given the size and location of a harvest operation. Multiple ownership along a stream could be problematic for this option. This option would need to be studied carefully from both an ecological and operational perspective to determine if it is desirable.
- 5) This will require additional resources from the state, both for the additional staff necessary to manage the RMA leases, as well as for the cost of the leases. There may be logistical problems as well. The most cost-effective way for the state to manage the RMAs would be to do so at the same time the landowner is harvesting adjacent areas. This could mean multiple operations distributed across the state at any given time. ODF field offices will need the additional resources necessary to handle the increased workload and the flexibility needed for this type of program.
- 6 and 7) There will be a financial cost to the landowner if the largest trees that must be retained have a higher value than a number of smaller trees with equivalent basal area. Depending on where these trees are that must be retained, there may be additional operational costs to the landowner.

Option #30: Riparian Monitoring Program

Objective:

Maintain a riparian monitoring program

Description:

Continued monitoring of the rules protecting riparian functions must occur in order to understand how the rules are being implemented and to evaluate whether or not they are achieving their objectives. Currently, as part of the BMP Compliance Audit Project, the ODF is monitoring compliance with the water protection rules. This project is a three-year effort to monitor compliance with the Forest Practice Rules in general. The ODF also has an on-going stream temperature monitoring project. Resources should be provided to enable the ODF to do effectiveness monitoring related to the large wood objectives of the OPSW and water quality standards, as well as continued compliance monitoring.

Methods/Approaches:

- 1) Increase the resources available to fund additional monitoring of rules and measures affecting riparian functions above and beyond what is currently being done.
- 2) Ensure that adequate resources are available to continue the riparian monitoring work that is currently being done.

Benefits:

- 1) This will allow for a more thorough analysis of OPSW measures that goes beyond the straightforward list of what measures were implemented. Additional resources will allow for an examination of the actual effect of the rules related to LW and stream temperature on fish populations. This will also allow for a continuation of ODF compliance monitoring over

time and potentially increase the quantity of useful information available to evaluate forest practice rule implementation.

Costs:

- 1) This will require a significant increase in monitoring staff and a long-term commitment of resources, as these types of monitoring efforts can take years to implement successfully. These additional resources are necessary if the ODF is to continue its monitoring efforts related to issues other than the OPSW and rule compliance.

Option #38: LW Inputs and Shade Functions for Small Perennial Type N Streams

(Option #61 in the Landslide issue paper addresses LW inputs from seasonal Type N streams prone to debris flows)

Objective:

To ensure that adequate LW inputs and shade are maintained for riparian areas along small perennial Type N streams.

Description:

There is increasing scientific evidence that small nonfish bearing streams prone to debris flows provide an important source of large wood for downstream fish habitat. It is also known that the removal of shade-producing vegetation along small perennial Type N streams temporarily increases stream temperatures, until regeneration occurs. While these streams are providing some level of functional LW inputs and shade production under the current rules, the rules were not specifically designed to provide significant sources of LW and shade in these areas. Action should be taken to increase LW inputs along small perennial Type N streams prone to landslides and debris flows, and to ensure that adequate shade is maintained along small perennial Type N stream segments that may influence Type F streams downstream.

Methods/Approaches:

Listed below are specific methods that apply to small perennial Type N streams (areas upslope of small perennial Type N streams are addressed in the Landslides issue paper):

- 1) Create no-harvest buffers on small perennial Type N streams.
- 2) Create RMAs on small perennial Type N streams (i.e., allow for active management).
- 3) Create RMAs only on small perennial Type N streams that are prone to landslides and debris flows and have the potential to influence downstream water temperatures.
- 4) Create RMAs only on small perennial Type-N streams that are prone to landslides and debris flows and have the potential to influence downstream water temperatures, upstream a specified distance (e.g., 100, 300, or 500 feet) from the junction with a fish bearing stream. The distance could be scaled to the basin size, debris flow delivery probability, and/or georegion.

Benefits:

This option will create additional LW inputs to small Type N streams. Some increase in the delivery of ‘key pieces’ of large wood to downstream fish bearing streams will also occur in

areas with steep slopes where the occurrence of landslides and debris flows are a part of the natural disturbance regime. It is also likely to increase the amount of effective shade along small Type N streams. The relative benefit of a wider or longer RMA will depend on what and where trees are retained. Leave-trees would serve a dual purpose. They would provide both the conventional leave-tree functions the current rules aim to achieve, as well as potential LW in the future for fish bearing streams downslope. Where the current number of leave-trees required under the rules are simply located in a different area, there will be no extra financial cost to the landowner.

Costs:

The cost of retaining some type of riparian buffer on small Type N streams (whether it is a no-harvest, actively managed, or a combination of the two) will be proportional to the number and size of trees that are retained. The potential cost to the landowner in creating RMAs along these streams, however, is high. There may be some ecological costs associated with clustering leave-trees in areas prone to landslides and debris flows as opposed to leaving them in other areas across the harvest unit. If additional leave-trees are required, there will be a financial cost associated with this option.

Option #41: Statewide Riparian Management Policy

Objective:

Develop a statewide riparian management policy.

Description:

Currently, there are conflicting policies across the state that deal with the management of riparian areas and LW in streams. Riparian vegetation and instream wood protection policies and regulations vary substantially across the state, and between different land use sectors. As an example, a number of cities and counties are actively removing LW to reduce the risks of flooding and property damage. At the same time, forestland owners upstream are being asked to put more LW into streams. This option would work towards a statewide policy on the management of riparian areas in streams across all land uses.

Methods/Approaches:

Have similar riparian protection zones on all other land uses that are designed to achieve temperature standards and retain large wood. Work towards a statewide policy on the management of riparian areas across all land uses.

Benefits:

This will spread the burden of managing riparian areas and providing LW to streams equally among all landowners. There is the potential to increase the total stream miles that provide fish habitat by maintaining vegetation and LW on streams in land uses that currently do not provide fish habitat. Since the majority of LW originates from areas closest to the stream, this option will provide significantly more LW inputs as compared to an equivalent widening of RMAs on forestlands only. For example, creating 100-foot buffers on large fish bearing streams regardless

of land ownership would provide significantly more LW as compared to doubling the 100-foot RMA on large fish bearing streams on forestlands only.

Costs:

This will create additional costs to agricultural and urban landowners that will have limitations placed on the use of their land. The addition of LW to some streams in agricultural and urban areas could increase physical hazard risks. Where additional LW creates debris dams and diverts stream flows in lowland areas during periods of high runoff, there will be an increase in the potential for flood damage.

