Chapter B1: Certainty that the Conservation Effort will Be Effective: Riparian Areas

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Part 4D PECE Criteria Papers

Morgan J. 2005. ***Certainty that the conservation effort will be implemented: Forest Practices Act. Oregon Plan Assessment Part 4D, ODF A1***. http://nrimp.dfw.state.or.us/OregonPlan/

Lee B. 2005. ***Certainty that the conservation effort will be implemented:: State Forests Program Oregon Plan Assessment Part 4D, ODF A2***. http://nrimp.dfw.state.or.us/OregonPlan/

Dent L. 2005. ***Certainty that the conservation effort will be effective: Riparian Areas. Oregon Plan Assessment Part 4D ODF B1***. http://nrimp.dfw.state.or.us/OregonPlan/

Dent L. 2005. ***Certainty that the Conservation Effort Will Be Effective: Fish Passage, Roads, and Landslides Oregon Plan Assessment Part 4D, ODF B2.*** (http://nrimp.dfw.state.or.us/OregonPlan/

Part 4J Technical Reports

Mills K., L. Dent L., J. Paul , B. Riggors. 2005. ***Reducing Effects of Roads on Salmonids under the Oregon Plan. Oregon Plan Assessment Part 4J, Technical Report 1***. http://nrimp.dfw.state.or.us/OregonPlan/

Dent L., A. Herstrom, E. Gilbert. 2005. ***A Spatial Evaluation of Habitat Access Conditions and Oregon Plan Fish Passage Improvement Projects in the Coastal Coho ESU Oregon Plan Assessment Part 4J, OP Technical Report 2.*** http://nrimp.dfw.state.or.us/OregonPlan/ 18 pp.

Dent L. and A. Herstrom. 2005. ***Land Use and Land Cover Characteristics in the Coastal Coho ESU Oregon Plan Assessment Part 4J OP Technical Report 3***. http://nrimp.dfw.state.or.us/OregonPlan/

Other Relative ODF Riparian Technical Reports

FP Technical Report #12
Harvest Effects on Riparian Function And Structure Under Current Oregon Forest Practice Rules July 2001

FP Technical Report #13
Shade Conditions Over Forested Streams in the Blue Mountain and Coast Range Georegions of Oregon August 2001

Sufficiency Analysis: A statewide evaluation of forest practice act effe ctiveness in protecting water quality DEQ and ODF (October 2002).
http://www.odf.state.or.us/pcf/pub/fp/AllSAv1031.pdf

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Introduction

This chapter addresses criteria in Section B of the Policy for Evaluation of Conservation Efforts (PECE) that National Oceanic and Atmospheric Agency and US Fish and Wildlife Service will use when making listing decisions. The focus of this chapter is on riparian areas as they relate to aquatic habitat.

Riparian areas fill a special environmental niche between aquatic and terrestrial systems and provide a unique linkage from the headwaters of a basin to the outlet. Structural characteristics of riparian areas vary greatly, in part, because plant communities reflect fluvial and fire disturbances, soil and geomorphic characteristics and management practices (Hayes et al. 1996).

Riparian vegetation is important for fish because it provides nutrients from litter fall, root masses for bank stability, shade for temperature control, and large woody debris for channel development. Upland conditions and processes influence the conditions and functions of aquatic and riparian conditions as well. Examples include landslide and debris torrents that deliver wood, boulders, and sediment to streams; wildfires that create a mosaic of upland and riparian stand structure; roads that can chronically deliver sediment to streams or change the timing and magnitude of high stream flow events. Small headwater channels are important conduits of structure and nutrients.

We focused our assessment of riparian conditions on shade (we used cover as a surrogate) and large wood recruitment. A focus on these two parameters does not mean that these are the only important functions that riparian areas provide. Rather they were selected for several reasons. First, an evaluation of water quality by the Department of Environmental quality (DEQ) for this Coho assessment suggests temperature remains an important water quality risk to aquatic biota (DEQ 2004). Of all the factors that influence temperature, solar radiation-moderated by shade over the stream- is the biggest driver and the one most likely to be influenced by human activities. We also discuss conifer stocking in riparian areas because it too is highly responsive to management and large wood recruitment is still considered a risk for coho habitat (ODF&W 2004). Finally, for this Coho ESU, we have the best available information for describing riparian conditions with respect to cover and large wood recruitment (ODF&W Aquatic Habitat Surveys).

The contributions of riparian and upslope hardwoods is overlooked to the detriment of our scientific understanding and management approaches to riparian areas. Current thinking, available data, and criteria for evaluating riparian areas reflects a myopic focus on large riparian conifers and maximizing shade. Therefore the bulk of our analysis on the certainty of effectiveness was focused on large wood recruitment from conifers and shade. Even so, it is important to recognize the role of hardwoods in coastal riparian areas. Hardwoods are in important component of riparian structure and it is likely that hardwoods historically dominated significant miles of riparian areas in the Oregon Coast Range. This is because they tend to have a competitive advantage over conifers in the highly disturbed zones next to streams and along debris torrent pathways. Current research has documented differences in nutrient cycling and nitrogen levels from streams that are alder dominated in the coast range (Compton et al. 2003) and from small non-fish bearing alder dominated streams in Alaska (Deal and Wipfli 2004). Nitrate and dissolved organic nitrogen increases as the percent of red alder increase (Compton et al. 2003). Researchers suggest that red alder increases habitat quality for wildlife, stream productivity, and nutrients for fish, amphibians, songbirds, and other invertivores. Ecological function of red alder is increased if it is grown in patches, rather than as an understory (Deal and Wipfli 2004). Future analyses should incorporate measures of stand structure that recognize and measure the ecological role of hardwoods.

The Oregon Plan has several regulatory and non-regulatory measures in place to address wood, shade, and sediment issues. Programs range from landscape to site-specific approaches. Specific riparian and upland strategies are described as well as an evaluation of the likelihood that these measures are being and will continue to be implemented and effective. For detailed descriptions of the overall programs, legal processes, authorities, partners, and funding (Section A of the PECE criteria) see chapters A1 and A2 (Morgan 2005 and Lee 2005). For more information on sediment see chapter B2 (Dent 2004) and technical report TR1 (Mills et al. 2005).

An evaluation of future riparian conditions that might result under various management scenarios and how those relate to a fish response is not available at this time. This is the subject of current research from Coastal Landscape Analysis and Modeling Project (CLAMS). In the absence of such information the State provides the following:

- *Status and Trend data to report on current conditions:*
    - Comparison of randomly selected sites throughout the coast range to reference sites.
- *Effectiveness*:
    - General research that depicts process and function used as the foundation for current polices
    - Specific monitoring data on effects as measured under current management practices
- *Likelihood to be effective in the future*:
    - General research on process, function, and historic range of conditions
    - Estimates of effectiveness over 50 years as described in Murphy (1995)

The status and trend analyses rely on comparisons to conditions at "reference" sites. We recognize that conditions at both reference and random sites are expected to change over space and time. Environmental characteristics are a reflection of disturbance processes that act over very long and very short time periods, very large and small spatial scales, and range from simple to complex. Climate cycles, forest fires, windstorms, landslides, floods, and insect and disease outbreaks are normal events that have occurred throughout the history of the coast range and have helped shaped the dynamic landscape of the Pacific Northwest. Over the centuries, these disturbances in combination with forest succession created diverse forests. In forests, large-scale disturbances generally favor colonizing species such as Douglas fir. Small-scale disturbances can create gaps where shade-tolerant understory species, hardwoods, and herbaceous plants flourish, and also increase the supply of snags and large woody material in the forest. The landscape was never homogeneous, and only part of the forest was old growth at any one time (Agee, 1993).

Wimberly et al. (2000) estimated that old-growth forest coverage in the Oregon Coast Range varied from 25-75% during the past 3000 years.

Likewise, riparian stand characteristics are highly variable throughout the coast range. Species composition and structure of riparian vegetation are influenced by the same disturbances described for upland stands with the addition of floods and debris flows that have strong influences on riparian characteristics. Location in the channel network and landform characteristics also influences riparian stand structure. In general riparian stands along higher gradient streams, higher up in the channel network tend to be dominated by conifers. The exception is areas disturbed by landslides and debris torrents where alder and salmonberry, and other deciduous vegetation have the competitive advantage (Pabst and Spies 1998 and 1999). On these very small streams, riparian areas are less influenced by stream and watershed processes so the vegetation tends to be more consistent with the adjacent upland stand. Moving lower down into the system mixed conifer and hardwood stands are more common. Larger river systems in the coast range historically supported species that could tolerate moister soils such as cedar, ash, and willow. In the coast range, the removal of trees in riparian areas, tends to favor rapid establishment of alder, salmonberry, and other deciduous vegetation.

At the heart of a dynamic ecosystem perspective is the principle that both random and reference sites are expected to change over space and time. Therefore, we compare the range of conditions observed at reference sites with those observed at randomly selected sites.

1. a. What is the nature and extent of the threats being addressed?

Analyses of the current status and recent trend in riparian conditions were conducted on data from random, spatially balanced habitat surveys conducted since 1998 as part of ODFW's OPSW monitoring. For these analyses, riparian conditions were characterized by four habitat variables: 1) number of conifers of any size within 30 m of both sides of the stream per 305 meters of primary stream length; 2) number of conifers larger than 50 cm DBH within 30 m of both sides of the stream per 305 meters of primary stream length; 3) number of conifers larger than 90 cm DBH within 30 m of both sides of the stream per 305 meters of primary stream length; and 4) percent of 180 degree sky that is shaded by trees or other topographic features. For a detailed discussion of sediment see chapter B2 (Dent 2005), and Technical Report TRI (Mills et al. 2005).

<u>Status and Trend Survey Design and Methods</u>

ODFW habitat surveys are designed to assess habitat in all "wadeable" streams within the distribution of coho in the ESU. Specifically, the sample frame is derived from 1st through 3rd order coho bearing streams depicted on a 1:100,000 scale digital hydrography layer developed by the USGS. Streams above dams that block adult coho passage are removed from the selection frame. A random tessellation stratified (RTS) design (Stevens 2002) is used to select potential sample sites from the candidate stream reaches in each monitoring area. The RTS selection protocol results in a pool of random, spatially balanced sites across the landscape, thereby reducing potential site selection bias.

Habitat surveys are conducted as described by Moore et al. (1997) with the modification that survey lengths are restricted to 500-1,000 m per site (typically 1,000 m) and all habitat unit lengths and widths are measured rather than estimated. Roughly 10 percent of the sites per year in each monitoring area are resampled by a separate two-person crew to measure variation within season and between crews. Using this methodology, a total of 353 sites were surveyed in the ESU from 1998-2003.

Reference Site Selection

To assess the impact that human activities have had on habitat conditions in the ESU, we compare conditions found at random survey sites to those with a low impact from human activities (i.e. reference sites). Reference sites were selected from all habitat surveys conducted by ODFW in the ESU using a process outlined in Thom et al. (2001). Sites were initially selected based on land use and riparian classifications generally associated with low human impact (e.g. wilderness or roadless area, late successional or mature forest conditions). We further screened candidate reference sites by eliminating those in watersheds with non-ridge top roads. The final list of 124 reference sites (Figure 3) was similar to random sites in gradient, geology, and stream size (Table 2).

Site Weighting

A preliminary analysis of random survey data indicated differences in habitat quality by land use. In theory, the RTS site selection process should provide a list of candidate sample sites that are representative of landuse. However, due to a higher rate of access denial to private lands compared to public lands, there is a bias in our "random" survey data because landuse types are not represented in proportion to their occurrence. To reduce this bias, we re-apportion site weights based on landuse through the following steps: 1) site landuse is stratified into one of five categories using a GIS coverage developed by Dent et al. 2004; 2) the number of coho stream miles within each ownership class and monitoring area is determined by overlaying a 1:100k digital coho distribution layer (http://rainbow.dfw.state.or.us/nrimp/information/fishdistdata.htm) on the landuse coverage; 3) the number of sites sampled within each landuse class is totaled for each monitoring area; 4) the final site weight is determined by dividing the number of sites within each landuse class into the number of stream miles for that class. The primary assumption we make when weights are adjusted is that the sampled sites are representative of the non-sampled sites. However, there is no way to test the validity of this assumption.

Status and Trend Analytical Methods

S-PLUS 6.1 (Insightful Corporation) programs written by the U.S.E.P.A. was used to determine weighted values for the mean, median, and percentiles. More information on these S-Plus programs may be obtained at: (http://www.epa.gov/nheerl/arm/analysispages/techinfoanalysis.htm)

To compare stream conditions at the random sites to conditions at reference sites, we combine all years of random surveys according to spatial scale or landuse category. Sites with multiple years of survey data are averaged to provide one estimate per site. We use T-tests (Snedecor and Cochran 1980) to compare differences between the weighted means of the spatial scale or landuse categories to those of the reference sites. Differences in means are considered significant if P-values are ≤ 0.05. To compare the quality of habitat within monitoring areas or landuses, we use a nonparametric analysis that ranks the condition of a particular parameter for coho relative to other monitoring areas or landuses.

Trends over Time

With the exception of streams flowing through public forested lands, no significant trends were observed in riparian conditions in any of the monitoring areas or land use categories within the

ESU. Riparian areas along public forested streams showed a significant improving (increasing) trend in the number of conifers > 50 cm DBH (Figure 1). Results suggest that the number of conifers in this size range is increasing on public forested lands at a rate of approximately 20% per year. However, when collectively considering all ownerships, riparian conditions have not changed since sampling began in 1998 when considering cover over streams and large wood recruitment. Therefore the data were combined for all six years for an evaluation of conditions.

Spatial Trends

To evaluate spatial trends we compared reference sites to randomly selected sites. These comparisons are used as a “yardstick” for understanding if the range of riparian conditions in the ESU is similar to the range of conditions that is likely to provide desirable riparian and aquatic habitat that favors coho. Data from reference sites are not meant to provide benchmarks or standards for cover or large wood recruitment. Except for the percentage of shade along streams flowing through public forested lands, all spatial scales and landuse categories had lower shade levels and conifer stocking than reference sites (Table 1 and Figures 2, 3, 4, and 5).

Compared to other monitoring areas in the ESU, the North Coast and the Umpqua had the lowest numbers of large conifers (> 50 cm). The North Coast also had the lowest numbers of very large conifers (>90 cm). The Umpqua had the lowest level of shade, however, it ranked the highest in total number of conifers. The Mid-South Coast monitoring area had the lowest total conifers and the highest percent shade. Riparian conditions along public forested streams had the highest levels of shade, large conifers, very large conifers, and total conifers as compared to other landuses. Streams flowing through agricultural and urban, ranked the lowest in three out of the four riparian variables when compared to private or public forested lands in the ESU (Figures 2, 3, 4, and 5).

Cover

We used cover as a surrogate for shade. Shade on randomly selected sites is statistically less than shade on reference sites. While the difference is statistically significant a comparison of summary statistics suggests the difference may not be biologically significant. For example the median percent shade for random and reference sites is 81% and 85% respectfully. There is a larger difference between means, 76% and 84% for random and reference respectfully. The greatest differences in the distributions occurs at the low end with 5 percent of random sites having shade of 36% or less versus 65% or less for reference sites (Table 2 and Figure 2).

Large Wood Recruitment

We used numbers of large (DBH > 50 cm), numbers of very large (DBH > 90 cm), and total numbers of conifers within riparian areas as an index of *potential future sources* of large wood recruitment *to streams*. The sample reaches were 305 meters long. For all three indices, reference sites have substantially more trees than random sites (Table 3 and Figures 3, 4, and 5). Both reference sites and random sites have very low numbers of large conifer trees (means = 120 trees/305 meters vs 30 trees/305 meters) (Table 3 and Figure 3). However, reference sites have substantially (75%) more large conifers than random sites. There are even fewer very large confer trees and again reference sites had substantially more (85%) 90-cm conifer trees than random sites (means = 54 trees/305 meters vs.8 trees/305 meters). Finally, reference sites also had substantially more total conifers (44%) than reference sites (means = 583 vs. 320 trees/305 meters).

Table 1. Results of T-tests comparing random surveys to reference conditions. The shaded boxes represent results that are not statistically different (i.e. no difference between random and reference sites). All others demonstrate statistical differences between random and reference sites.

Spatial Scale	Habitat Variable	Time Span	P-value
ESU	Conifers > 50	All Years	0.001
ESU	Conifers > 90	All Years	0.001
ESU	Shade	All Years	0.001
ESU	Total Conifers	All Years	0.001
North Coast	Conifers > 50	All Years	0.001
North Coast	Conifers > 90	All Years	0.001
North Coast	Shade	All Years	0.001
North Coast	Total Conifers	All Years	0.001
Mid-Coast	Conifers > 50	All Years	0.001
Mid-Coast	Conifers > 90	All Years	0.001
Mid-Coast	Shade	All Years	0.018
Mid-Coast	Total Conifers	All Years	0.001
Mid-South Coast	Conifers > 50	All Years	0.001
Mid-South Coast	Conifers > 90	All Years	0.001
Mid-South Coast	Shade	All Years	0.001
Mid-South Coast	Total Conifers	All Years	0.002
Umpqua	Conifers > 50	All Years	0.001
Umpqua	Conifers > 90	All Years	0.001
Umpqua	Shade	All Years	0.001
Umpqua	Total Conifers	All Years	0.11
Agriculture	Conifers > 50	All Years	0.001
Agriculture	Conifers > 90	All Years	0.001
Agriculture	Shade	All Years	0.001
Agriculture	Total Conifers	All Years	0.001
Private Forested	Conifers > 50	All Years	0.001
Private Forested	Conifers > 90	All Years	0.001
Private Forested	Shade	All Years	0.007
Private Forested	Total Conifers	All Years	0.001
Public Forested	Conifers > 50	All Years	0.001
Public Forested	Conifers > 50	Last Year	0.009
Public Forested	Conifers > 90	All Years	0.001
Public Forested	Shade	All Years	0.978
Public Forested	Total Conifers	All Years	0.008
Urban	Conifers > 50	All Years	0.002
Urban	Conifers > 90	All Years	0.006
Urban	Shade	All Years	0.001
Urban	Total Conifers	All Years	0.004

Table 2. Maximum, median and average cover conditions for reference and random sites in the Oregon Coastal Coho ESU.

Summary Statistic	Percent Cover Random	Percent Cover Reference
95th percentile	97	98
Median	81	85
Mean	76	84
5th percentile	36	65

Table 3. Summary statistics for numbers of conifer trees/305 meters of stream for random and reference sites in the ESU.

Summary Statistic	Large Conifers (DBH>50 cm) (number of trees /305 meters) Random	Large Conifers (DBH>50cm) (number of trees /305 meters) Reference	Very Large Conifers (DBH>90 cm) (number of trees /305 meters) Random	Very Large Conifers (DBH>90 cm) (number of trees /305 meters) Reference	Total Conifers (number of trees /305 meters) Random	Total Conifers (number of trees /305 meters) Reference
Sample Size	352	107	352	107	352	105
95th Percentile	119	421	41	193	1185	1661
Median	8	61	0	22	159	372
Mean	30	120	8	54	320	583
5th percentile	0	0	0	0	0	0

1. (b) How does the conservation effort reduce the threats?

Overall

Historic management practices in the Oregon Coast range have contributed to current riparian and aquatic ecosystem conditions. Many of them are clearly considered detrimental including splash dams, salvage logging in streams (cedar wood shingles, etc.), stream cleaning (at the time thought to improve fish passage), logging without leaving trees in riparian zones, railroad logging, legacy road building, equipment in riparian areas, ditching, diking, and draining wetlands. Farm and urban development tend to capitalize on the flat areas adjacent to low gradient streams that are considered to historically provide key winter habitat for coho. Most of these practices have been eliminated while others are regulated with management goals geared towards achieving properly functioning aquatic and riparian areas.

The Oregon Plan programs reduce the threat created by these kinds of historic practices with a three-pronged approach: regulatory, non-regulatory, and monitoring. All riparian areas adjacent to Coho streams in the ESU receive some kind of protection. These protections include water quality management plans on agricultural lands in watersheds where problems are identified, riparian reserves on federal forestlands, restricted riparian management areas on state and private forestlands, setbacks from development, and non-regulatory riparian improvement projects. We estimate that there are about 36,500 miles of streams in the ESU with adjacent forests in riparian reserves or riparian management areas. These areas occupy about 20 percent of all the forestland in the ESU.

Leaving riparian buffers along streams is now a common approach to protecting aquatic habitat. However, the practice is generally less than 30 years old. Prior to the early 1970's there were no regulatory requirements for the retention of riparian vegetation. With the implementation of the Oregon Forest Practices Act in 1972, minimal buffers were required on forestland streams "important for fish." By the mid-1980's more substantial buffers that required retention of some conifers were in place for streams "important for fish" on forestland. It was not until 1994 that riparian management areas requiring substantial conifer retention were in place for "all fish-bearing streams." Requiring riparian management areas along "all fish-bearing streams" versus just streams "important for fish" likely increased streams receiving riparian protection on private forestlands by 30 percent. Buffers along streams in agricultural and urban settings are even more recent. Thus, for many lands where land use conversion or timber harvest has occurred n the ESU, it is now reasonable to expect that the majority of vegetation is less than 40 years of age and reflects a likely bias toward hardwood composition. Although second growth trees may recruit wood into streams at a higher rate than more mature stands, the total volume of wood is less, smaller in diameter, more highly mobile and more subject to decay than in mature forests. Conversely, where timber harvest or land use conversion has not occurred, due to fire suppression and/or reductions in beaver populations, both understory and overstory vegetation composition are likely also different. The implications for these differences are unknown, but may result in higher levels of shade, and/or lower levels of recruitment than if fire suppression didn't occur or beaver populations were greater.