Option #62: RMA Widths

Objective:

Ensure that the width of RMAs are consistent with achieving mature forest conditions and desirable levels of LW inputs and shade functions.

Description:

The Water Protection Rules were designed to provide a level of LW inputs based, in-part, on the relationship between the proximity of woody vegetation to the stream and the potential for that vegetation to deliver wood to the stream. Action should be taken to ensure that the level of LW inputs and shade being provided is consistent with the goals of the rules. This option aims to increase the level of LW inputs and to ensure that adequate shade is maintained to protect water quality by increasing the width of RMAs.

Methods/Approaches:

- 1) Increase the width of the RMA on small streams.
- 2) Increase the width of the RMA on medium streams.
- 3) Increase the width of the RMA on large streams.
- 4) Increase the width of the 20-foot no-harvest buffer.
- 5) Treat nonfish bearing streams the same as small, medium, and large fish bearing streams when determining buffer widths (**IMST recommendation #3**).

Benefits:

This will increase the LW input potential of the RMA. The relative benefit of a wider RMA will depend on what and where trees are retained, however, beyond about 100 feet this relative benefit will be small. For RMAs where the basal area (BA) target is significantly less than the growth potential, increasing the width of the RMA will have little effect on LW inputs. (For example, if the BA target is satisfied in the first 20 to 30 feet, increasing the buffer width will not significantly change the volume of LW retained after the RMA is managed to the target.)

Costs:

Where the BA target is equal to the growth potential, there will be a financial cost to the landowner. Where the BA target is significantly greater than the growth potential, this option will result in an even greater cost to the landowner. Methods 1-5 would have major financial

impacts to landowners due to increased numbers of trees and acres taken out of timber production and set aside for improving stream habitat.

Option #63: Floodplain protection

Objective:

To ensure adequate protection of floodplain functions necessary to maintain and recover salmonids and meet state water quality standards.

Methods/Approaches:

- 1) Monitor the effectiveness of the rules and measures to evaluate the current level of floodplain protection provided for by the rules and voluntary measures. Provide additional protection where current floodplain protection is inadequate.
- 2) Provide for additional floodplain protection outside of what is provided for under the current rules and voluntary measures.
- 3) Provide increased riparian protection for the 100-year floodplains and islands. (**IMST recommendation #4**).

Costs and benefits have not been developed for this option.

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Appendix A: MOA Riparian Workshop Summary Points

MOA Committee Riparian Aquatic Habitat Workshop: Summary Points

- 1) Riparian systems are complex systems and not well understood. Given the current state of knowledge, LWD, shade, litterfall, and fluvial geomorphology factors are the most ‘important.’
- 2) LWD levels are low in western Oregon streams. Beschta figure generally depicts a model of LWD temporal dynamics as influenced by forest practices on private lands.
- 3) High variability in space and time as to how riparian characteristics influence habitat. One size does not fit all.
- 4) There is a difference between “optimal” and “healthy viable population” in terms of goals of riparian needs.
- 5) Hardwoods can provide for important functions other than LWD and shade.
- 6) Some form of active management in riparian areas can accelerate the development of a desired condition.
- 7) We do not have a clear demonstration that adding LWD and artificial structures has a meaningful effect on overall fish populations, due to the long time and basin-wide scale needed to measure a statistically meaningful response.
 - We have demonstrated that for a given stream-reach, fish populations will increase with additional LWD and structure. We just don’t know if this is a reshuffling of the existing population, or a true increase in total population.
- 8) “Upslope areas” contribute some additional LWD above and beyond what adjacent riparian stands contribute.
- 9) “The curve can be shifted.” (re: Beschta figure)
- 10) LWD in the stream is good, but the devil is in the details.
- 11) Regeneration of conifer in riparian areas is very difficult with rules that only allow for thinning of the existing stand.
 - With current conifer retention standards, replacement of those conifers is likely precluded due to low light conditions. Increased growth will occur with thinning, but regeneration will be difficult. (See Dave Hibbs’ data on understory shade vs. what is needed for regeneration.)
- 12) Small streams make an ecological contribution, but the contribution varies by stream. (The implication is that management prescriptions around small streams should be done on a site-specific basis.)
- 13) In terms of the distance from stream edge, the data that define how the various riparian functions are provided by riparian vegetation are generally limited and variable. Nonetheless, most functions are provided by vegetation within a distance somewhere between 60 to 130 feet (60 feet to 40 meters) of the stream. The law of diminishing returns exists for all the functions as distance increases.
- 14) Disturbance regimes are variable across western Oregon, but fire, wind and floods "reset" the landscape with different return intervals and intensities of disturbance.

Appendix B: Oregon Plan Objectives

Instream Roughness

- i.) In cooperation with local groups and federal agencies, refine by reach or stream type, the amount of instream roughness necessary to support healthy salmonid stocks in all coastal streams by 2002.
- ii.) The interim habitat objectives for instream roughness for streams west of the Oregon cascade crest are 50 percent of the stream length (orders 2-5) will have more than three functional large wood key pieces/100 meters of stream length. A functional key piece is woody debris that has adequate length and diameter to be "stable" and create habitat within a channel. This is a piece that is greater than 1.5 times as long as the channel is wide with a rootwad attached and 2 times as long as the channel is wide with no rootwad. Functional diameter is 18 inches or greater on the small end of the piece¹⁰.
- iii.) In cooperation with watershed councils, private landowners, and local, state and federal agencies, create watershed assessments and action plans in every basin in all steelhead ESUs that gives the status of current channel large roughness conditions and prioritizes options for further study, restoration, and protection by 2002¹¹.
- iv.) Ensure that existing programs prevent, minimize or mitigate the effects of human activities on present (1997) instream roughness elements important to salmonids.
- v.) Ensure that instream roughness elements important to salmonids deposited and transported during floods and other natural events remain in place to the extent consistent with public health and safety.
- vi.) In steelhead streams deficient in instream roughness elements important to salmonids, actively restore those elements and/or the upstream and upland processes that will restore them naturally, in 5 percent of the deficient stream miles per biennium.

Temperature Biological Objectives

1. In ESU watersheds that support or have historically supported steelhead, where water quality currently is equal to, or better than, the Department of Environmental Quality (DEQ) water quality standard for temperature, manage activities such that water quality is not degraded.

¹⁰ For streams with a bankfull width less than 10 feet, the functional diameter is 10 inches; 10 to 20 feet = 16 inches; 20 to 30 feet = 18 inches; greater than 30 feet = 24 inches.

¹¹ This time frame was drafted when the Oregon Plan applied only to the coastal ESU watersheds. Now that the implementation of the plan is statewide, the time frame may need to be extended.

2. To meet the DEQ water quality standard for temperature in ESU watersheds that support steelhead, or have historically supported steelhead, according to the following milestones (% of watersheds meeting numeric criteria for temperature):

Year	Coast ESUs	Lower Columbia ESUs	Upper Willamette ESU	SNAKE BASIN ESU	All Steelhead ESUs
1997	18%	39%	11%	7%	18%
2007	35%	45%	20%	20%	35%
2012	45%	60%	40%	40%	45%
2017	65%	80%	60%	60%	65%
2027	90%	90%	90%	90%	90%

3. To identify watersheds in the steelhead ESUs not meeting the water quality standard for temperature through biennial updates to the 303(d) list according to the following milestones (% of watersheds measured):

2002 - 50%
2007 - 95%

4. To identify temperature conditions within unimpaired or least-impaired reference sites in the steelhead ESUs according to the following milestones (% of reference sites monitored per ESU):

Proposed Number of Reference Sites per ESU			
Klamath Mountains and Oregon Coast	SW Washington and Lower Columbia	Upper Willamette River	SNAKE RIVER BASIN
75	50	50	50

Year	Sites Sampled	Total Sites Sampled
1998	First 20%	20%
1999	Second 20%	40%
2000	Third 20%	60%
2001	Fourth 20%	80%
2002	Last 20%	100%
2003+	Repeat cycle by re-sampling beginning with first 20%	

5. To determine the status and trend of temperature conditions within the steelhead ESUs through randomly selected monitoring sites according to the following milestones (% of random sites monitored per ESU):

Proposed Number of Random Sites per ESU			
Klamath Mountains and Oregon Coast	SW Washington and Lower Columbia	Upper Willamette River	Snake River Basin
150	100	100	100

Year	Sites Sampled	Total Sites Sampled
1998	First 20%	20%
1999	Second 20%	40%
2000	Third 20%	60%
2001	Fourth 20%	80%
2002	Last 20%	100%
2003+	Repeat cycle by re-sampling beginning with first 20%	

6. To evaluate the effectiveness of restoration projects and Agricultural Water Quality Management Plans (AWQMP) by developing and implementing monitoring strategies for assessing temperature conditions following the implementation of such activities within steelhead ESUs. DEQ will rely heavily on watershed councils or other agencies for these data. DEQ will provide technical assistance as needed.
7. Review the numeric criteria in the temperature standard during each Triennial Review Period to determine if the standard needs to be scheduled for revision to ensure it remains protective of beneficial uses based upon the most current scientific information.

Appendix C: Figures from Thom et al. (1999)

The figures and tables on the following pages are taken directly from Thom et al. (1999).

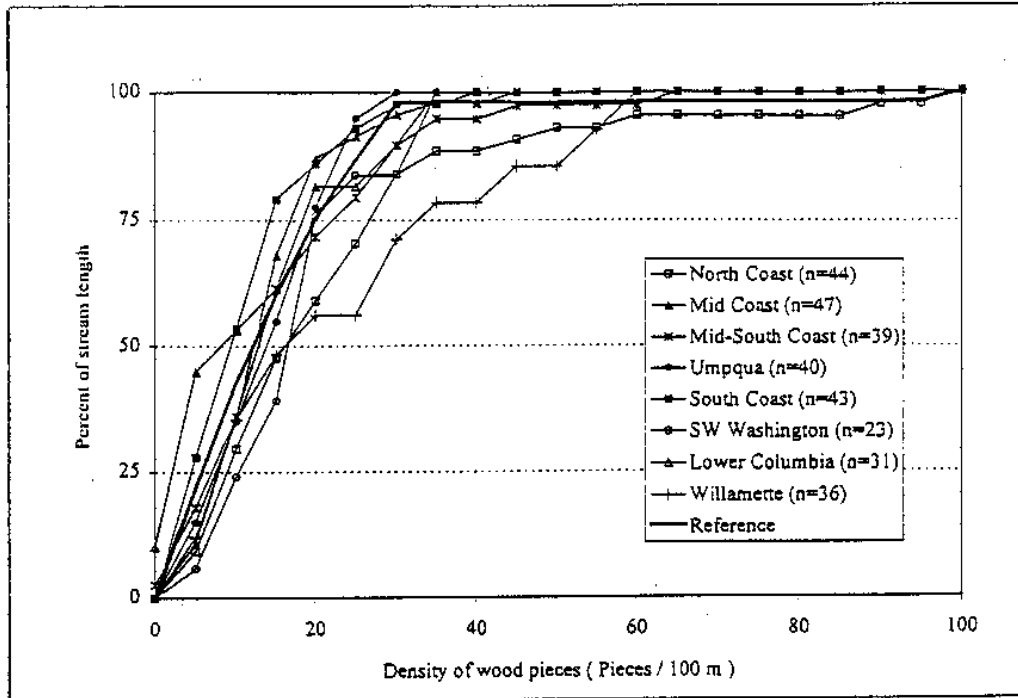


Figure 9: Cumulative distribution of frequency for the density of wood pieces for eight geographic areas in western Oregon.