Re-establishing riparian function by way of riparian buffers is expected to take 50 to 100 years. Therefore it is unreasonable to expect a signature in the status and trends as a result of management changes within the last 30 years. However, it is reasonable to expect that conditions will continue to improve under current management practices and even more as the practices continue to adapt to new information. What follows is a description of the regulatory, non-regulatory, and restoration programs and how they are likely to reduce the threats associated with riparian conditions in the Coho ESU.

Riparian management strategies vary depending on ownership. This paper focuses on privately-owned and state owned and managed forest land in the Coastal Coho ESU. In the following we provide a narrative of regulatory goals and strategies for reducing the threat to coho and available research and monitoring on the effectiveness of these strategies. Private and state strategies are complicated and differ from each other. We have summarized the strategies in Appendix A. The complete rules and strategies for state forests are provided in Appendix B. The complete rules for privately owned riparian areas are found in OAR Division 635-660 at the following web site: http://www.odf.state.or.us/pcf/pub/fp/FPArulebk.pdf

Regulatory

Privately Managed Forest Land-Forest Practices Act

Goal

Management of riparian areas on private forestland is regulated by the Forest Practices Act and Rules (FPA). The act acknowledges that the leading use on private forestland is the growing and harvesting of trees (OAR 629-635-0100). However, the act also acknowledges that the unique concentration of public resource values in and near waters of the state shifts the focus from production to protection measures in riparian areas. The desired future condition for streamside areas along fish-bearing streams is to grow and retain vegetation so that, over time, average conditions across the landscape become similar to mature streamside stands (80 – 200 years of age). The goals for streamside areas that do not have fish is to have sufficient streamside vegetation to support the functions and processes that are important to downstream fish use waters and domestic water use.

Approach: Riparian Areas

The purpose of the vegetation retention rules is to maintain and promote *desired future riparian stand conditions* that will provide ample shade, an abundance of large wood to the channel, bank stability, snags, nutrient input and nutrient uptake. Under the 1994 stream rules, riparian stands can be managed to the extent that these goals can be met. The water protection rules require the establishment of riparian management areas (RMAs) on most streams that are within or adjacent to a harvest unit. The RMA width requirements vary depending on the stream classification (OAR 629-635-300) (Table 4). Oregon Department of Forestry (ODF) classifies streams by "Type" and by stream size. The "Type" designations include Type F for fish-bearing streams, Type N for non-fish-bearing streams, and Type D for domestic water sources without fish presence. Stream sizes are based on average annual stream flow in cubic feet per second (cfs). The stream size classifications are small (< 2 cfs), medium (≥2cfs and <10 cfs), or large (≥10cfs).

Table 4. Riparian Management Area Widths.

Stream Size	Fish-bearing Stream (Type F)	Domestic Use (Type D)	Non-fish bearing, Non-Domestic Use (Type N)
Large	100 Feet	70 Feet	70 Feet
Medium	70 Feet	50 Feet	50 Feet
Small	50 Feet	20 Feet	--

A landowner has multiple options for harvesting within the RMA. One scenario under which RMAs can be managed is if the existing basal area exceeds the "standard target" for basal area. Normal conifer yield tables from average upland stands were used to develop conifer basal area standard targets. The effects of riparian influences on stocking, growth and mortality were used to lower the basal area targets to a level thought to be reasonable for riparian areas (Lorensen et al. 1994).

Available data on stocking levels that were used to construct the current rules are shown in Figure 6 (Data sources: Andrus and Froehlich 1987, Heimann 1988, Pabst. and Spies 1999, Thom et al. 1999, and Ursitti 1990). For the coast range the average assumed stocking that would occur midway through a 50-year rotation was 159 ft^2/acre. The stocking levels for unmanaged riparian areas range from 31-426 ft^2/acre with an average of 123ft^{2}/acre. For riparian areas managed to achieve mature forest conditions a 50 -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 harvest rotation (25 years). The RMA widths were established because they were believed to supply between 65 percent and 95 percent of the potential conifer large wood of mature forest, assuming the zones contain conifer stocking of mature forest (McDade et al., 1990). The range in large wood potential will also vary within each of the stream size classes defined under the FPA.

Landowners have the option to harvest conifer trees within riparian management areas that are in "excess" of the basal area targets while maintaining a 20-foot no-cut buffer zone as measured from the average annual high water mark. This standard target prescription and five other prescriptions are described below.

No-cut Buffer (OAR 629-635-310): The landowner can leave a fixed buffer width and not harvest within the RMA.

Standard Target Basal Area (OAR 629-640-100): A standard conifer basal area target has been established that varies by stream size, Type and georegion. If the pre-harvest conifer basal area within the RMA exceeds the target, the landowner can harvest to the standard target while retaining a 20-foot no-cut buffer, and a specified minimum number of trees per 1000 feet of stream length, which also varies by stream size. If the basal area is less than the standard target but greater than one-half the standard target, the landowner doesn't have the option to manage.

Active Management (OAR 629-640-110): A landowner can place large wood in the stream and receive a basal area credit. Piece size and credit vary by stream size and Type. The credit allows for additional harvest in the RMA but never below the active management basal area target.

Small Type N Streams: (OAR 629-649-200): Understory vegetation and unmerchantable trees must be retained within 10 feet of each side of perennial small Type N in the Eastern Cascade and Blue Mountain georegions. These requirements also apply to perennial streams in the South Coast, Interior, and Siskiyou Georegions that meet basin area requirements (160, 330, and 580 acres, respectively). No vegetation retention is required in the Coast Range and Western Cascade georegions or for seasonal small Type N streams.

Alternative Prescription (OAR 629-640-300): If the basal area is less than one-half the standard target, the landowner can use an alternative prescription. There are two conditions which may warrant an alternative prescription: a catastrophic event or a riparian stand capable of supporting conifers which currently is dominated by hardwoods.

On sites that are hardwood-dominated, a hardwood conversion prescription can be used to convert a hardwood-dominated riparian area to one dominated by conifers. Alternating conversion (maximum 500 feet long) and retention blocks (minimum 200 feet long) are established. In the conversion block, the landowner can harvest all trees to within 10 feet of the stream and must replant conifers. Within retention blocks the landowner may apply general prescriptions if the block meets the basal area targets. If the retention blocks do not meet the standard target, then the landowner can harvest all conifers to within 50, 30, and 20 feet on large, medium and small streams, respectively.

Site Specific Plan (OAR 629-640- 400): A landowner has the option to develop a site-specific plan for harvesting within the RMA. The goal of this rule option is to encourage landowners to look for opportunities to enhance and restore riparian areas.

Issues concerning roads and landslides are addressed in Chapter B2 (Dent et al. 2004) and Roads and Stream Crossing technical reports TR1 and TR2 (Mills et al 2004, Dent et al. 2004).

Approach: Upslope Sources of Large Wood
The Board of Forestry is considering rule revisions that address aquatic habitat processes such as large wood recruitment from debris flows. The most recent changes to the regulations (in 2002) were to implement a policy for not locating roads in critical locations such as steep slopes that may have a moderate to high risk of slope failure (OAR 629-625-0100 and 0200). New rules were also adopted to guide evaluation and management around landslide prone areas that pose a risk to public safety (OAR 629-623-0000-0800).

Planning and Notification: Operators (the landowner, logger and/or road builder) must notify ODF prior to road construction or reconstruction as described above, if roads are on very steep slopes. The operator must submit a written plan detailing road design and construction practices at these critical locations. Roads in these locations are also a high priority for regulatory inspection.

Harvest Restriction and Leave Tree Requirements for High Landslide Hazard Locations: These rules (629 623-0100-0800) are designed to address public safety and are not geared towards protection of aquatic habitat. However, overlap with aquatic goals include rules that describe situations in which upslope harvesting is restricted (629 623-0100-0400) and large standing trees must be left along likely depositional reaches of debris torrent-pone streams (629 623-0100-0600).

Managing small non-fish bearing streams: The Board of Forestry approved draft rule language in April of 2004 for increased protection for some small non-fish bearing streams to improve the "quality" of landslides that could deliver to fish-bearing streams.

<u>*State Managed Forest Land*</u>
Riparian and Aquatic Goal
The biological and ecological objectives of the Forest Management Plan (FMP) are to maintain and or restore the ecological functions of aquatic and riparian areas as well as upland areas that directly influence aquatic and riparian areas (ODF 2001). The intention is to manage for proper functioning aquatic systems by providing diverse aquatic and riparian conditions over time and space. This approach is intended to more closely emulate the historical conditions maintained by the natural disturbance regimes under which native species evolved. Desired conditions are explicitly described for (a) fish-bearing and large and medium non-fish bearing streams and (b) small-non-fish bearing streams. Desired future conditions for non-fish bearing streams are differentiated for those that are perennial streams, seasonally high-energy streams, and potential debris flow track reaches.

Approach
Aquatic and riparian conditions are linked with landscape processes such as mass soil movements and hydrologic regimes. Therefore, the FMP uses a blended approach to manage riparian and aquatic habitat at the landscape and site-specific levels. The Independent Multi-disciplinary Science Team (IMST) cited this approach as necessary to achieve a high likelihood of restoring and maintaining properly functioning aquatic systems (IMST 1999). What follows is a brief summary of the blended approach.

Landscape Strategies. The FMP describes a number of strategies for managing at the landscape level to achieve desired riparian and aquatic conditions. These include: Watershed Analysis, Salmon Anchor Habitat Strategies, Slope Stability and Road Management Strategies. The following is a brief description of each of these strategies.

Watershed analysis is described as a critical process for refining and planning management activities related to implementation of the forest management plan. State Forests has developed a watershed analysis manual (ODF 2004) that describes the goals for watershed analysis, a process for implementing the analysis, and a process for incorporating watershed analysis findings into implementation plans. The goal for each watershed analysis is to identify if proper functioning conditions exist along streams. If the aquatic system is not in proper functioning condition, the analysis will evaluate if existing ODF strategies are likely to remedy the limiting factors and if not, if there are other measures that ODF can take to address the limiting factors. In this way, watershed analysis provides a tool for adapting FMP strategies at a watershed scale to create the desired future conditions for riparian and aquatic ecosystems.

The FMP identifies the Salmon Anchor Habitat approach as a strategy for managing species of concern. This approach establishes seventeen watersheds in the Tillamook and Clatsop State Forests that were identified as the core of salmon recovery efforts on state managed forestland. These watersheds were selected because they are considered to currently support the best existing habitat and high salmonid production. These watersheds are managed in accordance with a strategy that prioritizes salmonid recovery while balancing multiple purposes of state forests. The strategy is accomplished by lowering short-term risk to salmonids in salmon anchor habitats through additional management restriction within riparian areas, around small non-fish bearing streams, and goals to extend no-harvest buffers for debris flow recruitment.

Slope stability affects riparian and aquatic habitat through geologic processes that result in landslide delivery to streams. The general goals of the slope stability strategies are to minimize road-related landslides and chronic erosion, and to manage uplands to ensure that large wood is available in the track of potential debris slides and torrents. This will be achieved through management at three levels. (1) Through the watershed analysis the state will complete a broad-level assessment of landslide hazards. (2) At the district level, implementation planning and annual operations planning the department will utilize geotechnical expertise in evaluating alternatives that can minimize for or avoid risk in high and moderate hazard areas. (3) During project planning and design level, utilize geotechnical expertise in evaluating alternatives that can minimize for or avoid risk in high and moderate hazard areas. The analyses will result in three possible risk ratings and associated management alternatives to promote desired functions such as delivery of large wood to downstream reaches.

Road Management is one of the most critical forest management activities with the potential to impact riparian and aquatic conditions because of their permanent nature and their potential connectivity to stream systems. Road systems will be managed to keep as much forest land in a natural productive condition as possible, prevent water quality problems and associated impacts on aquatic and riparian resources, minimize disruption of natural drainage patterns, provide adequate fish passage and minimize exacerbation of natural mass-wasting processes. Four primary areas of road system management in the FMP are described in detail in ODFs Forest Road Manual (ODF 2000). The four areas include: transportation planning, road design construction and improvement, road maintenance, and road closure. ODF has completed a pilot study to evaluate each of the components and begin implementation. For a more detailed discussion on roads see chapter B2 (Dent 2004) and Oregon Plan Technical Report OPTR1 (Mills et al 2004).

Sites-Specific. The FMP describes a number of strategies for managing at the site-specific level to achieve desired riparian and aquatic conditions. They can be described in two groups: Management standards for aquatic and riparian management areas and restore aquatic habitat.

The site-specific strategies are achieved with a set of aquatic and riparian management strategies which include (1) applying management standards (2) applying alternative vegetation treatment to achieve desired conditions, or (3) applying strategies to other aquatic habitats: wetlands, lakes, ponds, estuaries, bogs, seeps, and springs (FMP-Appendix J). Riparian areas will be managed through two basic approaches. One is to achieve conditions associated with mature forests. Once a riparian area has met the desired condition, it will have limited or no management activity. For riparian areas that do not meet the desired conditions, management strategies will be designed to move the stand toward these conditions in a timely manner.

The riparian and aquatic strategies describe a combination of buffer widths and management strategies that can be used to meet these goals and objectives. In general, riparian management areas on fish bearing streams are 170 feet wide with inner and outer zones that vary in their management restrictions. There is also a 25 foot no harvest zone. The inner zone (25 – 100 feet) is to be managed for mature forest conditions (basal area = 220 ft^2/acre). The outer zone is managed to further insure the basal area target is met. Additional requirements include maintaining 10–43 conifer trees per acre, all snags, dead and down wood, and minimize ground disturbance. The management strategies include alternative prescriptions, basal area requirements, and habitat restoration.

Reducing the Threat- Large Wood and Shade from Riparian Areas

Large Wood Recruitment

Since the FPA riparian rules were adopted in 1994 and the FMP Riparian and Aquatic strategies in 2001, there has been little time to demonstrate effectiveness in large wood recruitment over the long term, nor to investigate what the improvements mean to fish. In the previous section we discussed the scientific bases for establishing basal area targets. In the following we provide estimates from Murphy (1995) on the likelihood that the strategies will be effective in both the short term and longer term, data on riparian structure and shade immediately following harvest under current riparian management practices, and describe the adaptive management processes in place that are responding to and collecting new monitoring data.

There exists no standard for large wood recruitment against which to evaluate neither the current effectiveness nor the likelihood that the riparian rules and strategies will be effective in the future. Therefore we provide an evaluation based on percent reductions in potential large wood recruitment.

Murphy (1995) estimated the effectiveness of current forest practice rules in a number of western states in protecting and restoring riparian aquatic habitat. Murphy performed two analyses to quantitatively evaluate and rank large wood input protection among different sites. One analysis assumed no harvest within RMAs while the other assumed harvest down to the basal area target.

Based on the RMA width alone (and assuming an unharvested, fully stocked mature conifer forest within the buffer), Murphy estimated 92% of the potential large wood delivery is provided from large Type F streams in the Oregon Coast Range (Table 5). Though not stated by Murphy, we expanded the analysis to evaluate Medium and Small streams in the Oregon Coast Range. We estimate that harvest under the current rules would retain approximately 80% of potential large wood delivery for medium fish-bearing streams and 70% for small fish-bearing streams.

Murphy further estimated potential large wood sources (conifer volume) present immediately after timber harvest, assuming the retention of the minimum basal area only (Table 5). Based upon his analysis, Murphy estimated that approximately 58% of potential conifer large wood sources of mature forest stands would be present on large Type F streams in the Oregon Coast Ranges following timber harvest. Though not completed by Murphy, we expanded the analysis to evaluate medium and small streams in the Oregon Coast Range. Results estimate that approximately 38% and 12% of potential large wood recruitment would be retained in medium and small stream respectively. This is immediately following harvest. Over a 50 year period recruitment would increase to 65% and 26% respectively for medium and small streams.

Monitoring data from riparian areas managed under the 1994 forest practices act provide a means to validate Murphy's estimates immediately following harvest (year 0) (Table 5). Dent (2001) evaluated 1994 riparian management rules using a before-after-treatment design. Riparian and stream shade (cover) plots were established prior to harvest and revisited the same time of year after harvest. This study was conducted at sites distributed throughout the state of Oregon (Figure 7). Fourteen sites were in the Coastal, 12 in the Interior, four in the West Cascades, two in the East Cascades, two in the Siskiyou, and six in the Blue Mountain georegions. Results described here and displayed in associated figures represent statewide analyses of sites managed with both no-cut RMAs and basal area targets.

On average potential large wood recruitment immediately following harvest was 82% on large streams, 68% on medium streams, and 41% on small streams (Figures 8, 9 and 10). Changes in large wood recruitment were not statistically significant for medium or large streams. A comparison of these results to Murphy (1995) is shown in Table 5. The Dent (2001) results show greater reductions than the no-cut harvest analysis of Murphy, but lower reductions than the accompanying basal area target analysis. This is likely because the RMAs studied by Dent (2001) represent a combination of RMAs managed with either a no-cut buffers or basal area targets. Furthermore, as discussed later, landowners generally do not harvest down to the minimum basal area target. The Dent (2001) and Murphy (1995) results seem to validate each other.

Table 5. Estimated and observed potential conifer large wood recruitment following harvest on Type F streams. Numbers were generated using corrected calculations from Murphy (1995) and from pre- and post-harvest observations from Dent (2001).

	Large Streams			Medium Streams			Small Streams		
Years Since Harvest	0 yrs	25 yrs	50 yrs	0 yrs	25 yrs	50 yrs	0 yrs	25 yrs	50 yrs
[1]Assume No Harvest in RMA	92	*na	na	80	na	na	70	na	na
[2]Assume RMA retention is Basal Area Target	46	73	100	30	48	65	12	19	26
[3] Observations from Dent 2001 State Wide with combination of no-harvest and management within RMAs	**82	na	na	**68	na	na	41	na	na

[1] Estimates based on Murphy (1995) for large streams assuming no harvest in RMA. Same procedures described in Murphy (1995) were used to calculate large wood recruitment on medium and small streams.
[2] Estimates based on analysis with corrected calculations from Murphy (1995) with harvest in RMA assuming retention down to FPA basal area target.
[3] Observations from Dent 2001 study of riparian areas that measured large wood recruitment potential before and after harvesting. RMAs were treated with either a no-cut buffer or managed with the basal area target.
* na = values not available
** Not statistically significant difference before and after harvesting.

Researchers modeled large wood recruitment and pool development under varying successional pathways for riparian forests along streams in north-western Washington modeled (Beechie et al. 2000). The authors modeled growth in riparian forests following simulations of stand replacement fires and clear-cut logging with succession to Douglas-fir and red alder. They then modeled relative large wood recruitment with harvesting at 40, 60 and 80 years old for clearcuts, a range of thinning regimes, and compared with an unmanaged fire-regenerated riparian model. They also related large wood recruitment to formation of pools in the stream. The study demonstrates that compared with a natural fire regime, timber harvest rotations of 40-80 years reduce the percent of riparian stands that can recruit large wood. Findings suggest that thinning riparian areas where trees are already large enough to form pools reduces large wood recruitment. Conversely, thinning riparian areas where trees are too small to form pools, is projected to result in increased tree growth, greater large wood abundance, over a shorter time period than unthinned stands with similar characteristics. For alder stands, findings suggest thinning is most effective on streams greater than 20 meters with trees smaller in diameter than the pool-forming diameter. The study results are sensitive to the selected diameter considered important for pool formation. The selection of a larger diameter would result in a greater proportion of stands showing accelerated large wood recruitment.

Shade
As described above, Dent 2001 evaluated shade before and after harvesting at 40 sites throughout the Oregon. Reductions in cover of greater than 10% were common for small streams, were uncommon for medium streams, and were not observed on large streams (Figure 11). The average

reduction in cover was 12%, 7%, and 1% for small, medium, and large streams respectively. Statistical significance of these changes was tested with a paired t-test. The only statistically significant change in average cover was associated with small streams (p-value = 0.03).

Although cover reductions were greatest for small streams, the average cover was still relatively high (78%) and is expected to recover over a relatively short period of time (2-3 years). This is because shrub cover, which can recover relatively quickly, has a greater effect on narrow streams. Cover in small streams before harvesting ranged from 83 to 95%, and after harvesting, ranged from 60 to 95%. Streams managed with hardwood conversions had the greatest individual shade reductions of 34 to 36%.

In a separate study, Dent and Allen (2001) evaluated stream shade using a fish-eye lens camera comparing harvested sites to unharvested sites and reported similar results. Shade in the Coast Range varied from 51-89% and from 72-95% over harvested and unharvested streams, respectively. Average shade was 73% for harvested sites and 84% for unharvested sites (Figure 12 and Table 6). Results suggest that shade is lower by 19% and 12% on small and medium harvested streams than on unmanaged streams in the Oregon Coast range. This study also observed a difference in shade between harvested and unharvested large streams of 12%.

Table 6. Shade and bankfull widths of harvested and unharvested sites in the Coast Range georegion.