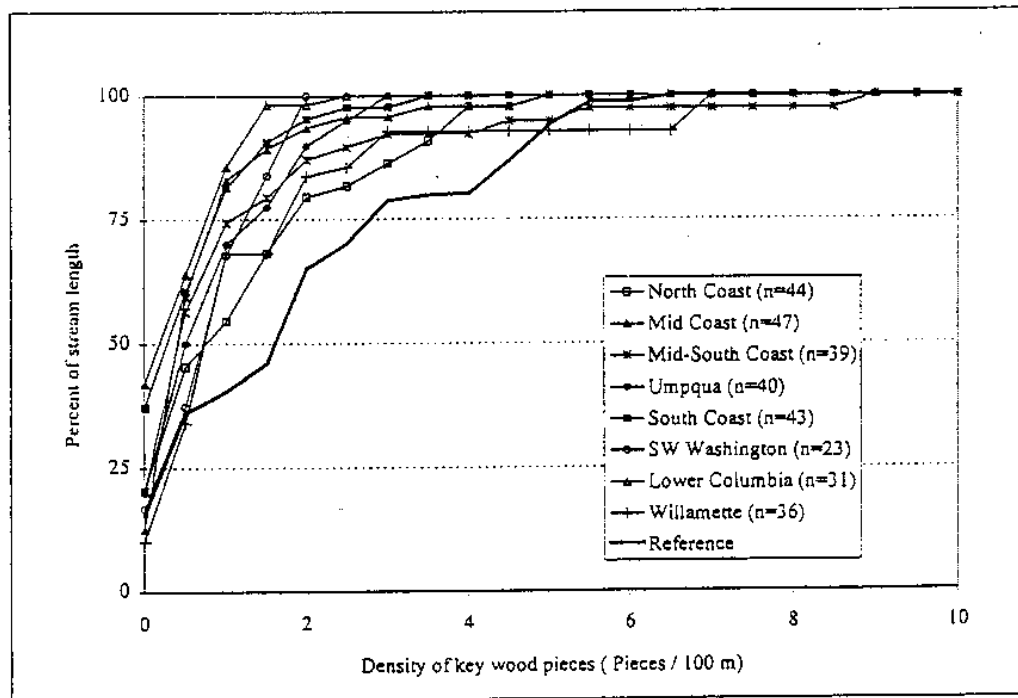


Figure 10: Cumulative distribution of frequency for the density of key wood pieces for eight geographic areas in western Oregon.

Table 7. Cumulative frequency distribution quartiles for the number of riparian conifers > 50 cm.

Analysis Area	Quartile		
	25th	50th	75th
North Coast	0	0	85
Mid-Coast	0	0	50
Mid-South Coast	0	0	<20
Umpqua	0	<20	50
South Coast	0	<20	105
Southwest Wash.	0	0	95
Lower Col.	0	25	120
Willamette	0	<20	60
Reference	25	90	240

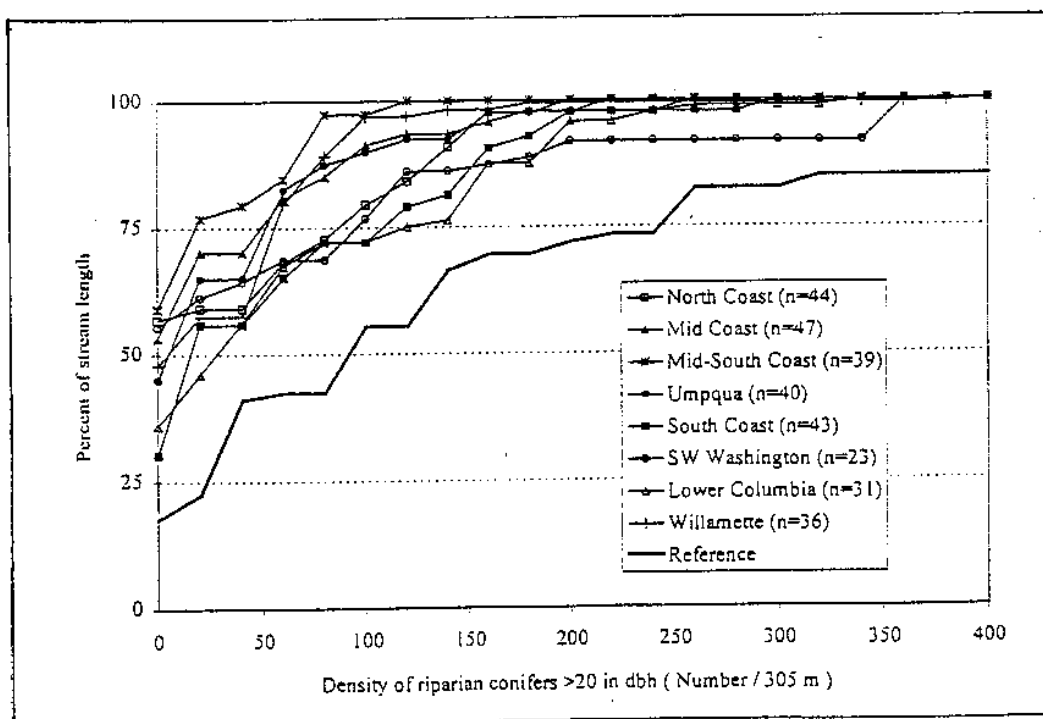


Figure 8: Cumulative distribution of frequency for the density of large riparian conifers for eight geographic areas in western Oregon.

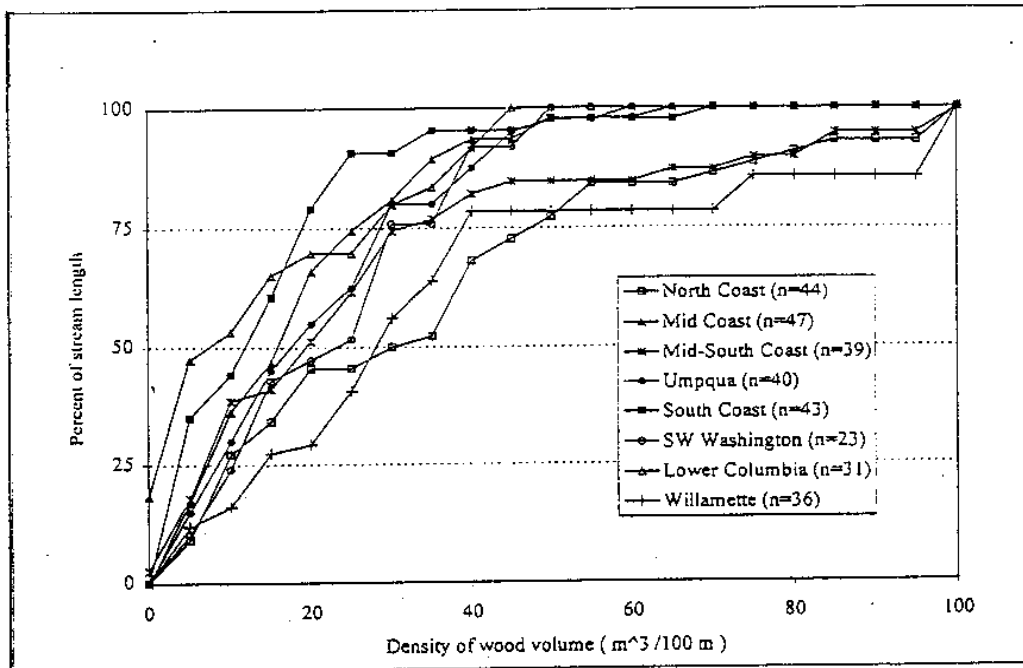


Figure 13: Cumulative distribution of frequency for wood volume density for eight geographic areas in western Oregon.

Table 8. Cumulative frequency distribution quartiles for the number of key pieces of wood. Habitat quality increases with increased number of key wood pieces.

Analysis Area	Quartile		
	25th	50th	75th
North Coast	<0.5	<0.5	1.8
Mid-Coast	<0.5	<0.5	<1.0
Mid-South Coast	<0.5	<0.5	1.1
Umpqua	<0.5	0.6	1.4
South Coast	0.0	<0.5	<1.0
Southwest Wash.	<0.5	0.6	1.2
Lower Col.	0.0	<0.5	<1.0
Willamette	<0.5	0.6	1.7
Reference	0.5	1.8	2.7

Appendix D: Additional Administrative Rules

OAR 340-041-0120

Implementation Program Applicable to All Basins

(11) EQC policy on surface water temperature (as regulated in the basin standards found in OAR 340-041-0205, OAR-340-041-0245, OAR-340-041-0285, OAR-340-041-0325, OAR-340-041-0365, OAR-340-041-0445, OAR-340-041-0485, OAR-340-041-0525, OAR-340-041-0565, OAR-340-041-0605, OAR-340-041-0645, OAR-340-041-0685, OAR-340-041-0725, OAR-340-041-0765, OAR-340-041-0805, OAR-340-041-0845, OAR-340-041-0885, OAR-340-041-0925, OAR-340-041-0965:

(a) It is the policy of the Environmental Quality Commission (EQC) to protect aquatic ecosystems from adverse surface water warming caused by anthropogenic activities. The intent of the EQC is to minimize the risk to cold-water aquatic ecosystems from anthropogenic warming of surface waters, to encourage the restoration of critical aquatic habitat, to reverse surface water warming trends, to cool the waters of the State, and to control extremes in temperature fluctuations due to anthropogenic activities:

(A) The first element of this policy is to encourage the proactive development and implementation of best management practices or other measures and available temperature control technologies for nonpoint and point source activities to prevent thermal pollution of surface waters;

(B) The second element of this policy is to require the development and implementation of surface water temperature management plans for those basins exceeding the numeric temperature criteria identified in the basin standards. The surface water temperature management plans will identify the best management practices (BMPs) or measures and approaches to be taken by nonpoint sources, and technologies to be implemented by point sources to limit or eliminate adverse anthropogenic warming of surface waters.

(e) Surface water temperature management plans will be required according to OAR 340-041-0026(3)(a)(D) when the relevant numeric temperature criteria are exceeded and the waterbody is designated as water-quality limited under Section 303(d) of the Clean Water Act. The plans will identify those steps, measures, technologies, and/or practices to be implemented by those sources determined by the Department to be contributing to the problem. The plan may be for an entire basin, a single watershed, a segment of a stream, single or multiple nonpoint source categories, single or multiple point sources or any combination of these, as deemed appropriate by the Department, to address the identified temperature problem:

(A) In the case of state and private forestlands, the practices identified in rules adopted pursuant to the State Forest Practices Act (FPA) will constitute the surface water temperature management plan for the activities covered by the act. Consequently, in those basins, watersheds or stream segments exceeding the relevant temperature criterion, and for those activities covered by the Forest Practices Act, the forestry component of the temperature management plan will be the practices required under the FPA. If the mandated practices need to be improved in specific basins, watersheds or stream segments to fully protect identified beneficial uses, the Departments of Forestry and Environmental Quality will follow the process described in ORS 527.765 to establish, implement, and improve practices in order to reduce thermal loads to achieve and maintain the surface water temperature criteria. Federal forest management agencies are required by the federal Clean Water Act to meet or exceed the substantive requirements of the state forestry nonpoint source program. The Department currently has Memoranda of Understanding with the U.S. Forest Service and Bureau of Land Management to implement this aspect of the Clean Water Act. These memoranda will be used to identify the temperature management plan requirements for federal forestlands;

(g) Maintaining low stream temperatures to the maximum extent practicable in basins where surface water temperatures are below the specific criteria identified in this rule shall be accomplished by implementing technology based permits, best management practices or other measures. Any measurable increase in surface water temperature resulting from anthropogenic activities in these basins shall be in accordance with the antidegradation policy contained in OAR 340-041-0026.

OAR 340-041-0026

Policy and Guidelines Generally Applicable to All Basins

(1) In order to maintain the quality of waters in the State of Oregon, the following is the general policy of the EQC:

(a) Antidegradation Policy for Surface Waters. The purpose of the Antidegradation Policy is to guide decisions that affect water quality such that unnecessary degradation from point and nonpoint sources of pollution is prevented, and to protect, maintain, and enhance existing surface water quality to protect all existing beneficial uses. The standards and policies set forth in OAR 340-041-0120 through 340-041-0962 are intended to implement the Antidegradation Policy;

(A) High Quality Waters Policy: Where existing water quality meets or exceeds those levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, and other designated beneficial uses, that level of water quality shall be maintained and protected. The Environmental Quality Commission, after full satisfaction of the intergovernmental coordination and public participation provisions of the continuing planning process, and with full consideration of sections (2), (3) and (5) of this rule, however, may allow a lowering of water quality in these high quality waters if they find:

- (i) No other reasonable alternatives exist except to lower water quality; and
- (ii) The action is necessary and justifiable for economic or social development benefits and outweighs the environmental costs of lowered water quality; and
- (iii) All water quality standards will be met and beneficial uses protected.

(3)(a)(D) Effective July 1, 1996, in any waterbody identified by the Department as exceeding the relevant numeric temperature criteria specified for each individual water quality management basin identified in OAR 340-041-0205, OAR-340-041-0245, OAR-340-041-0285, OAR-340-041-0325, OAR-340-041-0365, OAR-340-041-0445, OAR-340-041-0485, OAR-340-041-0525, OAR-340-041-0565, OAR-340-041-0605, OAR-340-041-0645, OAR-340-041-0685, OAR-340-041-0725, OAR-340-041-0765, OAR-340-041-0805, OAR-340-041-0845, OAR-340-041-0885, OAR-340-041-0925, OAR-340-041-0965, and designated as water quality limited under Section 303(d) of the Clean Water Act, the following requirements shall apply to appropriate watersheds or stream segments in accordance with priorities established by the Department. The Department may determine that a plan is not necessary for a particular stream segment or segments within a water-quality limited basin based on the contribution of the segment(s) to the temperature problem:

(i) Anthropogenic sources are required to develop and implement a surface water temperature management plan which describes the best management practices, measures, and/or control technologies which will be used to reverse the warming trend of the basin, watershed, or stream segment identified as water quality limited for temperature;