Coast Range Stand Type	Shade and Bankfull Width by ODF Stream Size											
	Small (n)			Medium (n)			Large (n)			Total (n)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
<u>Harvested</u>	12			6			1			19		
Shade (%)	51	72	83	61	77	89	NA	55	NA	51	73	89
Bnkfl. Width (ft)	5	10	17	17	20	27		32		5	14	32
<u>Unharvested</u>	2			3			2			7		
Shade (%)	83	89	95	85	89	93	66	69	72	66	85	95
Bnkfl. Width (ft)	6	7	8	7	19	26	30	33	37	6	14	37

In summary, the available research and monitoring suggests that the FPA RMAs are effective at maintaining shade and large wood recruitment on large streams in ways that are likely to meet the purpose and goals of the rules (Dent 2001). Conversely, the studies found that the goals for mature forest condition measured in terms of large wood recruitment and shade, were *not* likely to be met under the current rules for small and medium streams (Dent 2001, Dent and Allen 2001). However, it is important to note that the observed changes on medium streams were not statistically significant. These findings are also reported in the joint sufficiency analysis (ODF and DEQ 2002).

As described under regulatory approaches, there are differences in how riparian areas are managed under the FMP versus the FPA. However, comparable analyses are not available with specific measures of the FMP. In the absence of available monitoring results we offer the following discussion. The blended landscape and riparian and aquatic strategies are likely to be effective at reducing the threat to coho recovery for the following reasons:

- The goal to attain mature forest condition in riparian areas is likely to meet coho needs by creating and maintaining large diameter trees in riparian areas that will be available for recruitment to streams.
- The FMP has explicitly described basal area targets for achieving mature forest condition (80 – 100 years) and relates that to a typical number of large trees per acre (40-45 32-inch conifer trees).
- The FMP makes a commitment to leave riparian areas untouched that meet the mature forest condition.
- Riparian areas are 170 feet wide with varying management options to meet the mature forest condition within the 170 feet. The mature riparian forest goal, commitment to maintain these once achieved, and the wide buffers widths are likely to capture 70-99% of the large wood recruitment (Murphy and Koski 1989, Van Sickle and Gregory 1990, McDade et al. 1990, Bilby and Bisson 1998) (Figure 13).
- The wide buffers and standard management targets designed to mimic mature forest conditions are highly likely to maintain shade and thus stream temperature.
- The FMP describes alternative approaches for managing riparian areas that don't meet mature forest condition in ways that will achieve that condition in a more timely manner.
- The FMP describes goals and options for aquatic habitat restoration.
- Upland strategies designed to minimize impacts of roads on aquatic and riparian ecosystems recognize the connectivity between aquatic habitat and uplsope management practices.
- The FMP incorporates upland strategies that attempt to manage the risk of landslides so as to maintain and restore these areas to mimic historic process of upland large wood recruitment and routing to streams.

In addition to the reduced threats associated with the blended approach, the state forests program has devised a plan to further reduce the threat to anadromous fish in 17 watersheds identified as Salmon Anchor Habitat. Within these watersheds additional precautions have been outlined, in part with prescriptive elements. These elements include:

- No harvest on all fish-bearing streams and medium type F streams.
- Limitations on harvest along perennial, seasonal, and debris-flow prone non-fish bearing streams.
- No harvest within 50 feet of perennial and debris-flow prone, small, type N streams,
- No harvest within 25 feet of seasonal small type N streams.
- Additional leave tree requirements (15-25 conifer trees and snags per acre) within 100 feet.
- No ground based equipment operation is allowed within 50 feet of the aquatic zone on all small type N streams.
- There are specific limitations on timber harvest activities associated with specific basins. Examples include caps on the percent of watersheds that can be clearcut harvested (ranging from 10 – 25%)

These strategies accomplish the following with regard to reducing the threat to coho habitat:

- They virtually eliminate the possibility that that there will be reductions in shade on fish-bearing streams associated with timber harvest.
- They lower the risk that harvesting will reduce shade on non-fish bearing streams.

- No harvest within 100 feet of the stream is highly likely to capture 70 to 99% of the large wood recruitment potential (Murphy and Koski 1989, Van Sickle and Gregory 1990, McDade et al. 1990, Bilby and Bisson 1998).
- Increased retention of trees along non-fish bearing streams provides large wood recruitment to fish bearing streams that is associated with debris torrents.

Likelihood to be Effective in the Future- Riparian Areas and Upslope Sources of Large Wood
The Oregon Department of Forestry has demonstrated the use of adaptive management to revise rules when scientific analyses suggest a change is needed to meet desired conditions. If new rules are adopted it will be necessary to continue monitoring and researching the rules to determine if there is increased effectiveness associated with large wood recruitment and shade. In the absence of data on how the new rules might perform in the future the following discussion is offered.

Large Wood Recruitment
For the sake of clarity, the following terminology, as described in the joint DEQ/ODF sufficiency analysis will be used to define large wood sources for this discussion.

> Near-stream riparian: Areas directly adjacent to the stream. Large wood is delivered 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 large wood 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. Large wood is delivered by a landslide or landslide-debris flow combination that moves the wood into the stream channel from these areas.

Near-stream Sources: The bulk of the potential *riparian area* inputs of large wood comes from vegetation in close proximity to the channel, with diminishing amounts coming from distances farther from the stream (Figure 13). The majority of larger pieces of wood, that create key pieces, originate from within a distance less than 100 feet (Robison and Beschta, 1990). For example, anywhere from 70 to 99 percent of potential large wood input *from adjacent riparian stands* originates from within the first 30 meters, or about 100 feet, of the stream (Van Sickle and Gregory, 1990; McDade et al., 1990; Bilby and Bisson, 1998) (Figure 13). It is also possible, however, for 70-99 percent of the potential large wood input from riparian stands originates from within the first 50 feet of the stream (Murphy and Koski, 1989). It should be emphasized that these studies did not intend to examine upslope source areas. They analyze potential large wood inputs in terms of the total large wood potential from riparian areas only.

Historically periodic disturbance occurred across the forest 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 (Nierenburg and, Hibbs 2000). It is therefore reasonable to assume that all streams did not maintain 100% of large wood recruitment potential at all times. Estimates of the historical percentage of old growth occurring in Oregon west of the Cascades vary from as little as 35-40% to as high as 70-80% (Wimberly et al. 2000). Therefore, it is possible that providing approximately 46 to 100% of the potential conifer large wood of a mature forest is consistent with the historical levels of large wood potential given the historic variability of old growth conditions. Cleary the potential under forest management for medium and small stream is lower (30-68%) and 12-41% respectively (Murphy 1995 and Dent 2001).

The following assumptions were used in the development of RMA prescriptions in 1994.

1. Basal area targets were developed for the seven different georegions and it was believed these targets would be reasonably accurate in describing the potential for a given riparian stand in a given georegion.
2. Hardwood species would dominate the first 20 feet of the RMA across the landscape on small, medium, and large streams
3. The hardwood conversion option would provide an adequate incentive for landowners to convert riparian stands currently dominated by hardwoods back to conifer where tic is very likely that conifer existed historically.
4. The basal area targets would provide an incentive for landowners to grow trees in excess of what must be retained so the excess may be harvested
5. 25% and 75% of the large wood recruitment needs on medium and small Type F streams respectively, would originate from ingrowth an newly established stands following harvest (this assumption has not been evaluated/examined by monitoring).

Monitoring data collected by ODF provides some insight into assumptions 1-5. As for assumption (1), the high degree of variability in site potential within a given goeregion 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. Highly productive sites, on the other hand, may never reach potential because using a basal area target that is too low will result in harvesting levels that reduce the potential below what can actually be achieved.

It also appears that assumption (2) may not be valid, particularly for small confined channels. Monitoring data indicate variability is prevalent across all sizes of streams, and, 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 anticipated. 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 the case, the actual retention will be significantly less than assumed and it may not support the expected range of functions including shade and large wood at the level that was assumed.

Assumption (3) also may not be valid. The hardwood conversion option does not appear to be used very often by the landowner. This may be because some hardwood-dominated riparian areas do not have enough merchantable timber to make the operation profitable and/or there are unfavorable market conditions. Also, landowners might be wary to exercise this option out of concern they may inadvertently commit a violation.

Finally, assumption (4) may not be valid either. ODF implemented a BMP compliance study from 1999-2001. Sites were randomly selected throughout the state. The 2002 study observed that 45-61% (depending on ownership class) of riparian areas are treated as no-cut buffers (Robben and Dent 2002). Hairston-Strang and Adams (1997) report a higher percent of no-cut buffers with 79%

of landowners in that study treating RMAs as no-cut buffers. In RMAs managed with the basal area retention option, basal area averaged 202% of the required basal area (Robben and Dent 2002). Furthermore, on average, landowners left 258% of the numbers of trees required. In a separate study evaluating shade conditions, RMAs were generally treated as no-cut buffers. Landowners retained 22% more than required basal area in riparian management areas on small streams. Medium and large streams only exceeded basal area targets by 4-10% (Allen and Dent 2001).

There are many possible explanations for exceeding rule requirements: Implementation of Oregon Plan Activities, complexity of the rules and strategies, not enough economic incentive for management, or not enough conifer basal area to allow harvest. Regardless of the reason, the best available information suggests landowners are not commonly managing within riparian areas (45-79%) and when they do, on average the retention exceeds requirements by 4-202%). These findings suggest estimates made by Murphy (1995) likely underestimate potential large wood recruitment since the majority of RMAs are not managed and when they are, more basal area is commonly retained than is required.

Critics have expressed concern that the Forest Practice riparian rules do not adequately address large wood recruitment because landowners will disproportionately harvest large trees from riparian areas, preventing smaller diameter trees from ever maturing into trees that are important for large wood recruitment. Data from Dent (2001) demonstrate that in general, landowners do not disproportionately harvest large diameter trees from riparian areas (Figure 13). Box plots show conifer diameter distributions of trees for riparian areas before and after harvest. The average diameter within RMAs (within 50, 70 and 100 feet) of small, medium, and large streams did not change significantly with harvesting (p-value = 0.74, 0.48, and 0.18 respectively) (Figures 14).

Under the current forest practice rules, riparian management areas for small, medium and large streams are 50, 70, and 100 feet wide, respectively. Given the summary of literature and ODF monitoring findings discussed here, it is likely that increases in tree retention within 50 – 70 feet of the stream will contribute to increases in large wood recruitment from small and medium streams. The summary also supports Dent (2001) conclusions that 100-foot wide riparian management areas (as required on large fish-bearing streams) can adequately protect large wood recruitment functions if managed appropriately.

ODF and DEQ combined this information to evaluate the sufficiency of the FPA in meeting water quality standards (ODF and DEQ 2002). They made a series of recommendations for increasing tree retention to be consistent with achieving mature forest conditions in a timely manner. The Board of Forestry is currently considering a rule package to increase leave tree requirements on small and medium streams. This package also addresses portions of IMST (1999) recommendations for increased leave tree requirements on small and medium streams. See Chapter A1, for more information on this (Morgan 2005). The private and state forests programs at ODF have an ongoing study in the coast range that continues to evaluate the effectiveness of the forest practice rules and FMP strategies (described above). Preliminary results from this study describing baseline conditions will be available in 2005.

Upstream and Upslope Sources: Source areas for potential inputs of large wood are not limited to stream-adjacent locations. Upstream or upslope areas can also be a source of large wood for fish-bearing streams (Keller and Swanson 1979; McGarry 1994; Benda and Sias 1998, May and

Gresswell 2003). In steep landscapes, where the occurrence of debris flows is a normal part of the disturbance regime, relatively large pieces of wood 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 large wood 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 large wood 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 large wood to downstream riparian functions. These sources of large wood have been referred to as both "upslope" and "upstream" sources.

Available scientific information suggests the relative inputs from upslope sources ranges form 10-50%. McGarry (1994) attempted to quantify the relative contribution from each large wood source. He found that the large wood inputs in Cummins Creek, Oregon were split about 50/50 between near-stream riparian and other source areas. McGarry (1994) did not attempt to quantify what percent of the transported large wood originated from upstream versus upslope areas. McDade et al., (1990) also identified about 50 percent of the large wood 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 large wood downstream, it is difficult to determine what pieces of transported large wood 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 large wood sources. In terms of upslope sources, the relative importance of potential large wood 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 large wood 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 large wood 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 large wood 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 large wood by debris flows is limited to about 10-15 percent of the overall wood budget over very long time periods. This may imply that mass wasting plays a relatively minor role in the long-term wood budget of a given watershed. However, they stipulate that "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 large wood downstream is stream flow. For this population of streams, the hydrologic regime will determine what sizes of large wood 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 large wood can be stable in smaller streams.

Other research has found that the amount and distribution of large wood will vary with channel size. Smaller channels contain more abundant amounts of randomly distributed large wood, while larger streams more easily transport large wood, resulting in fewer pieces and reduced aggregation of large wood (Bilby and Bisson, 1998). On very large, mainstem channels, large wood 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).

The current forest practice rules establish a systematic process for identifying locations where landslides might occur. This is the first step in to reducing the landslide-associated management risks. The science and technology for identifying debris flow-prone terrain and channels is available (Montgomery and Dietrich 1994) and key drivers from that science have been incorporated into ODFs approach. Robison et al. (1999) documented that at least 78% of the landslides that occurred in the 1996 storm event were identified as "high risk sites" for landslides - confirming the value of that identification process. The process for identifying high landslide hazard locations is described in detail in Technical reports #2 and #6 (ODF 2003a and b respectively). A brief description follows

High landslide hazard locations are specific sites that are subject to initiation of shallow, rapidly moving landslides due to steepness, shape, and geology of the site. Note that high landslide hazard location identification is based on physical slope characteristics and is independent of proposed harvesting or road building practices. The specific criteria for determination of these sites is found in 629-623-0100 (3) as:

a) The presence, as measured on site, of any slope in western Oregon (excluding competent rock outcrops) steeper than 80 percent, except in the Tyee Core Area, where it is any slope steeper than 75 percent; or

b) The presence, as measured on site, of any headwall or draw in western Oregon steeper than 70 percent, except in the Tyee Core Area, where it is any headwall or draw steeper than 65 percent.

c) Notwithstanding the slopes specified in (a) or (b) above, field identification of atypical conditions by a geotechnical specialist may be used to develop site specific slope steepness thresholds for any part of the state where the hazard is equivalent to (a) or (b) above.

While research has established that the rates of erosion are higher in younger stands than in older stands, it has also established that landslides occur with or without forest management. Landslides supply both sediment and structure such as large wood and boulders to streams (Dietrich and Dunne 1978, Swanson et al 1987b). Therefore ODF's focus is on creating an environment so when landslides do occur they are beneficial to aquatic habitat. The science and technology for identifying debris flow-prone terrain and channels is available (Benda and Sias 1998, Montgomery and Dietrich 1994). However, the marriage between science and management strategies to reduce threats is not as well developed and requires more research and monitoring.

An analysis from Robison et al. (1999) suggests debris flow travel distance is reduced in part by the presence of large diameter trees along debris flow paths. The forest practices act now requires leave trees in debris flow paths that have the potential to impact public safety. While these rules are geared towards public safety, and would only affect a subset of small streams, it stands to reason that the practice would be beneficial to aquatic habitat as well. Research has also established that such areas provide high quality and complex aquatic habitat. Modeling exercises to evaluate leave tree management practices, while not available at this time, could inform management and monitoring strategies.

There is no scientific or monitoring data on the effectiveness of the High Landslide Hazard requirements to leave trees on headwalls in reducing the threats to coho associated with debris flows. However, acknowledging that these rules are geared towards public safety, it stands to reason that in the event of a debris torrent, a landslide that contributes wood as well as sediment and boulders could better mimic historic processes. Future analyses from CLAMS will be available that attempt to model likely large wood recruitment under various management scenarios (Burnett personal communication) with a focus on landslide and debris flow sources of wood. It will be important to collect empirical data to inform and validate the model.

Likelihood to be Effective in the Future-Stream Shade
While it is well accepted that shade is critically important to coho for controlling stream temperature, it is important to recognize that a focus on maximizing shade detracts from goals to increase large wood recruitment. Dent and Allen (2001) suggest that stand structure (i.e. basal area, stand density, and live crown ratio) plays an important role in determining the range of shade over streams and how this range will be affected by adjacent forest harvest activities. Stream shade levels reflect expected stand development characteristics. Open-grown stands (low basal area) tend to have high live crown ratios (>40%) and lower shade than dense stands (high basal area) with low live crown ratios (<30%) (Oliver and Larson 1996). Shade is expected to increase as a stand grows after harvest or disturbance, and is maximized during the stem exclusion stage (e.g. limited to no understory development such as herbs, shrubs, and seedlings). For the stand to move into the understory reinitiation stage, and later into older forest structure, light must filter through the forest canopy. Shade levels will vary as overstory trees succumb to age or disease, as suppressed trees are released, or die, and disturbances create openings.

Dent and Allen (2001) explore these concepts with an empirically derived model for the coast range. They predict shade will be maximized with high basal areas (100 – 200 ft^2/acre) and low live crown ratios (<30%) (Figure 15). However, live crown ratios less than 30% are considered indicative of poor stand vigor and can result in small diameter, unhealthy trees. The authors concluded that increasing basal area in western Oregon could result in higher shade on east-west flowing streams. The lower basal area requirements on small and medium streams were predicted to provide less shade than on large streams, particularly if the trees had larger diameters and higher live crown ratios. Their analyses suggests an increase in basal area on small and medium streams, as is being considered by the Board of Forestry, is likely to result in increased shade on small and medium streams.

However, the study also highlights the potential downfalls of managing strictly for shade. If shade were the primary goal, the riparian area would be managed towards the stem exclusion stage. The stem exclusion stage promotes small diameter trees of poor vigor and, therefore, is unlikely to meet the other important functions of riparian areas.

See also, Chapter A1 (Morgan 2005) for a list of actions and the factors for decline being addressed.

Restoration

Implementation and Reducing the Threat

From 1997-2003 landowners have implemented 1372 riparian improvement projects on a total of 938 miles (Figure 16). The majority of these projects can be described as planting, fencing and volunteer tree retention projects. These efforts reduce the threats of low shade and low levels of large wood recruitment by establishing, maintaining, or preventing the loss of streamside vegetation. Some of them also result in the maintenance of large conifer trees beyond that required by law.

Riparian Planting and Fencing

About 2/3rds of projects were described as riparian planting (325 miles) and fencing (225 miles). There are few studies that have evaluated the effectiveness of riparian planting and fencing restoration projects. A 2002 OWEB (Anderson and Graziano 2002) study found that 45% of all riparian planting projects had a high survival rate. The sources of mortality for western Oregon were most commonly competition from other plants and animal damage. However, they found that the use of site preparation, post-planting maintenance, and tree protection increased the survival rates dramatically (to roughly 80% with high survival rate). They also found that CRP projects had a higher rate of site preparation and post-planting maintenance than other projects, and speculated this was because of the fiscal accountability required of landowners working with those grants. The same study evaluated fencing projects and determined that 83% of fences were intact. Of those sites with failing fences, 80% had low tree survival.

This study evaluates effectiveness based on tree survival. It will be important to couple this kind of work with projects that evaluate function such as shade and large wood recruitment. Bishaw et al. (2002) evaluated riparian planting, widths of planting and fencing projects and found that shade increased within 2 – 7 years of the planting. They also found that wider planting areas produced higher shade levels in a shorter time frame. The fencing projects decreased bank erosion within 1 year of excluding cattle.

Leave Tree Retention

While not considered a classical restoration project by some, the retention of trees around streams otherwise not required contributes to the conservation effort by decreasing risks associated with timber harvest. About 1/3 of riparian restoration projects (375 stream miles) are described as voluntary leave tree projects. These projects are overwhelmingly applied to forest land-specifically private industrial and state forestland. From 1997 – 2003 voluntary tree retention was applied to 325 miles of private-industrially owned forested streams and 41 miles of state-owned forested streams. There were no reports of voluntary leave tree activities from private non-industrial forestland owners.

These types of projects include: additional conifer retention on fish streams, increased RMA on Small Non-fish stream, leave tree placement & additional voluntary retention, and voluntary no-harvest in RMAs of fish bearing streams (Table 7).

In general these activities increase the numbers of trees left on non-fish bearing and fish bearing streams above that required by the forest practices act. The desired effect is to reduce risks to coho associated with otherwise low levels of large wood recruitment from near-stream and upland sources. Increased tree retention along non fish-bearing streams increases upland sources while increased retention along fish-bearing streams increases near-stream sources of large wood. Increased retention along fish-bearing streams may also benefit coho if shade levels are increased and stream temperature reduced. Effectiveness of these measures has not been demonstrated with a field study. Future monitoring should focus on the effectiveness of these practices to increase large wood recruitment from near-stream and upland sources, the effects on shade and stream temperature.

Table 7. Non-regulatory measures, actions, and desired effect on processes that address threats to coho.

Volunteer Measure	Action	Desired Effect on Process (threat)	Likely effect on Coho
Increase RMA on Small Non-fish streams	Establish 20-foot RMA	Increase availability of large wood for recruitment to downstream fish bearing streams	Over time increase potential for large wood recruitment from upslope sources such as landslides and debris flows.
Additional conifer retention on fish streams	No more than 25% basal area exceeding the standard target is harvested.	Increase sources of large wood recruitment from streamside sources and potential increase shade.	Over time increase levels of large wood in streams and reduced risk of increases in stream temperature.
Leave tree placement & additional voluntary retention	Landowner leaves more than the required 25% of leave trees within the RMA.	Additional leave trees further increase potential large wood recruitment from streamside sources.	Over time increase levels of large wood in streams
Voluntary no-harvest in RMAs (fish bearing streams)	Landowner elects not to harvest within the RMA even though the FPA allows harvesting to occur.	With no-harvest in RMAs, potential large wood recruitment is maximized within 100, 75 and 50 feet of large, medium and small fish-bearing streams.	Over time increase potential large wood recruitment from streamside sources, resulting in higher wood loading in streams over time. Further reduce risk of increases in stream temperature.

State and private industrial forestland owners retained additional trees in 541 and 3181 acres of riparian areas (Figure 17). About 20% of the leave tree acres on private industrial forestland were on small and medium non-fish bearing streams (597 acres) (Figure 18). The remainder was evenly distributed along fish bearing streams. About 33% of the acres on state forestland were on small and medium non-fish bearing streams (197 acres) (Figure 19). On fish bearing streams about 34% of the acres were on small fish streams, and 16% and 14% were on medium and large fish bearing streams, respectively. These results suggest that the benefits of these measures are distributed across all stream types and sizes and have the potential to improve large wood recruitment and shade throughout the watershed.

Herstrom and Dent (2005) characterized riparian areas in the ESU by ownership, zoning and cover. They estimate that 38% of riparian acres are within private forest ownership, 13% in agricultural, and 10% within state forest ownership. However, they estimate a shift in the ownership distribution when considering streams that have high intrinsic potential for winter coho habitat. Private forest ownership is still substantial with 37%, but 38% of riparian areas along streams considered to have a high intrinsic potential for coho habitats are within agricultural ownership.

These ownership patterns suggest those activities along industrial forest and state forest ownership will primarily influence coho restoration through watershed-scale processes such as wood and sediment routing to downstream reaches. A focus on riparian areas within agricultural and private forest ownership could influence coho restoration by providing near-stream sources of large wood and shade in areas that historically provided high quality winter habitat.

Summary of Certainty of Effectiveness

Certainty of Effectiveness

A detailed discussion of the benefits and impacts of riparian protection measures are provided. To summarize, available research and monitoring suggests that over time, and depending on how riparian areas are managed, the FPA Rules are estimated to maintain 46-92% of large wood potential recruitment on large streams, 30-80% on medium streams, and 12-26% on small streams. However, research also suggests that thinning riparian forests can increase large wood recruitment and abundance in streams, in a timelier manner if applied to stands with small diameter trees (Beechie et al. 2005). Success of thinning is dependent on stream size and the tree diameter needed to form pools.

Monitoring data on changes in shade under current FPA rules suggest the rules have a high certainty to be effective on large and medium fish-bearing streams. Greater uncertainty exists with regard to small fish-bearing streams.

Uncertainty of Effectiveness

Considerable debate remains as to what levels of retention of potential large wood recruitment are "adequate". At the core of this debate are perceptions of risk and how that risk should be managed. Also, there is no state standard for large wood recruitment, nor does the state suggest one should be created. Finally the applicability of potential forestry related impacts on small streams to coho streams is uncertain. Regardless of the debate, ODF and DEQ (2002) recommended increased riparian tree retention on small and medium streams to minimize potential risks, as described above.

From a risk perspective, concerns over shade reductions are balanced with research that demonstrates the benefits of increased light in terms of stream productivity. A significant body of literature has documented that increasing light to streams that otherwise are light-limited can result in increased primary productivity and a responding increase in salmonid production. Salmonid responses are attributed primarily to a greater abundance of prey base of invertebrate drift. (Wilzbach et al. 1986, Gregory et al. 1987, Beschta et al. 1987, Bilby & Bisson 1987, Bisson et al. 1988, Connolly & Hall 1999). This combined with the fact that observed changes in shade are sufficiently low on large and medium streams gives the state a high level of certainty that current approaches are likely to be effective in terms of coho conservation measures. Questions as to the likelihood that riparian management is effective on small streams with regard to shade, led to recommendations as described above by ODF and DEQ (2002).

The uncertainty is perhaps greatest with regard to debris-flow sources of large wood recruitment. The estimates of how much wood is delivered from small headwater streams to larger streams such as over-wintering coho streams, range form 15-60%. Furthermore, very little data are available on the effectiveness of current Oregon Plan measures and management strategies to provide these sources of wood. Preliminary results from CLAMS suggest that debris-flow sources of large wood will likely increase under current strategies as compared with previous practices.

Adaptive management principles are in place on state and private forest land to address uncertainties and are described in detail in the state reports. As an example, private and state forests programs at ODF have an ongoing study in the coast range to evaluate the effectiveness of the forest practice rules and FMP strategies. Preliminary results from this study describing baseline conditions will be available in 2005.

Finally, while adaptive management principles are in place, there is a lack of existing studies targeted to evaluate effectiveness of Oregon Plan non-regulatory riparian measures. This will be important to institute in the near term, so future analyses can speak specifically to Oregon Plan Measures. Furthermore, the contributions of riparian and upslope hardwoods is overlooked to the detriment of our scientific understanding and management approaches to riparian areas. Current thinking, available data, and criteria for evaluating riparian areas reflects this myopic focus on large riparian conifers and maximizing shade. More information is needed on the function and processes of alder-dominated riparian areas, how to manage them, and indicators for monitoring status and trends in conditions and effectiveness of management strategies.

2. What are the incremental objectives and timelines for achieving the objectives of the conservation effort?

Privately Managed Forest Land

The incremental objectives and timelines are detailed in the **Oregon Department of Forestry and State and Private Forestry Community Oregon Plan Statewide Work Program**.

State Managed Forest Land

The FMP for Board of Forestry Land (BOFL) is anticipated to endure for a decade, and even longer because they are goal-driven plans with strategies that will be most successful in achieving those goals when applied over the long term in an adaptive management context. Ten-year updates that describe how the plan is being applied, and provides insight into how well the goals are being achieved will be provided the State Land Board, Board of Forestry and public. The first such review is planned for 2011. These updates will be a primary mechanism for the Land Board and Board of Forestry to determine if there are portions of a plan that should be amended or if development of a new plan is necessary.

The body of integrated strategies defined in a FMP will apply across the landscape, providing both a coarse-filter or landscape level management focus and the necessary fine-filter emphasis for certain resource values. These integrated strategies will provide diverse forest habitats that are likely to accommodate most native wildlife species associated with forested habitats in the Oregon Coast Range.

Over time, active management targets will achieve a diversity of stand structures across the landscape, or the desired future condition, as described in Chapter A2 and shown below:

Regeneration	5-15%
Closed Single Canopy	10-20%
Understory	15-35%
Layered	20-30%
Older Forest Structure	20-30%

These stand structure percentages are the over-arching, long-term objective for the landscape managed under the Northwest (Northwest FMP, pp 4-48) and Southwest plans (Southwest FMP, pp 4-46). Due to the limited amounts of older, more complex stand types present on the state forest landscape, it is anticipated 5 to 10 decades will be required to achieve the targets on all western Oregon state forest lands.

These targets, along with the remaining FMP strategies are to be applied to the state forest landscape in each Department of Forestry district through the development of implementation plans. Implementation plans will describe how the district is moving towards achievement of the desired future condition through the implementation of the FMP strategies, including the landscape and riparian and aquatic management strategies. The State Forests Program cooperated in the development of the road assessment with the Forest Practices Program, and has been implementing ongoing road activities to address identified concerns. In addition, watershed analyses, due to be completed by 2011 on state-managed lands, will assess riparian and aquatic conditions. Findings will be addressed on an annual basis during the implementation of management operations. At ten-year intervals (OAR 629-035-0030), an FMP will be reviewed, and adjustments to the strategies made if needed, with the first review scheduled to occur in 2011.

As monitoring provides feedback, research is conducted, and IP and AOP activities are accomplished, these adaptive management activities will help determine compliance with and effectiveness of the resource management strategies, and ultimately the achievement of the FMP goals and objectives. The information will be processed through the adaptive management framework, and may lead to improvements in the management plan or practices. During the ten-year FMP review following when 30% in aggregate of layered and older forest structure stands is achieved on lands in the Northwest and Southwest Oregon planning areas, a comprehensive review of landscape management strategy 1 and the array described above will be conducted. The review will evaluate whether the stand conditions meet the habitat needs of native species, and whether the stand structure percentage targets need to be changed.

3. What are the steps for implementing the conservation effort?

Privately Managed Forest Land

The steps for implementing the Oregon Plan are described in the **Oregon Department of Forestry and State and Private Forestry Community Oregon Plan Statewide Work Program**. The steps are listed above in Section 2. During 2005-2006 the ODF and landowners will review the non-regulatory measures, including those for roads and fish passage. We will evaluate how we are doing—trends and effectiveness. For instance, we know that industrial forest landowners have completed many projects. We have monitored these projects for conformance with current standards and have shared information on what works best. Still, we cannot say how much work remains to be completed. Better ways of gathering and sharing information is needed to help us understand how far we have come and how far we have left to go. Numbers of some types of reported projects have decreased recently. We would like to know whether the decrease is due to work having been completed, or whether other issues are involved. If work is nearing completion, how can we document that? If the latter, how can agencies better serve the process to provide meaningful incentives or service needed? We believe that projects conducted by the non-industrial landowners are under reported (Table 9). Improvements are needed to better serve non-industrial landowners, who through conversation, have told us that they would like to improve legacy roads but need financial assistance and/or assistance in reporting what they have already accomplished.

State Managed Forest Land

A management plan is developed following requirements of OAR for BOFL and the Common School Forestland (CSFL) Agreement for CSFL. The BOF then approves the BOFL plan and adopts it as OAR, and the State Land Board approves the CSFL management plan. The State Forests Program develops the district-specific, ten-year implementation plans for BOFL, and annual operation plans for both BOFL and CSFL. The annual operation plans describe the exact location and nature of management activities that are proposed for a given fiscal year (see Chapter A2-Lee 2005) criterion 6 for a discussion of both a IP and AOP). A ten-year review of the management plan is conducted, and adjustments are made to the management strategies if needed. A new implementation plan is then developed and approved, and operation plans are developed on an annual basis. Public involvement in the review of each of these plans is an important component of implementation.

4. What are the quantifiable, scientifically valid parameters that will demonstrate achievement of the objectives? What are the standards for these parameters by which progress will be measured and identified?

Riparian areas vary both spatially and temporally. Change is the rule, not the exception. Species composition and structure of riparian vegetation are influenced by the same disturbances that upland stands experience: natural mortality, insect and disease, fire, wind, and ice storms, with the addition of floods, bank erosion, and debris flows. All these processes have strong influences on riparian characteristics (Reeves et al.1995). Locations in the channel network and landform characteristics also influence riparian stand structure. In general riparian stands along higher gradient streams, higher up in the channel network, tend to be dominated by conifers. The exception is those areas disturbed by landslides and debris torrents where alder, salmonberry, and other deciduous vegetation have the competitive advantage (Pabst and Spies 1998 and 1999). On these very small streams, riparian areas are less influenced by stream and watershed processes so the vegetation tends to be more consistent with the upland stand. Moving lower down into the system mixed conifer and hardwood stands are more common. Larger river systems in the coast range historically supported species that could tolerate moister soils such as cedar, ash, and willow or favored disturbance such as alders.

These ecological transitions in space and time must be embraced when considering how to define, manage towards, and measure our success in achieving desirable riparian conditions across the landscape. Therefore, while standards do exist, we submit it is unreasonable to expect that a single condition should exist everywhere, all the time. Such an approach artificially imposes a static perspective on a dynamic ecosystem. The Oregon Department of Forestry is working towards incorporating the well-accepted concepts of dynamic ecosystems into management and regulatory goals. The ODF and Oregon Department of Agriculture have established performance measures or BMPs designed to minimize negative human impacts on aquatic and riparian resources. DEQ has begun evaluating data based on a range of conditions rather than a single point.

Incorporating spatial and temporal variability into standards is challenging and requires a dramatic paradigm shift. Given this fact, we commonly lapse back to comfortable and measurable approaches to characterizing ecosystems with a static view of the world. Riparian and physical habitat has been researched and monitored for decades by federal and state agencies based on this static view of the world. These products provide commonly agreed on parameters and monitoring techniques (Table 8). Furthermore, under the static paradigm, most of the parameters have an established state standard or management goal to which monitoring results can be compared. It will be important to demonstrate ways of utilizing these well-established parameters and measurement techniques in more appropriate analyses that embrace the well-established dynamic nature of riparian and aquatic ecosystems.

Table 8. Riparian function, monitoring parameter and state standards.

Function or Process	**Parameter**	**Standard**
Large Wood Recruitment	Numbers of large diameter trees, distance from the stream of large trees	State Riparian Policy Agency goals -Average similar to Mature Forest at a landscape level -Similar to historic range of conditions while avoiding the extemes Federal Measures: riparian function in a watershed context (AREMP) ODF&W-Benchmarks such as numbers large conifers per length of stream
Shade	Cover, Shade (solar pathfinder, fish-eye lens camara)	DEQ TMDLs Similar to historic range of conditions while avoiding the extremes
Stream Temperature	Daily Max, Min, and average Temperature 7-day moving mean of daily maximum stream temperature Diurnal Fluctuation	DEQ Numeric and Anti-degradation standards
Nutrients	pH, Nitrogen, Macroinvertebrates, percent hardwoods by stream order	DEQ draft Bio-criteria Hardwood criteria not currently available
Road-Related Factors	Fish passage barriers, usually at culverts; Roads built in critical locations (landslide areas and near streams); Diversion/washout potential of structure Road drainage; connectivity to streams; Stability of the road surface, especially risk of chronic erosion during wet season use	DEQ standards for turbidity
Landslide-Related Factors	Likelihood to deliver sediment and wood to stream via debris torrent,	None. Programmatic goals. Consider a descriptor for "high quality" landslides
Watershed-scale parameters	All of the above combined to describe watershed conditions	Typically described in terms of percent of stream miles or acres in "desirable" condition, or in comparison to a range of conditions.
Dynamic Ecosystem Approach	Same suite of parameters	Evaluated in the context of a range of conditions across the landscape and perhaps over time (with modeled likely outcomes)

5. What are the provisions for monitoring and reporting progress on implementation and effectiveness of the conservation effort?

State Managed Forest Land

<u>Monitoring Implementation and Effectiveness</u>

The following implementation and effectiveness monitoring projects are designed in part or in whole to address the state forest blended approach of landscape and site-specific strategies for achieving desired future conditions of riparian and aquatic ecosystems.

Implementation Monitoring: Initial recommendations have been made on how to conduct "implementation monitoring related to stand management strategies. A project plan for implementation monitoring is being developed that will include all processes and protocols for data collection, management, and reporting.

Effectiveness of Site Specific Strategies: The State Forests Program is currently involved in a collaborative effort with Private and Community Forests to evaluate the effectiveness, at a site-scale, of the riparian and aquatic strategies. This study uses a before-after-control-impact design and preliminary findings should be available in 2005. The study design can be found at www.odf.state.or.us .

Effectiveness of Landscape Strategies: The State Forests Program has a number of programs underway to evaluate effectiveness and implementation of the landscape strategies. They include (1) Road Information Management System (2) Watershed Scale Effectiveness, and (3) and Effects Analysis. These are briefly described below.

Effectiveness of Road Management Strategies: State forests has a draft report from a pilot study on road information management needs and strategies. The pilot study report describes and reviews the needs, authorities, and requirements for a road information management system; an investigation into road information management options; and proposes a vision and strategy for developing a State Forests road information management system. Short and long term actions are proposed and key decision needs are highlighted (Pilot Study Report-In review). Forest practice monitoring and available research has evaluated the types of practices that are applied under the State Forests Management Strategies and have found high compliance rates and effectiveness at minimizing sediment delivery to streams (Robben and Dent 2002).

The state forests program has initiated a process to design a program to evaluate effectiveness of the FMP strategies at a watershed scale. This approach can evaluate the following hypothesis with regard to the blended approach designed to achieve aquatic and riparian goals:

> "Active management through a combination of landscape level strategies and site-specific standards will result in maintain and restoring properly functioning aquatic and riparian habitats" (ODF 2001).

A draft document will be available by February 2005 that reviews potential approaches, identifies opportunities to collaborate with similar efforts in the state and region, and proposes an approach for use on state managed forest lands.

The state forests program has also contracted with an outside party to evaluate the potential effectiveness of the landscape, watershed, and riparian strategies in meeting the goals of the program. This will be available in February 2005 (MGA in press)

Private Forests

Implementation and Effectiveness Monitoring

The Private and Community Forests Program (PCF) **Research and Monitoring Program** conduct studies and surveys to monitor implementation and effectiveness of the forest practices act. Areas of study have included topics such as monitoring fish presence, shade conditions above streams, compliance with best management practices, and compliance and effectiveness of forest practice rules.

The program is guided by a Monitoring Strategy that is updated biennially (see link below). The strategy outlines an approach to the different types of monitoring and a list of key questions and priority levels. Monitoring riparian rules is a requirement, by forest practice rule, and the monitoring program manager reports findings annually to the Board of Forestry as required under OAR 629-635-0110. The program also reports findings to stakeholder groups, ODF staff, staff from other agencies, advisory committees.

Examples of applicable findings are as follows:

- Very high compliance rates with riparian rule requirements for basal area, leave tree requirements and buffer widths (Technical Reports 5 and 15)
- High Compliance rates with road location and maintenance rules (Technical Report 15)
- Recommendations for revisions to rules to accommodate goals for recruitment of wood from landslides and debris torrents (Technical Report 4 and Sufficiency Analysis)
- 1994 Rules are likely to meet goals on large fish bearing streams (Technical Report 12 and Sufficiency Analysis)
- 1994 rules are not likely to achieve mature forest goals with regard to shade and large wood recruitment on small streams (Technical Report 12 and Sufficiency Analysis). Rule revisions are underway to address this.
- Improvements needed in road rules to minimize turbidity during winter hauling. These changes have been made to the forest practices act (Technical Report 17- and Sufficiency Analysis)
- There is some risk current protection (as of 2002) standards may not be adequate at the site scale, but the significance and scope of the risk at larger scales is uncertain (and Sufficiency Analysis)

The monitoring program has produced a series of technical reports (17 to date) which address the topics discussed in this chapter and others. Key findings applicable to riparian and aquatic ecosystems have been highlighted in this report. A list of those technical reports is provided below. Copies of the full reports are available from ODF or on the ODF web site:
http://www.odf.state.or.us/pcf/fp/techreport.asp?id=401010207

Monitoring Strategy: 2002
http://www.odf.state.or.us/pcf/Pub/fp/Strategy2002.pdf

Technical Reports:

- **FP Technical Report #2**
  Cooperative Stream Temperature Monitoring Project Completion Report For 1994 - 1995 (Small Type N Streams) *Sept 1999*
- **FP Technical Report #3**
  Effectiveness of Riparian Management Areas and Hardwood Conversions In Maintaining Stream Temperature *March 1997*
- **FP Technical Report #4**
  ODF Storm Impacts And Landslides Of 1996 *June 1999*
- **FP Technical Report #7**
  ODF Aerial Pesticide Application Project Final Report *March 2000*
- **FP Technical Report #12**
  Harvest Effects on Riparian Function And Structure Under Current Oregon Forest Practice Rules *July 2001*

- **FP Technical Report #13**
  Shade Conditions Over Forested Streams in the Blue Mountain and Coast Range Georegions of Oregon *August 2001*
- **FP Technical Report #14**
  ODF Compliance With Fish Passage and Peak Flow Requirements at Stream Crossings: Final Study Results *April 2002*
- **FP Technical Report #15**
  ODF Forest Practices Compliance Monitoring Project: Final Study Results *April 2002*
- **FP Technical Report #16**
  Oregon Headwaters Research Cooperative: Workshop Summary *Oct 2001*

- **Sufficiency Analysis: A statewide evaluation of forest practice act effectiveness in protecting water quality DEQ and ODF (October 2002).**
  http://www.odf.state.or.us/pcf/pub/fp/AllSAv1031.pdf

6. What are the principles of adaptive management of the conservation effort?

State Managed Forest Land
Adaptive management is a primary tenet woven throughout the FMP and is described in detail in Chapter 5 of the FMP (ODF 2001). The FMP will be implemented using a scientifically based, systematically structured approach that tests and monitors assumptions, predictions, and actions and then uses the information to improve management plans or practices. The following key concepts provide the foundation for adaptive forest resource management as it is described in the FMP.

1. Adaptive management is a system of making decisions that recognizes that ecosystems and society are always changing. The FMP describes the need for a rigorous systematic approach for learning from our actions, improving management and accommodating change.

2. Adaptive management is not a replacement for decision-making at any level, but a system for making better decisions. The FMP describes a formal, rigorous approach to management where activities are treated as opportunities for generating information about the system being managed. While the adaptive management approach can resolve disagreements stemming form knowledge gaps, it cannot resolve conflicts stemming from conflicting values. An effective adaptive management program can help managers respond to changes in values but it cannot predict them.

3. Successful adaptive management requires a well designed process including a strong monitoring program: Six steps are described.

   Assessment: Define the scope of the management problem, synthesize existing knowledge about the system, and identify potential outcomes of alternative management actions. Make predictions about outcomes in order to assess which actions are most likely to meet management objectives.

   Design: Design experiments and related monitoring plans that are informative and provide reliable feedback. Chapter 5 describers replicated and non-replicated experiments and other sources of information such as results from research on ecosystem processes, extrapolation of results from small-scale experiments, and retrospective studies.

Implement: Implement experiments and monitoring as designed. Decide when and what types of deviations are acceptable. Ensure that these circumstances are clear and accepted by all involved. Monitor implementation, and document any deviations from the plan.

Monitor: Measure environmental characteristics and conditions over an extended period of time in order to determine status or trends in various aspects of environmental quality. Types of monitoring include implementation, effectiveness, and validation monitoring.