(ii) Sources shall continue to maintain and improve, if necessary, the surface water temperature management plan in order to maintain the cooling trend until the numeric criterion is achieved or until the Department, in consultation with the Designated Management Agencies (DMAs), has determined that all feasible steps have been taken to meet the criterion and that the designated beneficial uses are not being adversely impacted. In this latter situation, the temperature achieved after all feasible steps have been taken will be the temperature criterion for the surface waters covered by the applicable management plan. The determination that all feasible steps have been taken will be based on, but not limited to, a site-specific balance of the following criteria: protection of beneficial uses; appropriateness to local conditions; use of best treatment technologies or management practices or measures; and cost of compliance;

(iii) Once the numeric criterion is achieved or the Department has determined that all feasible steps have been taken, sources shall continue to implement the practices or measures described in the surface water temperature management plan in order to continually achieve the temperature criterion;

(iv) For point sources, the surface water temperature management plan will be part of their National Pollutant Discharge Elimination System Permit (NPDES);

(v) For nonpoint sources, the surface water temperature management plan will be developed by designated management agencies (DMAs) which will identify the appropriate BMPs or measures;

(vi) A source (including but not limited to permitted point sources, individual landowners and land managers) in compliance with the Department or DMA (as appropriate) approved surface water temperature management plan shall not be deemed to be causing or contributing to a violation of the numeric criterion if the surface water temperature exceeds the criterion;

OAR 340-041-0205

Water Quality Standards Not to be Exceeded [For N.Coast-Lower Columbia Basin, but generally applicable to all basins.]

(1) Notwithstanding the water quality standards contained below, the highest and best practicable treatment and/or control of wastes, activities, and flows shall in every case be provided so as to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor, and other deleterious factors at the lowest possible levels.

(2)(b) **Temperature:** The changes adopted by the Commission on January 11, 1996, become effective July 1, 1996. Until that time, the requirements of this rule that were in effect on January 10, 1996, apply. The method for measuring the numeric temperature criteria specified in this rule is defined in OAR 340-041-0006(54):

(A) To accomplish the goals identified in OAR 340-041-0120(11), unless specifically allowed under a Department-approved surface water temperature management plan as required under OAR 340-041-0026(3)(a)(D), no measurable surface water temperature increase resulting from anthropogenic activities is allowed:

- (i) In a basin for which salmonid fish rearing is a designated beneficial use, and in which surface water temperatures exceed 64.0°F (17.8°C);
- (ii) In the Columbia River or its associated sloughs and channels from the mouth to river mile 309 when surface water temperatures exceed 68.0°F (20.0°C);
- (iii) In waters and periods of the year determined by the Department to support native salmonid spawning, egg incubation, and fry emergence from the egg and from the gravels in a basin which exceeds 55.0°F (12.8°C);
- (iv) In waters determined by the Department to support or to be necessary to maintain the viability of native Oregon bull trout, when surface water temperatures exceed 50.0°F (10.0°C);
- (v) In waters determined by the Department to be ecologically significant cold-water refugia;
- (vi) In stream segments containing federally listed Threatened and Endangered species if the increase would impair the biological integrity of the Threatened and Endangered population;
- (vii) In Oregon waters when the dissolved oxygen (DO) levels are within 0.5 mg/l or 10 percent saturation of the water column or intergravel DO criterion for a given stream reach or subbasin;
- (viii) In natural lakes.

(B) An exceedance of the numeric criteria identified in subparagraphs (A)(i) through (iv) of this subsection will not be deemed a temperature standard violation if it occurs when the air temperature during the warmest seven-day period of the year exceeds the 90th percentile of the seven-day average daily maximum air temperature calculated in a yearly series over the historic record. However, during such periods, the anthropogenic sources must still continue to comply with their surface water temperature management plans developed under OAR 340-041-0026(3)(a)(D);

(C) Any source may petition the Commission for an exception to subparagraphs (A)(i) through (viii) of this subsection for discharge above the identified criteria if:

- (i) The source provides the necessary scientific information to describe how the designated beneficial uses would not be adversely impacted; or
- (ii) A source is implementing all reasonable management practices or measures; its activity will not significantly affect the beneficial uses; and the environmental cost of treating the parameter to the level necessary to assure full protection would outweigh the risk to the resource.

Appendix E: State Water Quality Standards and Rules

LISTING CRITERIA for OREGON'S 1998 303(d) LIST of WATER QUALITY LIMITED WATER BODIES [Oregon Department of Environmental Quality October 1998]:

BACKGROUND:

The 1972 Federal Clean Water Act (CWA) in Section 303(d) requires each state to identify those waters for which existing required pollution controls are not stringent enough to achieve that state's water quality standards. For these waters, states are required to establish total maximum daily loads (TMDLs) in accordance with a priority ranking. The requirements for listing water quality limited streams still in need of a TMDL are contained in several parts of the Code of Federal Regulations 40 CFR. The most recent updates were published July 24, 1992 and became effective August 24, 1992. In addition, the U. S. Environmental Protection Agency (EPA) Region 10 has established guidance entitled, "Guidance Document for listing water bodies in the Region 10 Section 303(d) Program," (November 1995, available upon request).

The clarification of the intent of Section 303(d) in 1992 required the State to "demonstrate good cause" for not listing a water body and puts the burden of proof on the State to justify exclusion of any water body (Federal Register, Volume 57, No. 143, Friday July 24, 1992, pg 33047, preamble to Section 130.7 TMDLs). The State must use all existing and readily available water quality data to prepare the Section 303(d) list. At a minimum, the following sources of data should be considered: waters identified as partially or not meeting water quality standards in the 305(b) report; waters for which dilution calculations or predictive models indicate nonattainment of standards; waters for which problems have been reported by other agencies, institutions and the public; and waters identified as impaired or threatened in the State's nonpoint assessments submitted to EPA under Section 319 of the CWA.

Standards are typically designed to protect the most sensitive beneficial use within a water body. Listings can be based on: evidence of a numeric standard exceedence; evidence of a narrative standard exceedence; evidence of a beneficial use impairment; or antidegradation (i.e. a declining trend in water quality such that it would exceed a standard prior to the next listing period). When a state submits its Section 303(d) list and supporting documentation to EPA for review and approval, the submission will constitute the bulk of the administrative record supporting EPA's approval of the list. The submission should include: the Section 303(d) list including pollutants impairing water quality and the priorities and waters targeted for TMDL development during the next listing cycle; a description of the process the state used in developing the list; any criteria and guidelines used by the state in developing the list; the basis for listing decisions made; and a summary of the response to public comments.