Evaluate: Analyze data and compare actual results to the forecasts made in Step 1. The evaluation should explain why outcomes occurred and include recommendations for future action.

Adjust: Verify or update the hypotheses used to make the initial forecasts and adjust management actions as necessary. Review the objectives and adjust as necessary to ensure they remain consistent with overall goals and values.

4. Adaptive management requires a well-defined framework for dealing with change. There are four planning levels at which change may be proposed, considered, and initiated: (1) FMP, (2) district implementation, (3) annual operations, and (4) management activity.

The FMP describes 4 strategies for implementation

1. Implement an adaptive management process and framework that provides for change at the appropriate planning level and in a timely manner. The range of decisions that will be made, how they will be made, and who will make them are described. Decisions at the FMP level are long term (10 years or more. District level decisions are periodic, typically no longer than 10 years. Annual decisions are incorporated in the Annual Operations Plans, and individual management activities are decided on an ongoing, sub-annual basis, or as appropriate for the operations. At each level examples of what might change, types of public involvement that will take place and monitoring activities that might support a call for change are provided.

2. Develop and implement a monitoring program designed to evaluate the working hypothesis over time. Review and update a monitoring and implementation plan at least every 10 years. The strategy described the application of monitoring with reference to Oregon administrative rules OAR 629 030 0000 to 0110. The framework involves validating assumptions and hypotheses, evaluating resource conditions, ecological and cultural trends, implementation of management actions and their effects. Key questions are described as well as reporting and information management, coordination and current monitoring.

3. There is a commitment to conduct a comprehensive review of the goals and strategies of the FMP every 10 years following adoption.

4. There is a commitment to conduct a comprehensive review of landscape management strategies when 30% in aggregate of LYR and OFS stand types is achieved on lands in the planning area.

A detailed description of each of these concepts and strategies for implementing adaptive management is provided in chapter 5 of the FMP (Pages 5-14 through 5-34).

The state forests research and monitoring program is in place to ensure that the levels of research, monitoring, and technology transfer are adequate to meet the information needs required for the adaptive management plan. Most of the elements are covered under #5. What follows is a brief description of Watershed Analysis.

Watershed Analysis Manual

Watershed analysis is described as a critical process for refining and planning management activities related to implementation of the forest management plan. State Forests has developed a watershed analysis manual (ODF 2004) that describes the goals for watershed analysis, a process for implementing the analysis, and a process for incorporating watershed analysis findings into implementation plans. The goal for each watershed analysis is identify if proper functioning conditions exist along streams. If the aquatic system is not in proper functioning condition, then the analysis will identify the limiting factors. The analysis will evaluate if existing ODF strategies are likely to remedy the limiting factors and if not, if there are other measures that ODF can take to address the limiting factors. In this way, watershed analysis provides an important tool for adapting FMP strategies at a watershed scale to create the desired future conditions for riparian and aquatic ecosystems.

Private Forest Land

The Forest Practices Monitoring Program (FPMP) has been evaluating implementation and effectiveness of the forest practices act since 1988. The program is guided by a Monitoring Strategy that is updated biennially and closely linked with the Oregon Plan (ODF 2002). The strategy is based on the concepts of adaptive management (echoes that described for the State Forests Program) and outlines an approach to different types of monitoring and a list of key questions and priority levels. Monitoring riparian rules is a requirement, by forest practice rule, and the monitoring program manager reports findings annually to the Board of Forestry as required under OAR 629-635-0110. The Board of Forestry considers the findings and recommendations and takes appropriate action with regard to rule revision. The program also reports findings to stakeholder groups, ODF staff, staff from other agencies, and forest practices advisory committees.

The goals of the P&CF MP are to:

- Evaluate the effectiveness, implementation and assumptions of the forest practices act
- Coordinate with other monitoring and research efforts
- Investigate the cumulative effects of forest practices on forest resources.
- Support efforts to establish benchmarks/criterion used to define the range of desired conditions/regional goals.
- Monitor the implementation and effectiveness of the Oregon Plan.
- Monitor temporal and spatial trends in forest and stream conditions.

Adaptive management is a system of making, implementing and evaluating decisions, that recognizes that there is uncertainty about the outcome of management activities and that ecosystems and social values are always changing. It can be defined as a scientifically based, systematically structured approach that tests and monitors management plans, assumptions, predictions and actions, and then uses the resulting information to improve management plans, policies, or practices.

The success of the adaptive management process depends on

- Commitment to a long-term process
- Deliberate monitoring designs that test policies and practices
- Careful implementation of policies and plans
- Scientifically sound monitoring designs that track indicators at multiple scales
- Analysis of outcomes that consider objectives and predictions
- Incorporating results into future decisions, policies, and practices.

While adaptive management must be flexible to accommodate change, monitoring data and efforts are of the greatest value if there is a structured approach to managing such change. The FPMP desired outcomes, strategies, tools and approaches are summarized in Table 9.

The FPMP Strategy discusses four types of monitoring (implementation, trend, effectiveness and validation) and sampling approaches that are scientifically based and designed to link with Oregon Plan and other ODF monitoring efforts. The goals of the sampling methods are to:

- capture the range of upland and riparian conditions across the landscape
- address multiple types of monitoring questions at multiple scales
- reflect management under current forest practice rules
- capture the representative range of practices that occur under the current rules
- test effectiveness across a range of stream classifications (Small, Medium, or Large and Fish-bearing, Non-fish bearing and Domestic Water Source)
- represent various landowner types (state, industrial, non-industrial)
- complement other monitoring efforts that are being carried out within the department, by other agencies and states, watershed councils, private landowners, and research communities.

To meet these goals, sampling methods are proposed at multiple spatial and temporal scales:

1. Landscape Trend Sampling: Sampling at the landscape scale is needed to answer integrated questions regarding trends in upland and riparian forest conditions. These studies can be implemented over a long time period and through out the entire state. This level of monitoring will also facilitate coordination with other Oregon Plan activities.
2. Current Forest Practices and the Oregon Plan: This scale of sampling is designed to answer questions about implementation and effectiveness of *current* forest practices at a state-level on a shorter-term scale (3-10 years). This scale will also be utilized to answer questions about Oregon Plan volunteer efforts. Multiple sample designs will be applied.

3. Watershed Effects: This scale of monitoring is designed to answer watershed/sub-basin scale questions for a wide range of time scales (3-30 years). Studies coordinated and funded with other agencies and groups will be designed to address how forest practices affect watershed processes and cumulative effects. There will be opportunities to set up pre-harvest and post-harvest studies within these watersheds, as well as evaluate Oregon Plan projects. Watersheds will be selected on the basis of
    - Available existing data (for example: ODF&W Index Basins)
    - Activity at the local level (watershed councils, Blue Mountain Demonstration Project, TMDLs, Senate Bill 1010 plans)
    - State Forest watershed assessment activities
    - Volunteer OPSW activities
4. Processes/Testing Hypotheses: Distinctions between research and monitoring can be difficult to identify. An important distinction is that research tests hypothesis to define cause and effect relationships, while monitoring tests those known relationships through time and space. In both cases, a scientifically sound process is needed. Research issues and questions will be addressed through contractual and cooperative agreements with university systems. To meet the needs of the Private and Community Forests Program, monitoring is conducted by means of the scientific process.

A series of monitoring questions, priorities, and protocols are described. The monitoring strategy also describes a peer review process and communication and reporting plan.

Table 9. Forest Practices Monitoring Program monitoring desired outcomes, strategies, tools, and approaches.

Outcome	Strategies	Tools and Approaches
The monitoring program provides timely, pertinent, and sound information at multiple scales regarding the forest practice rule implementation, effectiveness, and assumptions.	✓ Monitor the effectiveness and implementation of the forest practices rules on sites that have been harvested under current forest practices at both the landscape scale and watershed scales ✓ Coordinate and communicate priorities, approaches, and findings with research institutes.	✓ Data collection before and after harvest on volunteered sites ✓ Random selection through the FACTS database ✓ Pilot studies with active watershed councils. ✓ Formalize peer review process, submit findings to referred journals, communicate priorities with the OSU forest research lab.
Monitoring efforts are coordinated so as to maximize state resources and increase understanding with other state's efforts.	✓ Participate on the Oregon Plan for Salmon and Watersheds Monitoring Team ✓ Lead and participate on the internal ODF Monitoring Team ✓ Coordinate and communicate with monitoring and research efforts in other states.	✓ Develop agreed upon protocols ✓ Coordinate strategic plans ✓ Implement studies with sample designs that overlap with other state and federal agency's efforts.
The implementation and effectiveness of the Oregon Plan for Salmon and Watersheds (OPSW) is evaluated and communicated.	✓ Monitor the effectiveness and implementation of restoration, volunteer, and regulatory activities designed to protect/restore salmon populations and habitat. ✓ Monitor temporal and spatial trends in forest and stream conditions	✓ Monitor volunteered sites with OPSW projects and randomly selected sites from the OWEB database. ✓ Monitor conditions on sites randomly selected throughout the state on a long-term basis.
Monitoring results provide information to adapt and improve policies governing the management and protection of forest resources on non-federal forest land.	✓ Prioritize projects to address critical issues and communicate findings to policy makers.	✓ Report to board of forestry annually. ✓ Provide information to review committees.
There is understanding, acceptance and support for strategies, approaches and findings.	✓ Develop and implement a plan to receive input and communicate strategies, approaches and findings to internal and external stakeholders, conservation communities, and the public.	✓ Printed reports, articles, and newsletters. ✓ Updated Web Page with reports and data. ✓ Media tours, editorials, press releases. ✓ Presentations at existing forums and meetings,

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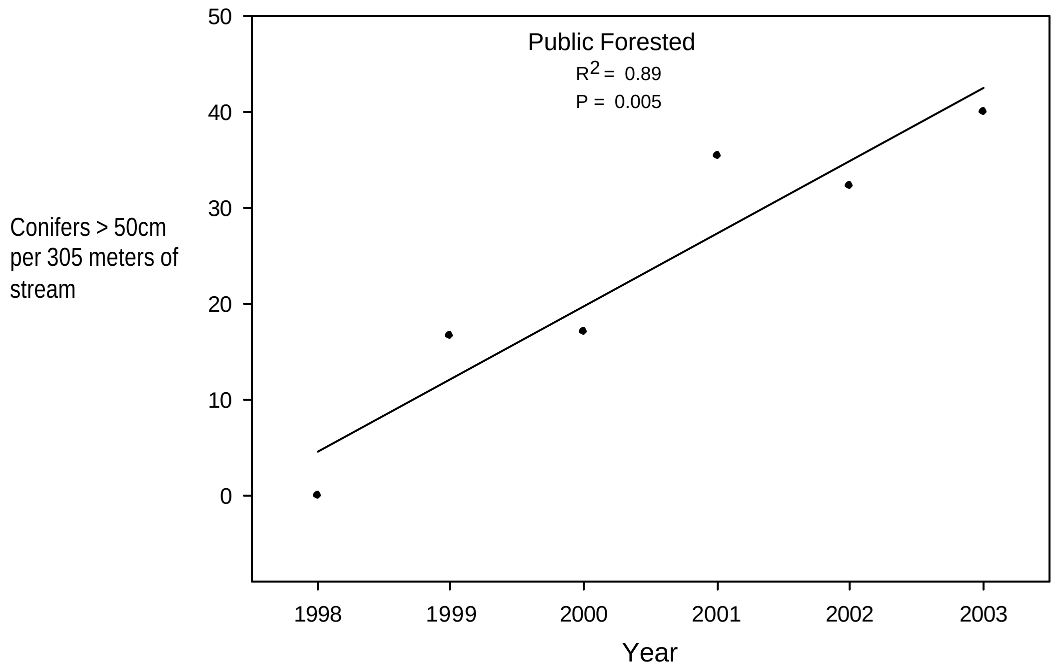

Figure 1. Temporal trends in numbers of conifers greater than 50 cm per 305 meters of stream. Data are for randomly selected public forest sites from 1998 – 2003.

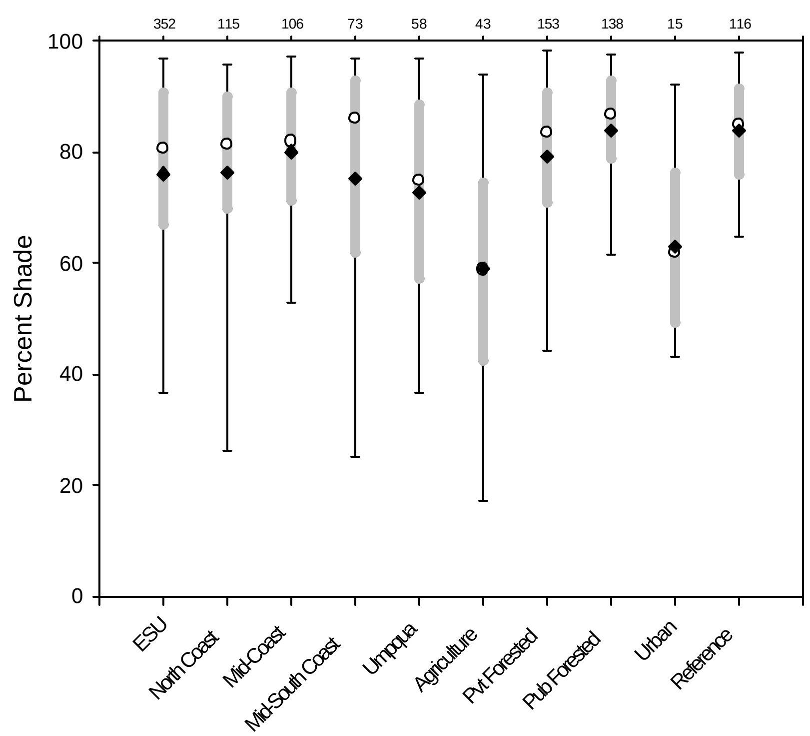

Figure 2. Spatial trends in shade (% cover) in the ESU, by monitoring unit, land use, and for reference sites. Sample size shown above the box and whisker plots.

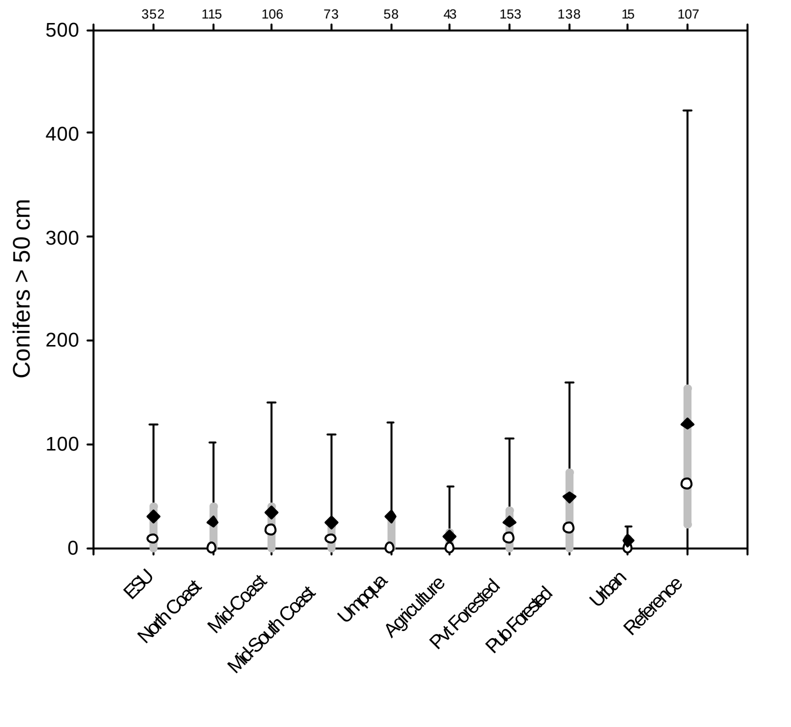

Figure 3. Number of conifers larger than 50 cm/305 meters of stream for the ESU, monitoring units, land use and for reference sites.

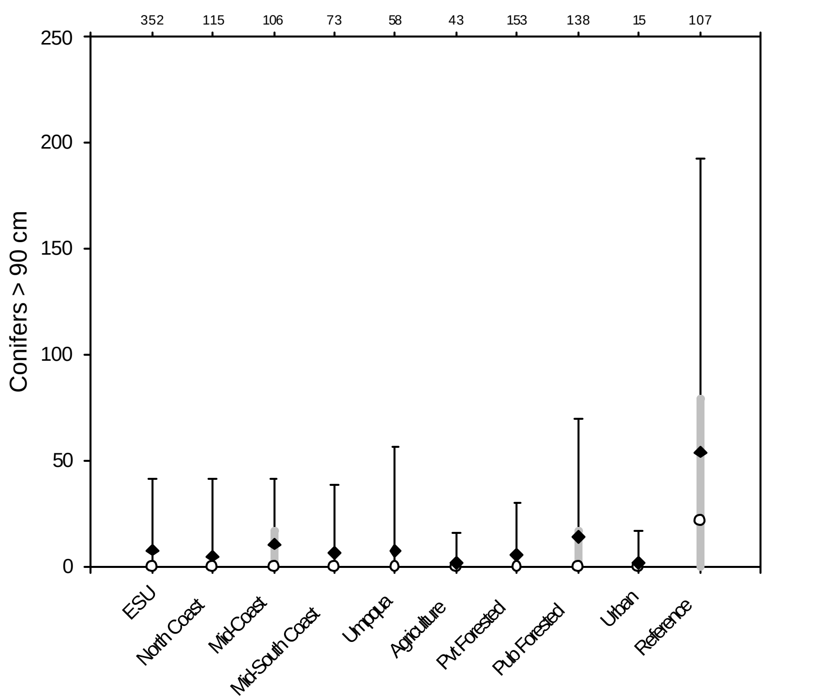

Figure 4. Number of conifers > 90 cm./305 meters of stream for the ESU, monitoring units, land use and for reference sites

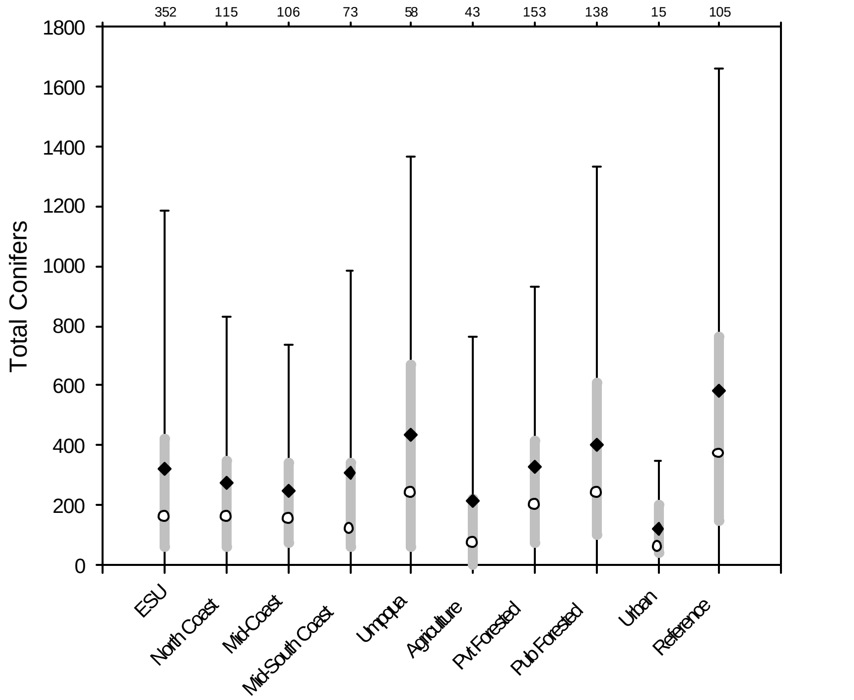

Figure 5. Total numbers of conifers/305 meters of stream for the ESU, monitoring units, land use and for reference sites

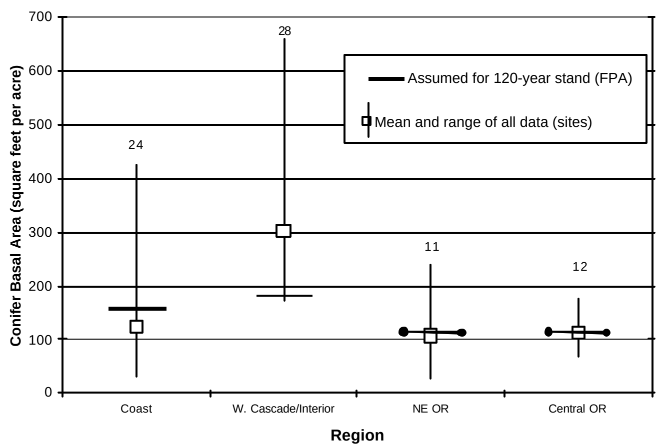

Figure 6. Mean and range of available data on unmanaged riparian areas and conifer stocking for different regions in Oregon. The dumbbell symbol represents the stocking level that is assumed for "mature forest conditions" (approximately 120 years old) under the 1994 Water Protection rules for large Type F streams. The basal areas represent by the dumbbells are those levels that are assumed to occur mid-way through a 50-year harvest rotations and are thus higher than the standard targets required by the rules.