This is a summary of the listing process and criteria used by the Oregon Department of Environmental Quality (DEQ) to develop its 1998 303(d). The 303(d) list decision matrix for developing the 303(d) list is contained in separate documentation. This guidance was based on the following documents: Oregon Water Quality Standards (OAR 340-41) and "Guidance Document for listing water bodies in the Region 10 Section 303(d) Program."

PARAMETER: Temperature

BENEFICIAL USES AFFECTED: Resident Fish and Aquatic Life, Salmonid Fish Spawning and Rearing

STANDARDS or CRITERIA: OAR 340-41-(basin)(2)(b)

Standards applicable to all basins (adopted 1/11/96, effective 7/1/96):

Seven (7) day moving average of the daily maximum shall not exceed the following values unless specifically allowed under a Department-approved basin surface water temperature management plan:

64° F (17.8° C);

55° F (12.8° C) during times and in waters that support salmon spawning, egg incubation and fry emergence from the egg and from the gravels;

50° F (10° C) in waters that support Oregon Bull Trout;

68° F (20° C) in the Columbia River (mouth to river mile 309);

64° F (20° C) in the Willamette River (mouth to river mile 50);

[except when the air temperature during the warmest seven-day period of the year exceeds the 90th percentile of the 7-day average daily maximum air temperature calculated in a yearly series over the historic record]

WATER QUALITY LIMITED CRITERIA: Rolling seven (7) day average of the daily maximum exceeds the appropriate standard listed above. In the cases where data was not collected in a manner to calculate the rolling seven (7) day average of the daily maximum, greater than 25 percent (and a minimum of at least two exceedences) of the samples exceed the appropriate standard based on multi-year monitoring programs that collect representative samples on separate days for the season of concern (typically summer) and time of day of concern (typically mid to late afternoon).

TIME PERIOD:

Rearing: June 1 through September 30;

Spawning through fry emergence: October 1 to May 31 or water body specific as identified by ODFW Biologists;

DATA REQUIREMENTS:

Data collected since Water Year 87 (10/86). Earlier data will be considered on a case by case basis. Given the statistical basis of the proposed standard, continuous monitoring data was preferred and should reflect conditions during the warmest months (typically July and August) or period of interest. Multi-year monitoring programs with monthly data collection or single year monitoring programs with weekly data collections (not continuous monitoring data) were utilized to fill in data gaps where there was no continuous monitoring data available and if they had quality assurance available and collected representative samples on separate days for the season of concern (typically summer) and time of day of concern (typically mid to late afternoon).

EXAMPLES OF DATA USED FOR 1998 LISTING:

Continuous temperature monitoring data collected by the Departmental of Environmental Quality, U.S. Geological Survey, U.S. Forest Service, Bureau of Land Management, Confederated Tribes of the Umatilla Indians, Oregon Department of Fish and Wildlife, and the Cooperative Extension Service.

Department of Environmental Quality, U.S. Geological Survey, U.S. Bureau of Reclamation and Unified Sewage Agency of Washington County routine or intensive monitoring data.

PARAMETER: Sedimentation

BENEFICIAL USES AFFECTED: Resident Fish and Aquatic Life, Salmonid Fish Spawning and Rearing

STANDARDS or CRITERIA: OAR 340-41-(basin)(2)(j)

Standards applicable to all basins:

The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry shall not be allowed.

WATER QUALITY LIMITED CRITERIA: Documented that sedimentation is a significant limitation to fish or other aquatic life as indicated by the following information:

Beneficial uses are impaired. This documentation can consist of data on aquatic community status that shows aquatic communities (primarily macroinvertebrates) which are 60 percent or less of the expected reference community **for both** multimetric scores and multivariate model scores are considered impaired. Streams with either multimetric scores or multivariate scores between 61 percent and 75 percent of expected reference communities are considered as streams of concern. Streams greater than 75 percent of expected reference communities using either multimetric or multivariate models are considered unimpaired.

-or-

Where monitoring methods determined a Biotic Condition Index, Index of Biotic Integrity, or similar metric rating of poor or a significant departure from reference conditions utilizing a suggested EPA biomonitoring protocol or other technique acceptable to DEQ.

-or-

Fishery data on escapement, redd counts, population survey, etc. that show fish species have declined due to water quality conditions; and documentation through a watershed analysis or other published report which summarizes the data and utilizes standard protocols, criteria and benchmarks (e.g. those currently used and accepted by Oregon Fish and Wildlife or Federal agencies (PACFISH)). Measurements of cobble embeddedness or percent fines are considered under sedimentation. Documentation should indicate that there are conditions that are deleterious to fish or other aquatic life.

TIME PERIOD:

Annual

DATA REQUIREMENTS:

Data collected since Water Year 87 (10/86) and included in the most recent watershed analysis or published report. Earlier data will be considered on a case by case basis.

EXAMPLES OF DATA USED FOR 1998 LISTING:

U.S. Forest Service and Bureau of Land Management Watershed Analyses or Wild and Scenic River Environmental Impact Statements or other published reports.

Appendix F: Eastern Oregon Riparian Areas and Site Productivity

The following is a comparison of the eastern Oregon riparian area stocking level recommendations provided by Fred C. Hall (Senior Plant Ecologist, USDA Forest Service, Pacific Northwest Region) with the standard basal area targets for the two eastside georegions in the current forest practice rules.

Fred's recommendations should be interpreted as stocking maximums. To maintain viable stands, stocking reductions (such as through commercial harvest) should occur when these stocking levels are reached to reduce the susceptibility of the trees to insect damage. Stocking reduction needs to be enough that regrowth before the next planned entry does not increase stocking above these thresholds.

Site Productivity Background:

Site Class 1	> 225	cubic feet/acre/year at culmination of mean annual increment (best westside ground)
Site Class 2	165-224	
Site Class 3	120-164	(very high site on the eastside)
Site Class 4	85-119	(eastside mixed conifer)
Site Class 5	50-84	(eastside mixed conifer)
Site Class 6	20-49	(typical ponderosa pine site)
Site Class 7	< 20	(typical juniper site, reforestation not required under current rules)

Fred Hall's Recommendations for Eastern Oregon Riparian Areas:

Site Class 4 (95 cubic feet/acre/year-grand fir/white fir, subalpine fir, larch white pine sites)

160 square feet of basal area per acre (BA/Ac)

Site Class 5 (60 cubic feet/acre/year-ponderosa pine, grand fir/white fir, Douglas-fir, incense cedar)

120 square feet BA/Ac

Site Class 6 (30 cubic feet/acre/year-pure ponderosa pine, some incense cedar)

80 square feet BA/Ac

Site Class 7 (12 cubic feet/acre/year-western juniper with some ponderosa pine)

40 square feet BA/Ac

Harvest Method	Current standard targets in rules converted to <u>basal area/acre</u>		
	<i>FPA-Large Type F (100' RMA)</i>	<i>FPA-Med. Type F (70' RMA)</i>	<i>FPA--Small Type F (50' RMA)</i>
Harvest Type 2 or 3 (including clearcutting, seed tree methods, overstory removals, etc.)	74	56	44
Thinnings and other partial cutting	96	75	44

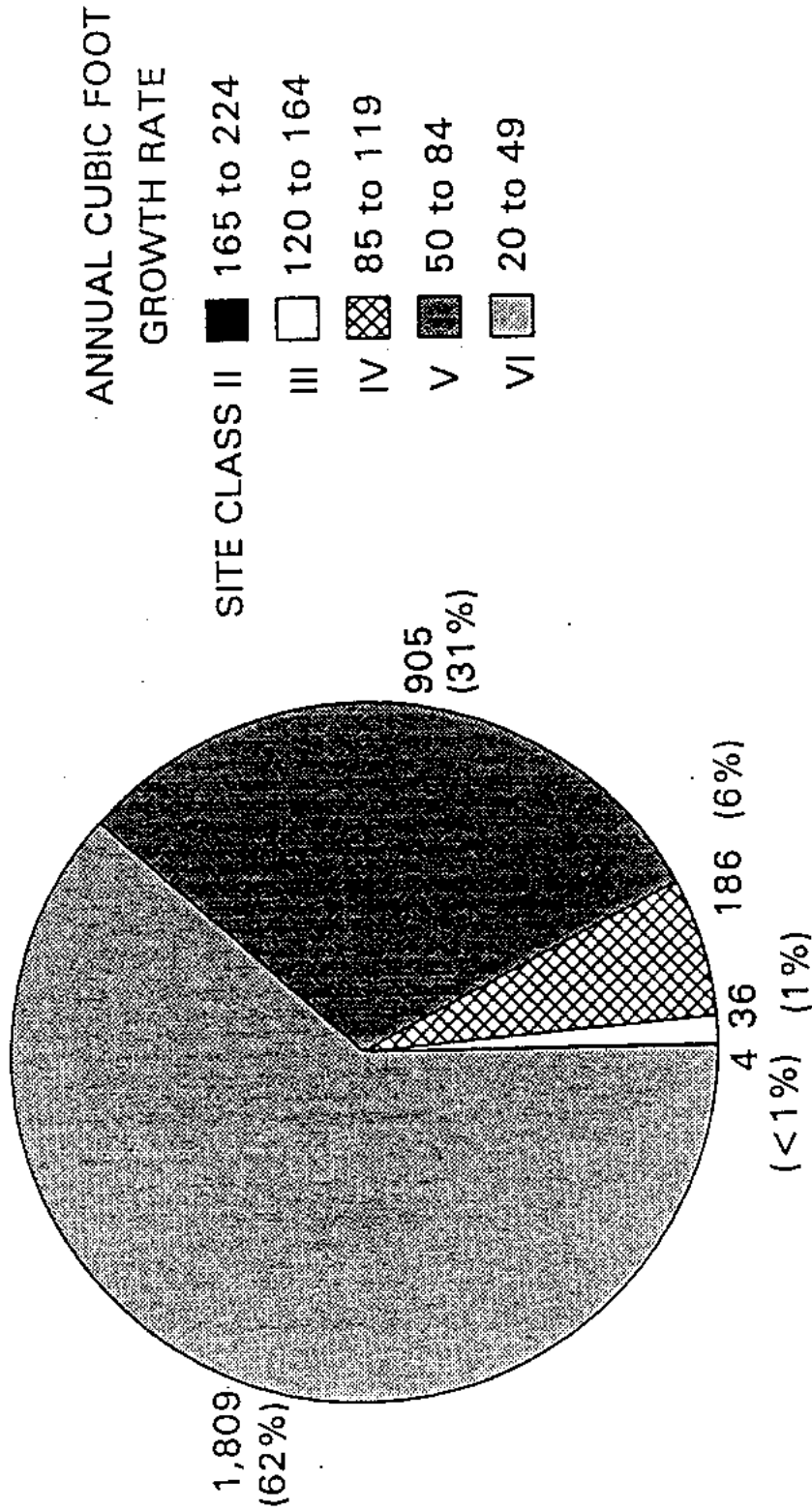
Important note: The rule targets are not directly comparable to Fred Hall's recommendations because they are stocking standards to be met immediately after harvest, and do not include regrowth that will occur prior to the next harvest entry. The rules assume a 50-year return interval for Harvest Type 2 and 3 units and a 25-year return interval for thinnings and other partial cutting. Based on data for mature eastern Oregon stands, a future stocking level target of 116 square feet/per acre across all eastside sites was assumed during development of the 1994 rules. This value is more directly comparable to Fred's recommendations.

Discussion: The rule targets apply to all eastern Oregon operations regardless of site productivity. A large amount of the "forestland" in eastern Oregon produces less than 20 cubic feet per acre per year (Site Class 7). These lands are generally considered to be "noncommercial" and typically support only western juniper. Occasionally, a commercial forest operation will take place on these low productivity sites and such operations are subject to the Forest Practices Act and the water protection rules. Through a study mandated by 1999 Senate Bill 1151, ODF in cooperation with DEQ, ODA, ODFW, and others will evaluate whether the forest practice rules should be modified with respect to commercial juniper harvests or whether such harvest should be considered agricultural activities associated with rangeland restoration and placed solely under ODA jurisdiction.

A majority of the eastern Oregon sites capable of growing 20 cubic feet per acre per year or more are in the Site Class 6 range. Based on Fred's recommendations, it appears the current eastern Oregon standard targets and future basal area targets may be requiring stocking levels that could leave residual stands, along at least large and medium Type F streams, susceptible to insect problems (primarily bark beetles) on these Site 6 areas. On Site 5 and better sites, the rule targets appear to result in stocking levels that are lower than the potential of the growing sites, according to Fred's information. Overall, the current rules may oversimplify the variable site conditions that exist in this part of the state and further analysis of the stocking targets may be needed.

(see figure on next page)

EASTERN OREGON NON-FOREST SERVICE FOREST LAND BY CUBIC FOOT SITE CLASS



AREA BY SITE CLASS IN THOUSANDS OF ACRES

Based on CMAI in fully stocked natural stands.