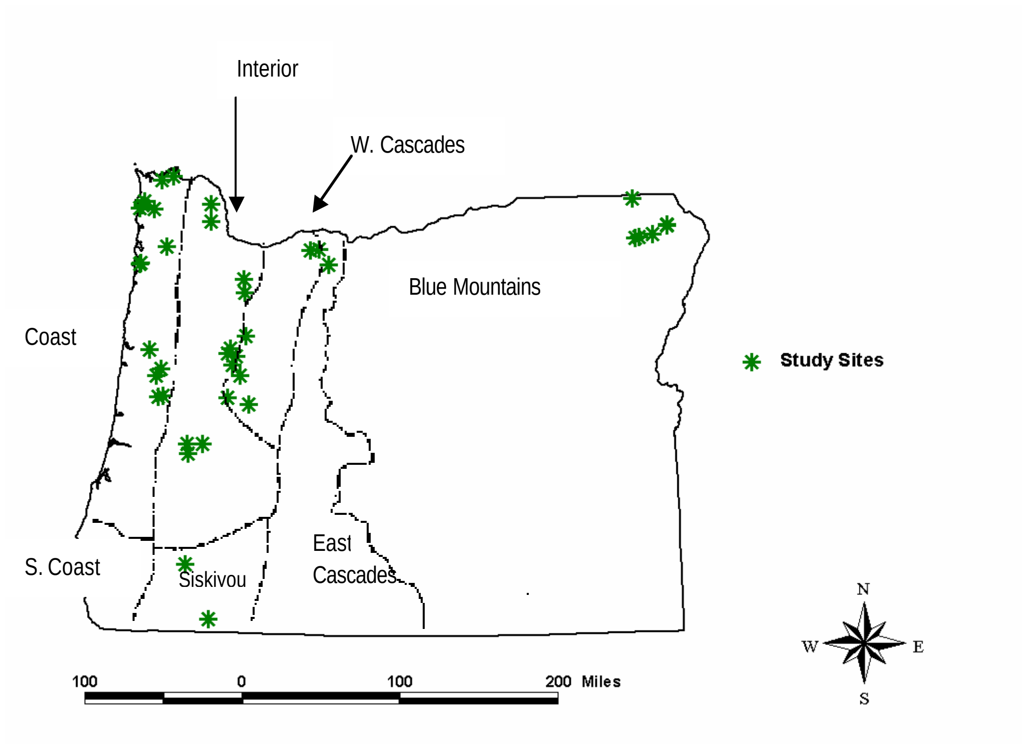

Figure 7. Study site locations for an ODF riparian structure and function study (Dent 2001).

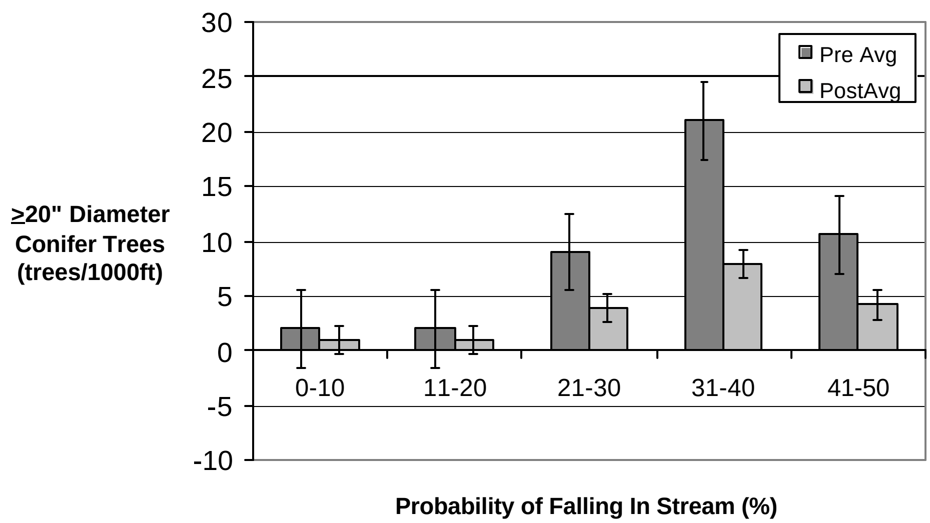

Figure 8. Small fish bearing streams: Large wood recruitment before (pre) and after (post) harvesting under the 1994 riparian rules (n =10).

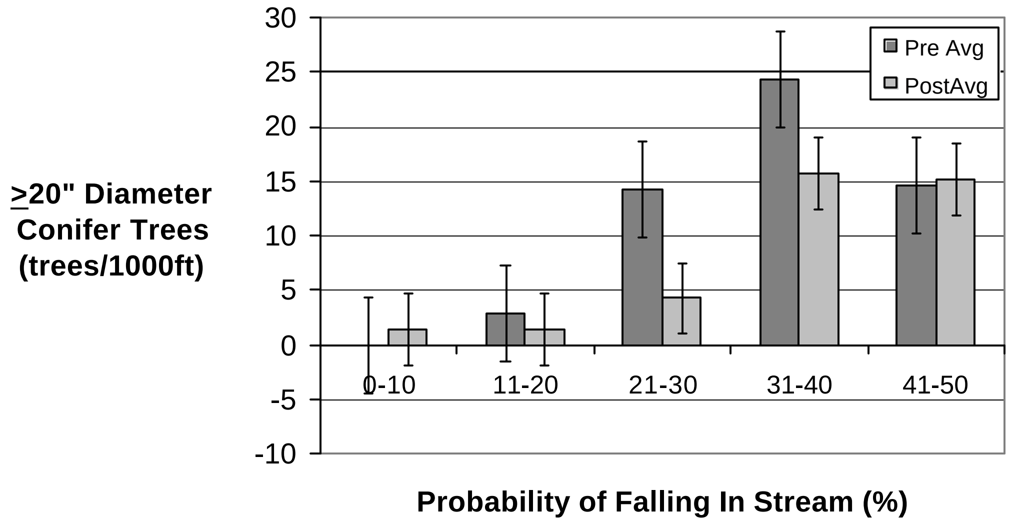

Figure 9. Medium fish bearing streams: Large wood recruitment before (pre) and after (post) harvesting under the 1994 riparian rules. (n =10).

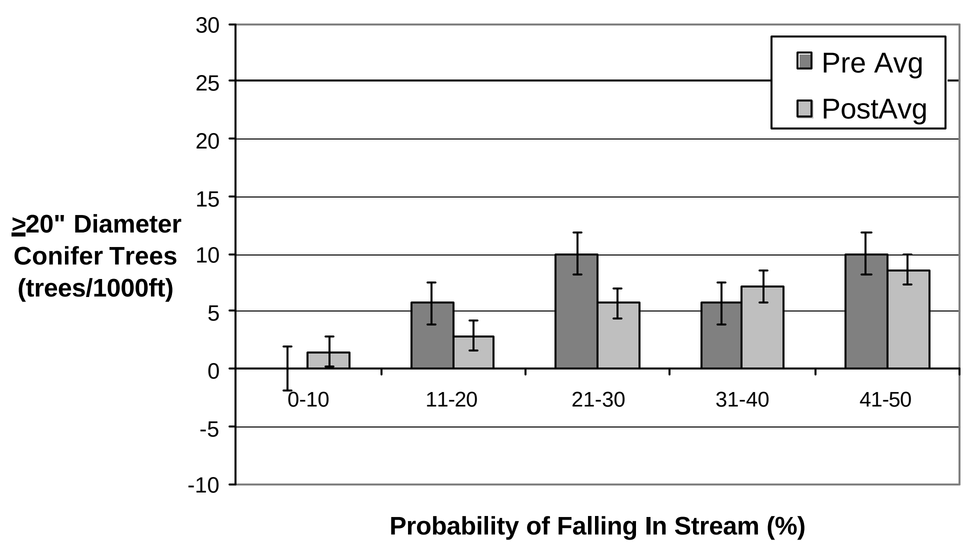

Figure 10. Large Fish Bearing Streams: Large wood recruitment before (pre) and after (post) harvesting under the 1994 riparian rules. (n = 7).

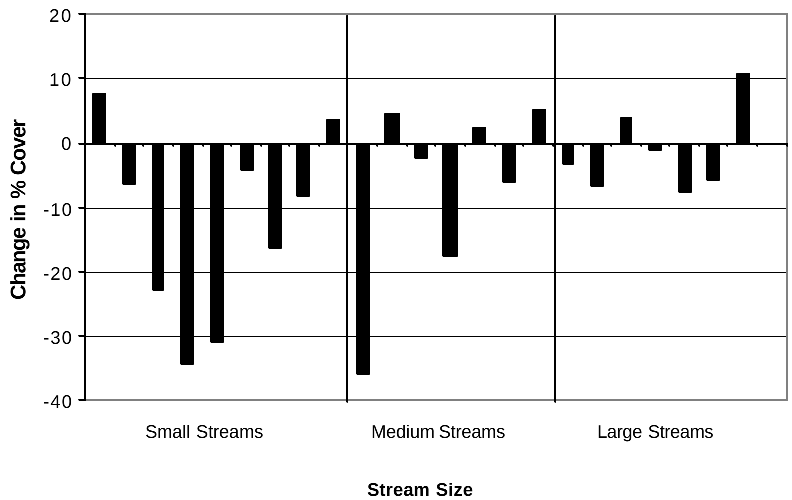

Figure 11. Change in average shade after harvest on small (n =9) medium (n =7), and large fish bearing streams (n = 8).

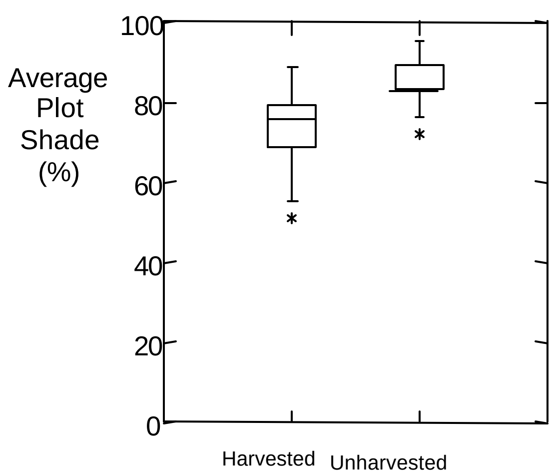

Figure 12. Average shade levels for harvested (n = 19) and unharvested streams (n = 7) in the Oregon Coast Range (Dent and Allen 2001)

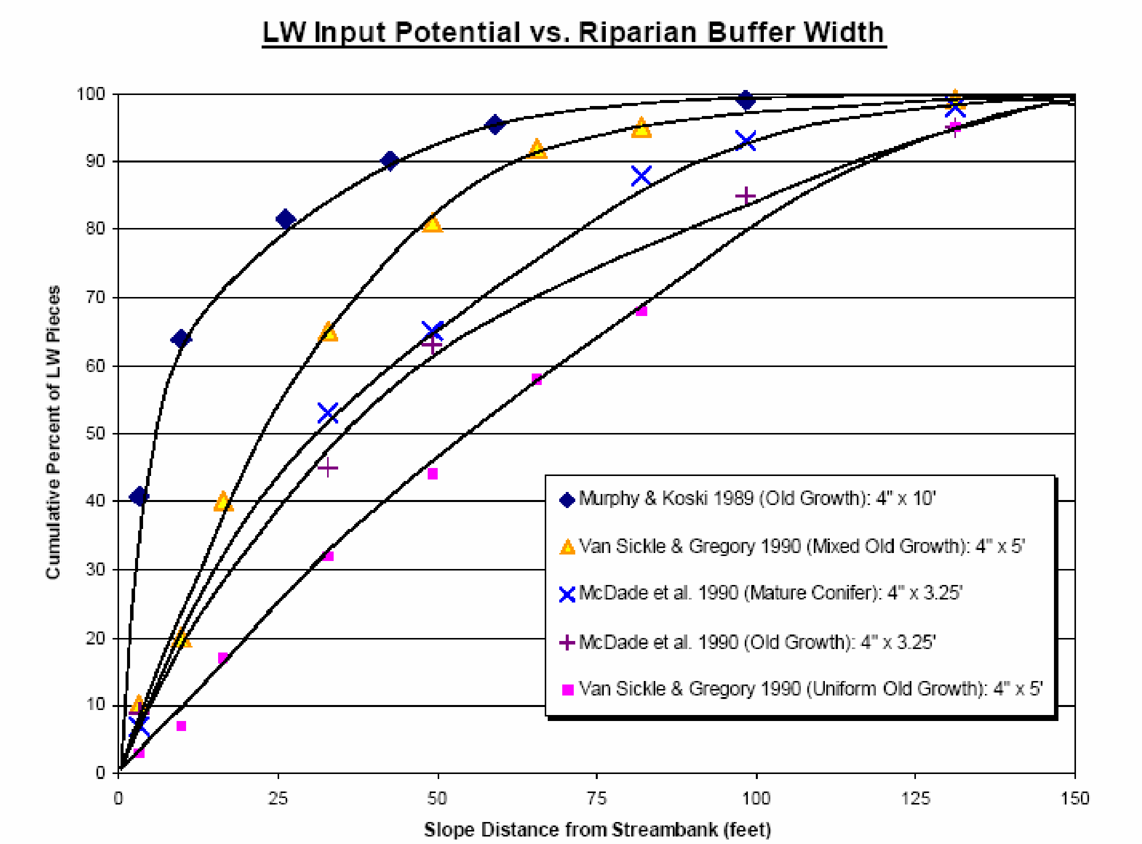

Figure 13. Compilation of current studies relating buffer width to large wood input potential. Murphy and Koski (1989) conducted their study in Alaska, the McDade et al. (1990) data is from the Oregon Cascades, Van Sickle and Gregory "mixed old growth" data is from the Oregon Cascades, and the Van Sickle and Gregory "uniform old growth" is modeled data from a hypothetical (modeled) stand.

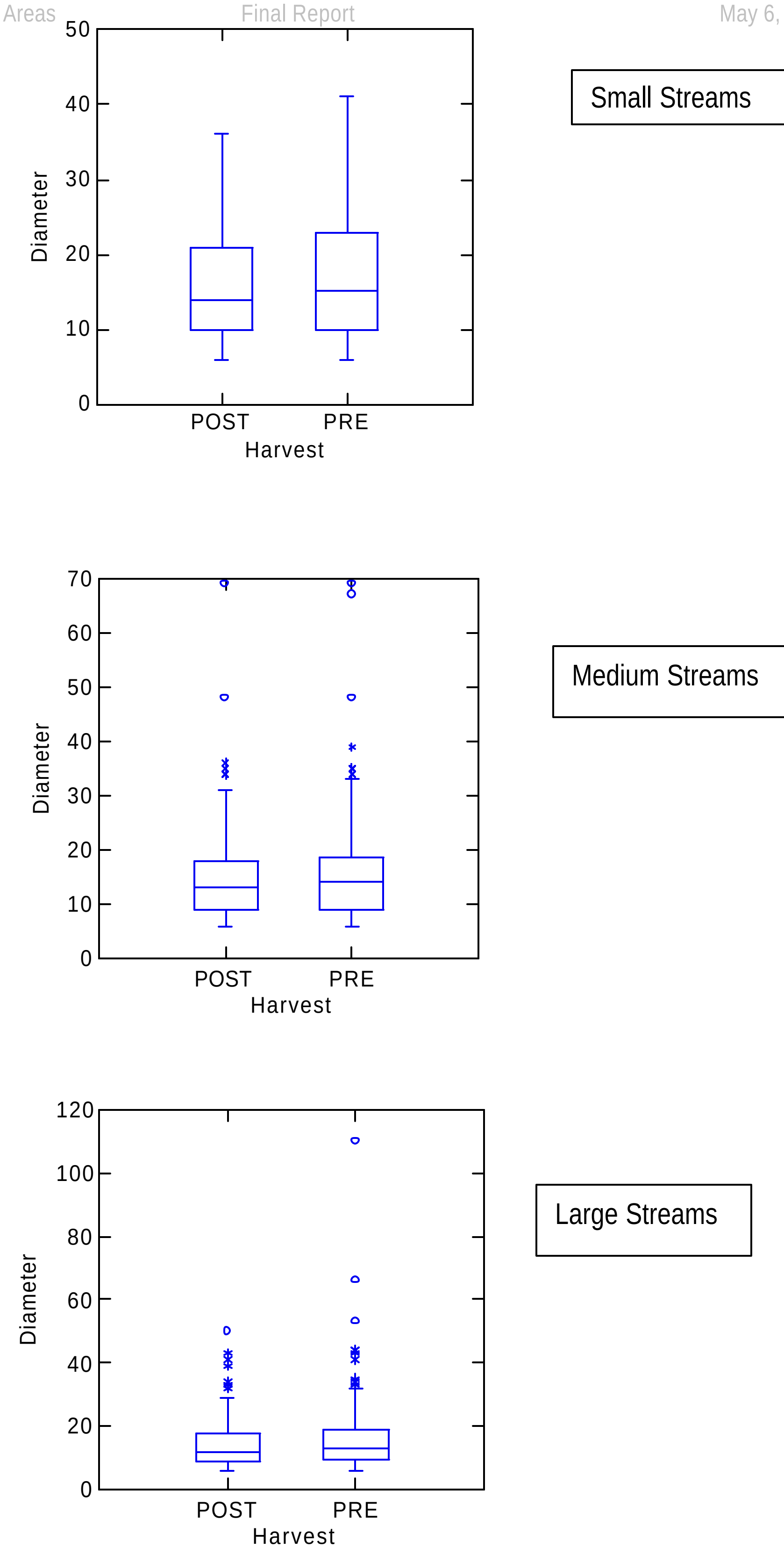

Figure 14. Box plots of conifer diameter distributions on small (n = 10), medium (n = 7), and large streams (n = 7) before and after harvesting.

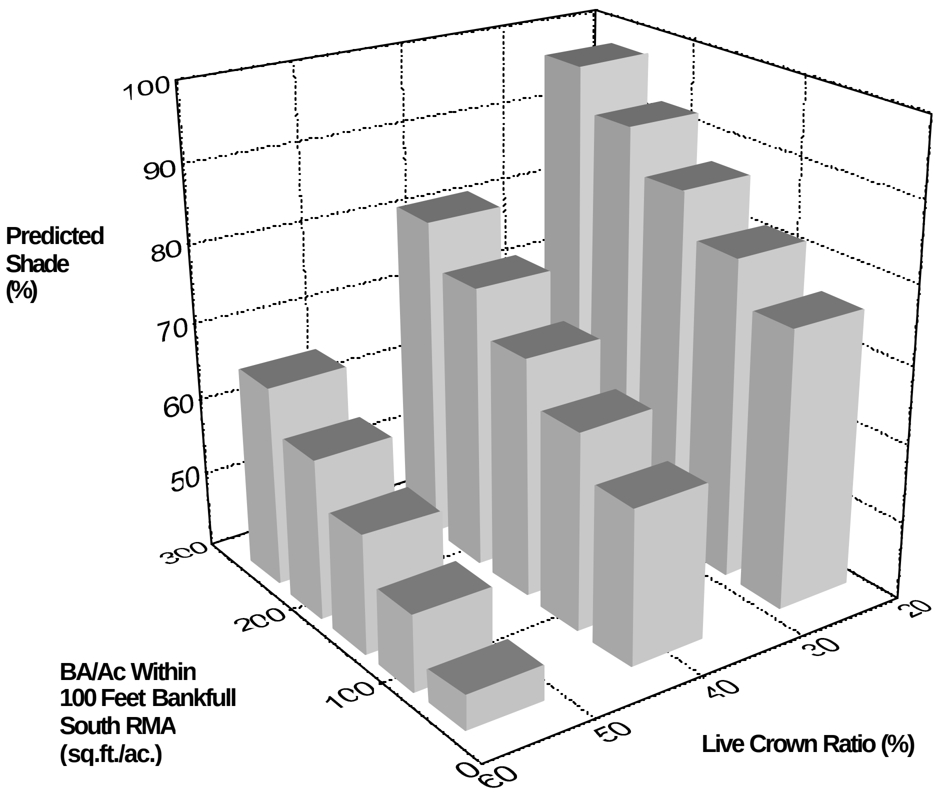

Figure 15. Predicted shade over east/west flowing Coast Range streams across a range of live crown ratios and basal areas (BA/Ac) within 100 feet of bankfull in the south RMA. Model was not signficant for the northern RMA.

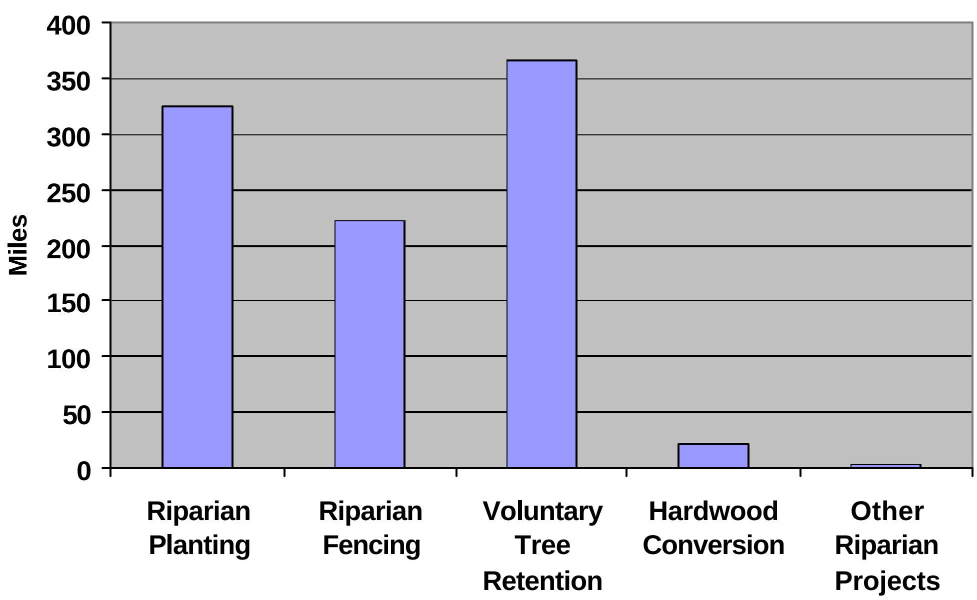

Figure 16. Numbers of miles with various riparian restoration treatments from 1997 to 2003.

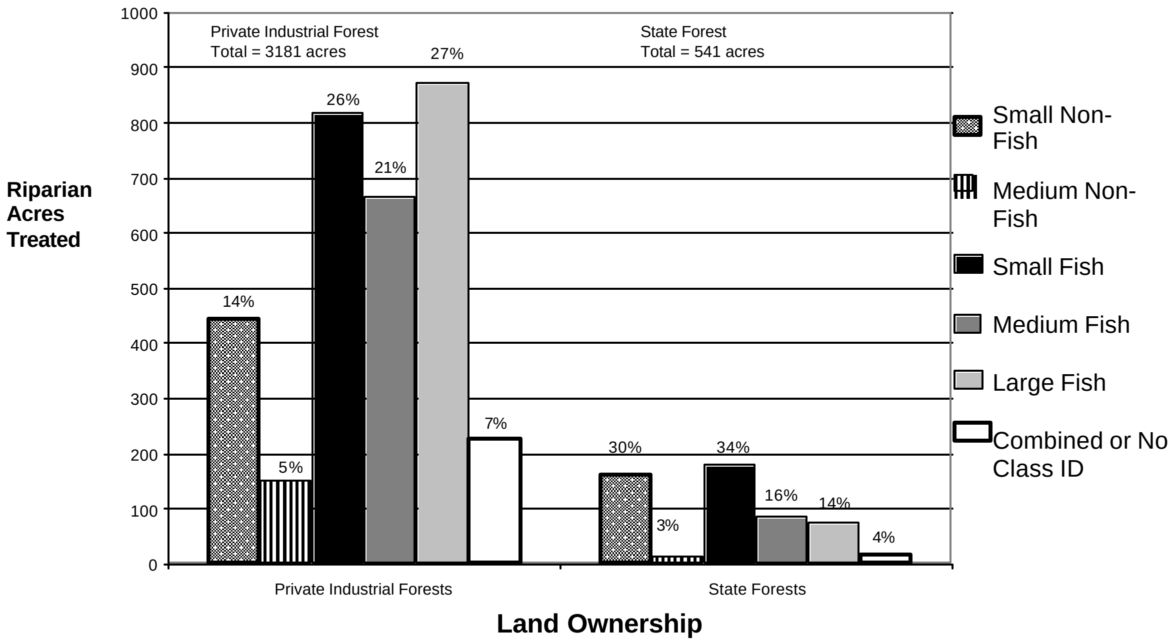

Figure 17. Riparian acres with additional leave tree retention on forested land in the ESU (1997 – 2003).

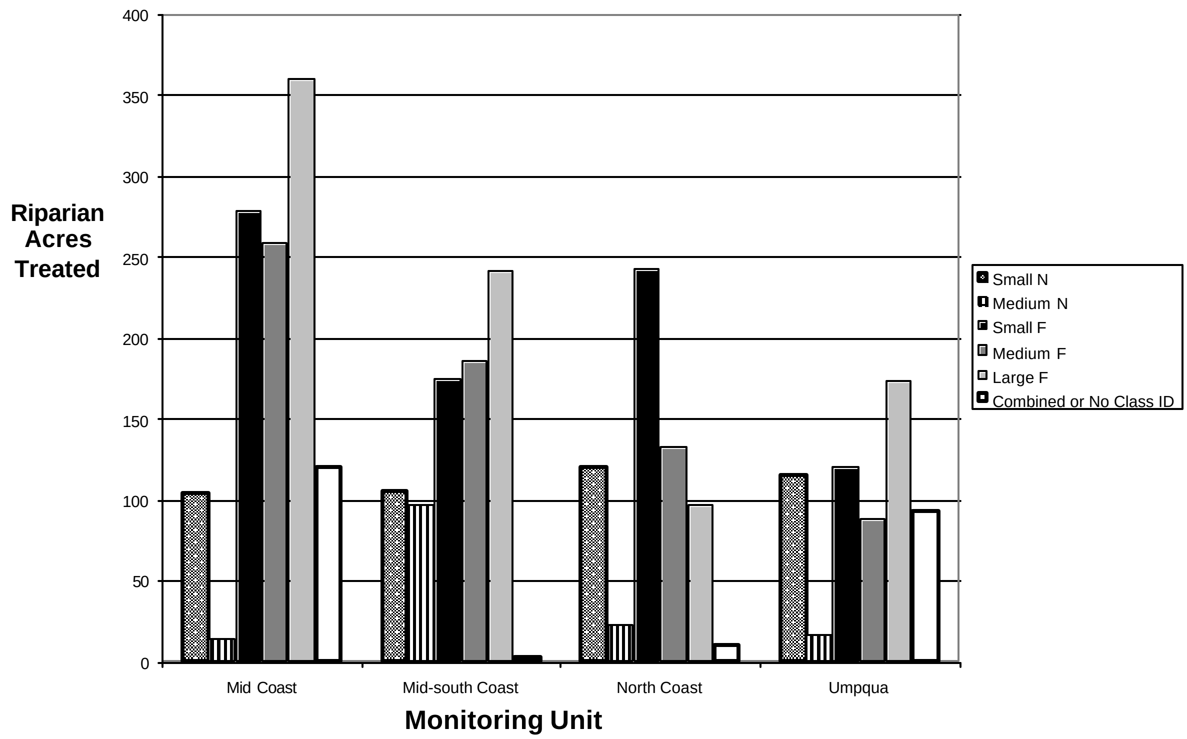

Figure 18. Riparian acres with additional leave tree retention on private industrial forestland in the ESU (1997-2003).

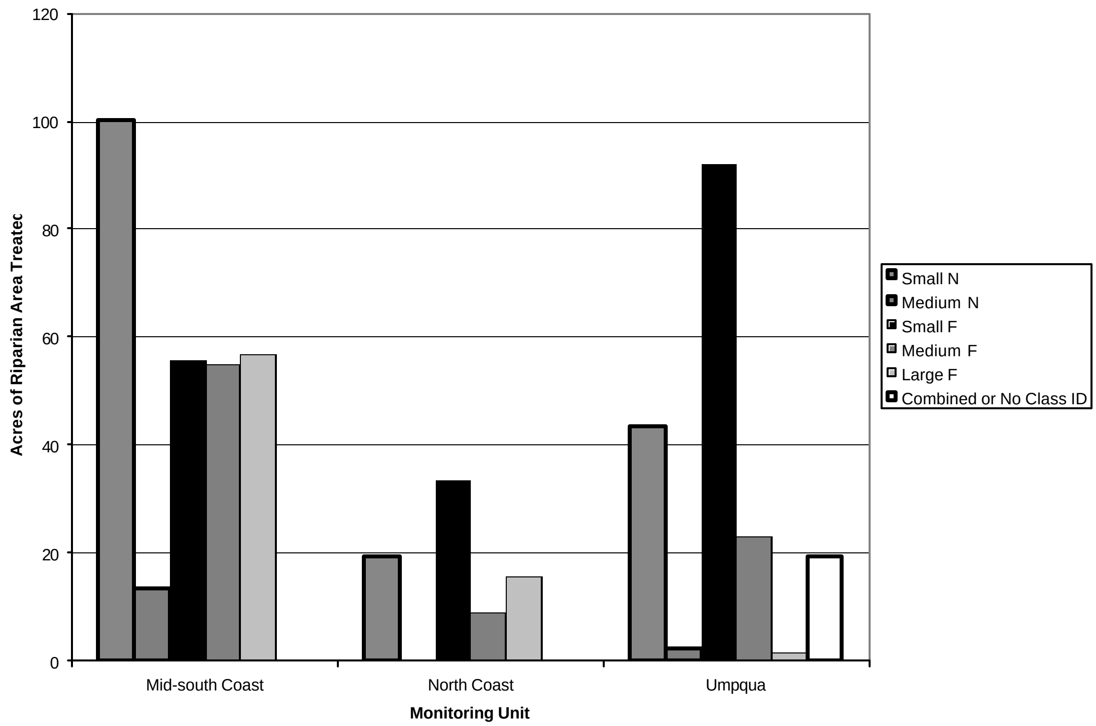

Figure 19. Riparian acres with additional leave tree retention on state forested land in the ESU (1997 – 2003).

Appendix A. Forest Practice Act, State Forest Management Plan, and Salmon Anchor Habitat Strategy comparison tables.

Table 1a. Comparison of protection measures under Forest Practices Act (FPA), State Forests Management Plan (FMP), and Salmon Anchor Habitat (SAH) for Fish-Bearing Streams. NOTE: The this table provides a general summary of practices and strategies. For a complete accounting of FPA rules please refer to FPA division 635 and 640 and for FMP strategies please refer to ODF 2001 (Appendix J).

Riparian Management Area[1]: Fish bearing streams (Type F)					
Stream Type	**Act or Plan**	**0' to 25'**	**25' to 50'**	**50 to 100' (70 feet for Medium under FPA)**	**100 to 170'**
Large Type F	FPA	No harvest within 20ft of stream. Trees in this zone count towards basal area and trees/acre retention.	Leave 230 (Type 2&3) to 300 (Type 1)[2] ft^2/1000ft. of conifer basal area and 40 conifers ≥11 inches per 1,000' on each side of stream from high water mark out to 100'. Retain all snags and downed wood.		NA
Large Type F	FMP	No harvest or ground equipment to 25ft.	INNER ZONE: Manage for mature forest conditions[3]. No activity where mature forest condition already exists or is likely to be met in reasonable time frame. Retain 50 trees/acre with a conifer SDI[4] =25%. Minimum entry to achieve desired future condition. Retain all snags and downed wood. No ground disturbance within 50ft of stream or on slopes >35%. Less than 10% ground disturbance from 50ft out to 170ft.		[5]OUTER ZONE: Retain 10- 45 conifer trees & snags/acre (15-70 trees/1000'). Retain all snags and downed wood. <10% ground disturbance.
Large Type F	SAH	Same for all Type F Streams to 25 ft.	INNER ZONE: No harvest		OUTER ZONE: Same as Large F
Medium Type F	FPA	Same for all Type F Streams to 20ft	Leave 120 (Type 2&3) to160(Type 1) ft^2/1000ft. of conifer basal area and 30 conifers ≥8 inches per 1000ft. on each side of stream from high water mark out to *70'.* Retain all snags and downed wood		NA
Medium Type F	FMP	Same for all Type F Streams to 25 ft.	INNER ZONE: Manage for mature forest conditions, same as Large Type F.		OUTER ZONE: Same as Large F
Medium Type F	SAH	Same for all Type F Streams to 25 ft.	INNER ZONE: No harvest		OUTER ZONE: Same as Large F
Small Type F	FPA	Same for all Type F Streams to 20ft	Leave 40 (Type 2 & 3) 50 (Type 1) ft^2/1000ft. of conifer basal area per 1,000' on each side of stream out to 50'. Retain all snags and downed wood.	NA	NA
Small Type F	FMP	Same for all Type F Streams to 25 ft.	INNER ZONE: Manage for mature forest conditions, same as Large Type F.		OUTER ZONE: Same as Large F

[1] Measured as horizontal distance for FMP and SAH, slope distance for FMP.
[2] Harvest Types 2 and 3 are clearcuts. Harvest Type 1 = partial cuts or thinnings.
[3] For conifer stands equates to approximately 220 ft2/acre or more, inclusive of trees >10 inch DBH or 40 – 45 trees 32 inches DBH/acre.
[4] SDI = Stand density index
[5] Inner zone = 50 – 100' from stream. Outer Zone =100-170'. Outer Zone tree retention is increased when less than the target number of conifers is present in the Inner Zone.

Riparian Management Area[1]: Fish bearing streams (Type F)					
Stream Type	**Act or Plan**	**0' to 25'**	**25' to 50'**	**50 to 100' (70 feet for Medium under FPA)**	**100 to 170'**
Small Type F	SAH	Same for all Type F Streams to 25 ft.	INNER ZONE: No harvest		OUTER ZONE: Same as Large F

Table 1b. Comparison of protection measures under Forest Practices Act (FPA), State Forests Management Plan (FMP), and Salmon Anchor Habitat (SAH) for Non-Fish-Bearing Streams. NOTE: The purpose of this table is to provide a general summary of practices and strategies. For a complete accounting of FPA rules please refer to FPA division 635 and 640 and for FMP strategies please refer to ODF 2001 (Appendix J).

Riparian Management Area: Non Fish-Bearing (Type N) and Domestic Water Use (Type D)

Stream Type	Act or Plan	0' to 25'	25' to 50'	50 to 100' (70 feet for Medium under FPA)	100 to 170'
Large Type N or D	FPA	Same as Type F Streams to 20ft	Leave 90 (Type 2 & 3) to 140 ft^2/1000ft (Type 1) of conifer basal area and 30 conifers ≥11inches per 1000ft. on each side of stream out to 70'. Retain all snags & downed wood		NA
Large Type N	FMP	Same as Type F Streams to 25 ft.	INNER ZONE: Manage for mature forest conditions, same as Large Type F.		OUTER ZONE: Retain at least 10 conifer trees & snags/acre (15 trees/1000'). Retain all snags
Large Type N	SAH	Same for all Type F Streams to 25 ft.	INNER ZONE: No harvest		OUTER ZONE: Same as above (FMP Large Type N)
Medium Type N or D	FPA	Same as Type F Streams to 20ft	Leave 50 (Type 2 & 3) to 60 ft^2/1000ft. (Type 1) of conifer basal area and 10 conifers ≥8 inches per 1000ft. on each side of stream out to 50'. Retain all snags and downed wood	NA	NA
Medium Type N	FMP	Same as Type F Streams to 25 ft.	INNER ZONE: Manage for mature forest conditions, same as Large Type F.		OUTER ZONE: Same as FMP Large Type N
Medium Type N	SAH	Same for all Type F Streams to 25 ft.	INNER ZONE: No harvest		OUTER ZONE: Retain at least 10 at least conifer trees & snags/ac (15 trees/1000') Retain all snags
Small Type D	FPA	Same as Type F Streams to 20ft	NA	NA	NA
Small Type N	FPA	NA in the coast range georegion	NA	NA	NA
Small Type N Perennial	FMP	Same as Type F Streams to 25 ft.	INNER ZONE: Retain 15-25 conifer trees & snags /acre (25-40 trees/1,000ft) of RMA each side. Retain all downed wood and snags. Within 500' of confluence of type F, retain hardwoods, non-merchantable & other conifer for 80% shade.		OUTER ZONE Retain 0-10 conifer & snags. Retain all snags
Small Type N Seasonal, High Energy Reach	FMP	Same as Type F Streams to 25 ft.	INNER ZONE: Retain 15-25 conifer trees & snags/are. Retain all snags and down wood.		OUTER ZONE: Same as Perennial Type N.

Riparian Management Area: Non Fish-Bearing (Type N) and Domestic Water Use (Type D)

Stream Type	Act or Plan	0' to 25'	25' to 50'	50 to 100' (70 feet for Medium under FPA)	100 to 170'
Small Type N Seasonal, Potential Debris Flow	FMP	Same as Type F Streams to 25 ft.	INNER ZONE: Retain at least 10 conifer trees & snags/ace (15 trees/1000') Retain all snags and down wood		OUTER ZONE: Retain trees and snags sufficient to meet landscape management strategy targets
Other Small Type N Seasonal	FMP	Maintain integrity of stream channel. No ground based equip.	INNER ZONE: Same as Debris Flow Small N.		OUTER ZONE: Same as Seasonal Debris Flow N
Small Type N Perennial	SAH	Same as Type F Streams to 25 ft.	INNER ZONE Type 1: Same as Perennial Small Type N FMP requirements, with the addition of no ground-based equipment within 50ft. INNER ZONE Type 2&3: Same as Perennial Small Type N FMP requirements, with the addition No Harvest within 50 ft of stream *and* retain 15-25 conifer trees an snags/acre from 50 – 100 feet from stream.		OUTER ZONE: Same as FMP Perennial Small N
Small Type N Seasonal High Energy Reach	SAH	Same as Type F Streams to 25 ft.	INNER ZONE: Same as High Energy Small Type N FMP requirements, with the addition of No Harvest within 50 ft of stream.		OUTER ZONE: Same as FMP Seasonal High Energy N
Small Type N Seasonal, Potential Debris Flow	SAH	Same as Type F Streams to 25 ft.	INNER ZONE: Same as Debris Flow Type N FMP requirements, with the addition no harvest within 50 ft of stream.		OUTER ZONE: Same as FMP Debris Flow Type N
Other Small Type N Seasonal	SAH	Maintain integrity of stream channel. No ground based equipment	INNER ZONE: Type 1 Harvest: Same as Seasonal Small Type N FMP requirements, with the addition of no ground-based equipment within 50ft. INNER ZONE: Type 2&3 Harvest: Retain 15-25 conifer trees and snags/acre and no ground-based equipment within 50ft.		OUTER ZONE: Same as FMP Seasonal Type N

Management Standards for Aquatic and Riparian Areas

The *Northwest Oregon State Forests Management Plan* uses a blended approach for the aquatic and riparian strategies. The first component is the landscape management strategies described in Chapter 4 of the plan. Over time, these strategies will create properly functioning riparian and aquatic conditions and processes. The second component a set of more site-specific strategies for aquatic and riparian areas is discussed in detail in this appendix.

The second component of the blended approach is a set of more site-specific or prescriptive strategies designed to protect key resource elements or provide for specific functional elements not necessarily addressed by the landscape strategies.

In Chapter 4, Aquatic and Riparian Strategy 2 states:

Apply management standards for aquatic and riparian areas. Establish and maintain riparian management areas adjacent to all streams, in accordance with the standards described in the proposed *Western Oregon State Forests Habitat Conservation Plan*, and Appendix J of this plan.

The site-specific, prescriptive standards in this appendix will guide forest management activities to achieve properly functioning aquatic and riparian habitat conditions over time. Management actions will be consistent with these standards, except where specific exceptions are documented and authorized by the District Forester. As information from monitoring efforts, watershed assessment and analysis, and other sources becomes available, specific standards may be changed or modified as necessary to meet the overall goal of maintaining and restoring properly functioning aquatic habitats.

Riparian Management Areas (RMAs)

Riparian management areas will be established immediately adjacent to waterways for the purpose of protecting aquatic and riparian resources, and maintaining the functions and ecological processes of the waterways. Within these areas, special management considerations and operational restrictions will be applied, and the protection of aquatic resources will be a high priority.

The width of riparian management areas will vary by the type and classification of the water body. These widths were developed by considering the functions and processes to be achieved or maintained by management activities. The width of a riparian management area (RMA) is measured horizontally beginning at the average high water level of the water body, or the edge of stream-associated wetland, side channel, or channel migration zone (whichever is farthest from the waterway), and extending toward the uplands. The width of these areas will be expanded, if necessary, to fully encompass certain sensitive sites such as inner gorge areas, or other special sites noted in the management prescriptions. See the “Key Terms” box on the next page for definitions.

Riparian management area widths are intended to be averages applied over the length of a management site. The actual extent of a specific RMA can be varied to tailor vegetation retention to site-specific conditions, or to address special resource considerations. For example, an RMA boundary will be expanded where a potentially unstable slope adjacent to a stream could deliver materials to the stream. The intent of this action is to increase the potential for large wood delivery should a disturbance event occur. Variations in RMA design will always be completed in a manner consistent with the management objectives for the specific aquatic or riparian area.

On the next several pages, guidelines are given for defining the four zones of a riparian management area and classifying streams. See “Basic Concepts for Aquatic and Riparian Conservation” in Chapter 4 for discussion of the functions and processes of healthy aquatic systems and the desired future condition for streams.

Key Terms

Active channel width — The average width of the stream channel at the normal high water level. The normal high water level is the stage reached during average annual high flow. This high water level mark often corresponds with the edge of streamside terraces; a change in vegetation, soil or litter characteristics; or the uppermost scour limit (bankfull stage) of a channel.

Average high water level — The stage reached during the average annual high flow period. This level often corresponds with the edge of streamside terraces, marked changes in vegetation, or changes in soil or litter characteristics.

Bog — A wetland that is characterized by the formation of peat soils and that supports specialized plant communities. A bog is a hydrologically closed system without flowing water. It is usually saturated, relatively acidic, and is dominated by ground mosses, especially sphagnum. Bogs are distinguished from other wetlands by the dominance of mosses and the presence of extensive peat deposits.

Channel migration zone (CMZ) — An area adjacent to an unconfined stream channel where channel migration is likely to occur during high flow events. The presence of side channels or oxbows, stream-associated wetlands, and low terraces are indicators of these zones. The extent of these areas will be determined through site inspections using professional judgment.

Inner gorge — An area next to a stream or river where the adjacent slope is significantly steeper than the gradient of the surrounding hillsides. In the absence of an on-site inspection and determination by a Department of Forestry geotechnical specialist or other qualified person, these areas are defined as having a slope gradient adjacent to the stream of 70 percent (35 degrees) or greater, and where the height of the slope break is at least 15 feet (measured vertically) above the elevation of the channel.

Guidelines: The Four Zones of a Stream Riparian Management Area

Riparian management areas established along streams will contain four zones. The purposes and differences between these four zones are defined below and on the next page.

Aquatic zone — The aquatic zone is the area that includes the stream channel(s) and associated aquatic habitat features. This zone includes beaver ponds, stream-associated wetlands, side channels, and the channel migration zone. The other zones of a riparian management area are established upslope from the outer edge of these features.

Stream bank zone — The stream bank zone is the land closest to the stream, including the stream banks. Most riparian functions are supported to some extent by vegetation in this zone, including providing aquatic shade, the delivery of down wood and organic inputs (leaves and tree litter) to the stream and riparian area, stabilizing the stream bank, contributing to floodplain functions, and influencing sediment routing processes.

- The stream bank zone is defined as the area within 25 feet of the outer edge of the aquatic zone for all streams. This zone exists on both sides of a stream.

Inner RMA zone — The inner RMA zone is the next area away from the stream, adjacent to the stream bank zone. Vegetation within this zone contributes substantially to desired riparian functions, including providing aquatic shade, delivering a high proportion of the potential large wood available, and contributing organic inputs to the stream. Vegetation within this area also provides some protection to certain aspects of riparian micro-climate. Because vegetation in this zone has a relatively greater role in supporting riparian functions and processes, a high priority is being placed on management actions in this area.

- The inner RMA zone extends from 25 feet (the outer edge of the stream bank zone) to 100 feet from the stream. This zone exists on both sides of a stream.

Outer RMA zone — The outer RMA zone is the portion of the riparian management area farthest away from the stream. Vegetation within this zone may still contribute to certain riparian functions and processes, but to a lesser extent than the two zones closest to the stream. The primary functions provided by vegetation in this area include additional contributions of large wood to the riparian zone and stream channel, and the protection of riparian micro-climate. In some cases, the outer zone may also partially buffer the two inner zones from certain disturbance events such as windthrow.

- The outer RMA zone extends from the edge of the inner zone at 100 feet out to 170 feet from the stream. This zone exists on both sides of a stream.

Guidelines: Stream Classification

Determination of the applicable management standards for riparian areas is based on a stream classification system. Streams are grouped into two major categories based on the primary beneficial uses of the stream. Streams are further classified according to size, based on average annual flow. Flow pattern (perennial and seasonal) is also considered for small non-fish-bearing waters. This classification system is generally consistent with the method used for administration of the Oregon Forest Practices Act, as described in the Department of Forestry's Forest Practice Technical Note FP1 — Water Classification (Oregon Department of Forestry 1994).

Beneficial Use Classifications

Streams, and other aquatic habitats, are classified into two major groups based on the presence or absence of certain fish species. The following definitions will be applied in classifying streams.

Fish-bearing (Type F) — Waters that are inhabited at any time of the year by anadromous or game fish species, or by fish species that are listed as threatened or endangered under either federal or state Endangered Species Acts.

Non-fish-bearing (Type N) — Waters that are not fish-bearing (see previous definition).

Stream Size Classifications

Streams are further classified by size, based on estimated average annual flow. The following definitions apply to these size categories.

- **Small —** Average annual flow of 2 cfs (cubic feet per second) or less.
- **Medium —** Average annual flow greater than 2 cfs, but less than 10 cfs.
- **Large —** Average annual flow of 10 cfs or greater.

Flow Pattern Classifications

Small non-fish-bearing (Type N) streams are also classified according to the flow pattern exhibited in normal water years. For the purposes of this plan, the following definitions will be used.

- **Perennial Type N streams —** streams that are expected to have summer surface flow after July 15.
- **Seasonal Type N streams —** streams that only flow during portions of the year; these streams are not expected to have summer surface flow after July 15.

Some seasonal non-fish-bearing streams are further classified as:

- **Seasonal high energy streams —** Seasonal streams with physical conditions that favor the periodic transport of coarse sediments and woody materials during high flow events. For the purposes of this plan, and in the absence of specific geomorphologic identification, stream reaches with an average gradient exceeding 15 percent, and an active channel width of five (5) feet or more will be defined as seasonal high energy streams.
- **Potential debris flow track reaches —** Potential debris flow track reaches are reaches on seasonal Type N streams that have been determined to have a high probability of delivering woody debris to a Type F stream.

Oregon Department of Forestry field staff will make the determination of the probability that a reach will deliver woody debris to a Type F stream, using the following criteria:

1. The seasonal stream reach must terminate at or below a high risk site. High risk sites include:
   a. Active landslides (slopes with tension cracks, unvegetated soil scarps, or jackstrawed trees caused by slope movement).
   b. Slopes steeper than 80 percent, excluding competent rock outcrops.
   c. Headwalls or draws steeper than 70 percent.
   d. Abrupt slope breaks, where the lower slope is the steeper and exceeds 70 percent, except where the steeper slope is a competent rock outcrop.
   e. Incised channels (hill slopes adjacent to the channel and steeper than the upland slope) with slopes steeper than 60 percent.
   f. Any other site determined to be of marginal stability by a Department of Forestry geotechnical specialist.

2. The path of a potential debris flow and the likelihood that a debris flow will reach a Type F stream. If any one of the following three conditions is present along the path from the high risk site to the Type F stream, then a debris flow is likely to stop and the stream reach would be determined to have a low probability of woody debris delivery:
   a. The presence of a channel junction that is 70 degrees or more, provided the channel downstream of the junction is less than 35 percent gradient.
   b. The presence of a stream reach which is less than 6 percent gradient for at least 300 feet.
   c. An average slope from the high risk site along the potential landslide path to the stream that is less than 20 percent.

Management Standards for RMAs

The following standards will guide management activities so that properly functioning riparian and aquatic conditions will be created over time. These standards will apply until alternative standards are identified through the adaptive management process. As new information and a better understanding of the watershed functions and processes become available, this knowledge will be integrated into the management of riparian and aquatic habitat through the adaptive management process. The management standards are presented in Tables J-1 and J-2.

Table J-1. Management Standards for Type F Stream RMAs

	All Stream Sizes: Large, Medium, and Small
Stream bank zone 0-25 ft.	• No harvest. • Less than 10% vegetative disturbance. • Full suspension required during cable yarding. • No ground-based equipment operation. • Leave any trees damaged or felled from yarding activities.
Inner RMA zone 25 to 100 ft.	• Manage for mature forest condition.[1] • No management activity where mature forest condition (MFC) exists, or where conditions are suitable for development of MFC in a reasonable time frame without further treatment. • Actively manage where necessary to achieve the desired future condition in a timely manner. • Minimum 15-year interval between harvest entries, and minimum number of entries necessary to achieve the desired future condition. • Partial cutting will maintain a conifer density of at least SDI 25%, and will retain at least 50 TPA. • No more than 10% vegetative disturbance allowed from cable yarding. • Full suspension wherever possible, or one-end suspension on all cable-yarded material. • Ground-based equipment operation limited to area more than 50 ft. from aquatic zone and slopes less than 35%, and allowed on no more than 10% of area. • Leave any trees damaged or felled from yarding activities and additional felled, girdled or topped trees to contribute toward down wood targets.[2] • Retain all dead and down material that was present prior to the operation.
Outer RMA zone 100 to 170 ft.	• Retain at least 10 to 45 [3] conifer trees and snags per acre (15 to 70 trees per 1,000 ft. of RMA). [4] • Retain all snags as safety permits. • Less than 10% ground disturbance from yarding activities. • Retain all dead and down material that was present prior to the operation.

1. Desired mature forest condition consists of a stand dominated by large conifer trees, or where hardwood-dominated conditions are expected to be the natural plant community, a mature hardwood/shrub community. For conifer stands, this equates to a basal area of 220 square feet or more per acre, inclusive of all conifers over 11 inches DBH. At a mature age (80-100 years or greater), this equals 40-45 conifer trees 32 inches in DBH per acre.
2. Up to 10 trees per acre will be retained as felled, girdled, or topped trees during partial cutting, to reach a target of 600-900 cubic feet per acre of hard down wood.
3. Outer zone tree retention target will be increased when less than the target number of conifers is present in the inner zone. The process for calculating the outer zone retention target is described in the section following the RMA prescription tables.
4. All trees retained will be dominant or co-dominant conifer trees (if available). In order to balance the need for short-term and long-term recruitment of large wood to the aquatic zone, preference will be given to retaining trees on adjacent slopes, trees leaning toward the aquatic zone, and trees closest to the channel.

Table J-2. Management Standards for Type N Stream RMAs

	Large and Medium Type N Streams
Stream bank zone 0-25 ft.	• No harvest. • Less than 10% vegetative disturbance from cable yarding. • Full suspension required. • No ground-based equipment operation. • Leave any trees damaged or felled from yarding activities.
Inner RMA zone 25-100 ft.	• Manage for mature forest condition.[1] • No management activity where mature forest condition target already exists. • Actively manage where beneficial to achieve desired future condition. • Minimum 15-year interval between harvest entries, and minimum number of entries necessary to achieve the desired future condition. • Partial cutting will maintain a conifer density of at least SDI 25%, and will retain at least 50 TPA. • No more than 10% vegetative disturbance allowed from cable yarding. • Full suspension wherever possible, or one-end suspension on all cable-yarded material. • Ground-based equipment operation limited to area more than 50 ft. from aquatic zone and slopes less than 35%, and allowed on no more than 10% of area. • Leave any trees damaged or felled from yarding activities and additional felled, girdled or topped trees to contribute to down wood targets.[2] • Retain all dead and down material that was present prior to the operation.
Outer RMA zone 100-170 ft.	• Manage to retain at least 10 conifer trees and snags per acre (15 trees per 1,000 ft. of RMA).[3] • Retain all snags as safety permits.

1. Desired mature forest condition consists of a stand dominated by large conifer trees, or where hardwood-dominated conditions are expected to be the natural plant community, a mature hardwood/shrub community. For conifer stands, this equates to a basal area of 220 square feet or more per acre, inclusive of all conifers over 11 inches DBH. At a mature age (80-100 years or greater), this equals 40-45 conifer trees 32 inches in DBH per acre.
2. Up to 10 trees per acre will be retained as felled, girdled, or topped trees during partial cutting, to reach a target of 600-900 cubic feet per acre of hard down wood.
3. All trees retained will be dominant or co-dominant conifer trees (if available). In order to balance the need for short-term and long-term recruitment of large wood to the aquatic zone, preference will be given to retaining trees on adjacent slopes, trees leaning toward the aquatic zone, and trees closest to the channel.

Table J-2 continued. Management Standards for Type N Stream RMAs

Small Perennial Type N Streams (applied to at least 75% of reach)[1]	
Stream bank zone 0-25 ft.	• No harvest. • No ground-based equipment operation.
Inner RMA zone 25-100 ft.	• Manage to retain at least 15-25 conifer trees and snags per acre (25-40 trees per 1,000 ft. of RMA).[2,3] • Retain all other snags as safety permits. • Within 500 ft. of a confluence with a Type F stream, retain all hardwoods, non-merchantable trees, and other conifers as necessary, to achieve 80% shade over aquatic zone. • Retain all dead and down material that was present prior to the operation.
Outer RMA zone 100-170 ft.	• Manage to retain 0-10 conifer trees and snags per acre (0-15 trees per 1,000 ft. of RMA).[2,3] • Retain all snags as safety permits.

1. Prescription to be applied to at least 75% of perennial stream reach, including the first 500 ft. above the confluence with a Type F, and areas that meet the definition of a Special Emphasis Area (SEA) according to the definitions in the section following these tables.
2. All trees retained will be dominant or co-dominant conifer trees (if available). In order to balance the need for short-term and long-term recruitment of large wood to the aquatic zone, preference will be given to retaining trees on adjacent slopes, trees leaning toward the aquatic zone, and trees closest to the channel.
3. In meeting the tree retention target for the inner and outer zones, preference will be given to retaining trees within the inner zone. Where there are sufficient trees within the inner zone to meet the combined target for the two zones (40 trees per 1,000 ft.), then no additional leave trees are required in the outer zone.

Table J-2 continued. Management Standards for Type N Stream RMAs

Small Seasonal Type N Streams: High Energy Reaches (applied to at least 75% of reach)[1]	
Stream bank zone 0-25 ft.	• No harvest. • No ground-based equipment operation.
Inner RMA zone 25-100 ft.	• Manage to retain at least 15-25 conifer trees and snags per acre (25-40 trees per 1,000 ft. of RMA).[2,3] • Retain all other snags as safety permits. • Retain all dead and down material that was present prior to the operation.
Outer RMA zone 100-170 ft.	• Manage to retain 0-10 conifer trees and snags per acre (0-15 trees per 1,000 ft. of RMA).[2,3] • Retain all snags as safety permits.
Small Seasonal Type N Streams: Potential Debris Flow Track Reaches (applied to at least 75% of reach)[1]	
Stream bank zone 0-25 ft.	• No harvest. • No ground-based equipment operation.
Inner RMA zone 25-100 ft.	• Manage to retain at least 10 conifer trees and snags per acre (15 trees per 1,000 ft. of RMA).[2,4] • Retain all other snags as safety permits. • Retain all dead and down material that was present prior to the operation.
Outer RMA zone 100-170 ft.	• Retain trees and snags sufficient to meet landscape management strategy targets.
Other Small Seasonal Type N Streams (applied to at least 75% of reach)	
Stream bank zone 0-25 ft.	• Maintain integrity of stream channel. • No ground-based equipment operation.
Inner RMA zone 25-100 ft.	• Manage to retain at least 10 conifer trees and snags per acre where operationally feasible (16 trees per 1,000 ft. of RMA).[2] • Retain all other snags as safety permits. • Retain all dead and down material that was present prior to the operation.
Outer RMA zone 100-170 ft.	• Retain trees and snags sufficient to meet landscape management strategy targets.

1. Prescription to be applied to at least 75% of stream reach, including the first 500 ft. above the confluence with a Type F stream.
2. All trees retained will be dominant or co-dominant conifer trees (if available). In order to balance the need for short-term and long-term recruitment of large wood to the aquatic zone, preference will be given to retaining trees on adjacent slopes, trees leaning toward the aquatic zone, and trees closest to the channel.
3. In meeting the tree retention target for the inner and outer zones, preference will be given to retaining trees within the inner zone. Where there are sufficient trees within the inner zone to meet the combined target for the two zones (40 trees per 1,000 ft.), then no additional leave trees are required in the outer zone.
4. To maximize the influence of retained trees on debris flow processes, preference will be given to retaining these trees as close to the stream channel as operationally feasible, or on adjacent slope features that exhibit a high potential for failure and delivery to the stream.

Increasing Outer Zone Conifer Retention on Type F Streams

On Type F streams, in situations where the number of conifers available for retention within the inner zone is not adequate to achieve the large wood delivery potential of a mature forest condition, additional conifers will be retained in the outer zone to provide additional large wood recruitment potential.

This additional outer zone target will apply when the number of conifers of suitable size (11 inches or greater DBH) in the inner zone is less than the mature forest condition target of 45 TPA (100 trees per 1,000 lineal feet of stream for a 100-foot inner zone).

The number of additional conifers to be retained in the outer zone will be equal to the deficit from the inner zone target, adjusted to account for the different widths of the zones. For example, if the inner zone has an average of 70 suitable conifers per 1,000 feet of stream, then the additional retention level for the outer zone would equal 30 times 0.7, or an additional 21 conifers per 1,000 feet of outer zone.

In no case shall the number of conifers required to be retained in the outer zone exceed the inner zone target for mature forest condition. This means no more than 70 conifers per 1,000 feet of outer zone or 45 TPA are required. In addition, no trees shall be required to be retained in the outer zone in locations where, due to topography, they would have no opportunity to reach the area within the channel migration zone and thus potentially function as large wood in the stream channel. All conifers retained under this strategy shall meet the conifer retention criteria as described in footnotes to Tables J-1 and J-2: dominant or co-dominant trees, with preference given to retaining trees on adjacent slopes, trees leaning toward the aquatic zone, and trees closest to the channel.

Perennial Type N Stream Special Emphasis Areas

On small Type N streams, the required riparian management areas will be located to provide protection to the following special emphasis areas. These special emphasis areas may be especially important to certain species (such as amphibians), or to the functions and processes within a watershed.

Seeps and Springs in Inner RMA Zone, Connected to Aquatic Zone

The 25-foot stream bank zone of the stream, which is the no-harvest zone, will be extended around the outer perimeter of side slope seeps and springs that are within 100 feet of the aquatic zone and connected to the channel via overland flow. The inner zone will follow that boundary.

Source Areas of Perennial Streams

The 25-foot stream bank zone, which is the no-harvest zone, will be extended for a distance of 100 feet above the initiation point of perennial flow.

Stream-Associated Wetlands

The 25-foot stream bank zone, which is the no-harvest zone, will be extended around the outer perimeter of the wetland area.

Inner Gorge Areas

- A no-harvest zone will be extended to the top of the slope break that defines the inner gorge.
- If the slope break is less than 100 feet from the edge of the CMZ, then the applicable inner zone standard will be applied for the remaining distance (out to a maximum of 100 feet), and the applicable outer zone standard will be applied out to 170 feet.
- If the slope break is greater than 100 feet from the edge of the CMZ, then the outer zone standard will be applied from the slope break out to 170 feet.

Stream Junctions

The 25-foot stream bank zone (no harvest) will be extended for a minimum of 100 feet upstream and downstream, on each stream, where two or more small Type N perennial streams intersect.

Significant Waterfalls

- A significant waterfall is one that has an identifiable splash zone. The splash zone is the area immediately adjacent to the stream channel that is occupied by vegetation commonly associated with wet areas, i.e., mosses, maidenhair or licorice fern, and other hydric species.
- For these sites, the stream bank zone (no harvest) will be extended around the outer perimeter of the splash zone of the waterfall.

Landscape Green Tree Retention and RMA Conifer Retention Targets

It is recognized that conifer trees retained on the landscape during regeneration harvests provide benefits to both upland and riparian species, as well as contributing to aquatic habitats. Although any given tree or group of trees retained may provide multiple benefits, it is assumed that it would be undesirable for all leave trees to be concentrated in riparian management areas, with few or none in upslope areas, or vice-versa. Therefore, the following standards and guidelines will be used in accounting for the required RMA and landscape-level live tree retention targets.

Management Standards

- Conifers retained to meet the requirements in the inner zone of streams managed for mature forest condition (Type F, and large or medium Type N) will not be counted towards achieving the landscape-level live tree retention standard.
- Conifer trees retained to meet the requirements on all other RMA zones may be counted towards achieving the landscape-level leave tree retention standard.

Management Guidelines

- On regeneration harvest units, leave trees should be arranged to meet the intent and functional objectives for both riparian and upslope habitat values.
- On average, at least 25 percent of the leave trees required to meet the landscape standard should be located in riparian areas that extend well into upslope areas, or in upslope areas that are outside of riparian areas.

Other Aquatic Habitats

The northwest Oregon state forests contain other aquatic habitats besides streams, such as wetlands, lakes, ponds, bogs, seeps and springs. The management objectives for these waters are generally similar to the objectives for streams, but the specific prescriptions are sometimes different. The following strategies apply to these other aquatic habitats.

Prescriptions

The prescriptions for other aquatic habitats are presented in the following two tables.

Key Terms

Wetland — An area that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal conditions does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. The process used to determine the presence of wetlands will be consistent with the method described in the 1989 *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (USDI Fish and Wildlife Service et al. 1989).

Bog — A wetland that is characterized by the formation of peat soils and that supports specialized plant communities. A bog is a hydrologically closed system without flowing water. It is usually saturated, relatively acidic, and is dominated by ground mosses, especially sphagnum. Bogs are distinguished from other wetlands by the dominance of mosses and the presence of extensive peat deposits.

Table J-3. Management Prescriptions for Lakes, Ponds, and Wetlands

Greater Than 1 Acre

- Establish a 25-foot no harvest zone, starting from the high water line, or wetland boundary (whichever is greater).
- Establish a riparian management area (RMA) of 100 feet from the high water line, or wetland boundary (whichever is greater).
- Manage vegetation to achieve and maintain mature forest conditions.
- The site-specific prescription will classify the wetland.

From 1/4 Acre to 1 Acre

- Establish a 25-foot no harvest zone, starting from the high water line, or wetland boundary (whichever is greater).
- Establish a riparian management area (RMA) of 50 feet from the high water line, or wetland boundary (whichever is greater).
- Within the RMA, harvest activities will retain at least 50% of the existing live tree basal area, or 110 square feet of basal area per acre (whichever is greater). Retained trees will generally be representative of the existing diameter classes and species distribution, with a preference for retaining trees greater than 20 inches DBH.
- If the waterway is inhabited by fish, or is identified as an important area for temperature-sensitive amphibian species, at least 80% shade will be maintained over the aquatic area.
- The site-specific prescription will classify the wetland.

Less Than 1/4 Acre

- Establish an RMA of 50 feet for waters containing fish (Type F), or 25 feet for non-fish-bearing (Type N) waters. These areas will be measured from the high water line, or wetland boundary (whichever is greater).
- For Type F waters, harvest within the RMA will retain at least 50% of the existing live tree basal area, or 110 square feet of basal area per acre (whichever is greater). Retained trees will generally be representative of the existing diameter classes and species distribution, with a preference for retaining trees greater than 20 inches DBH.
- For Type N waters, hardwood trees and brush will be retained to protect the hydrologic functions and wildlife habitat values of the site.
- If the waterway is inhabited by fish, or is identified as an important area for temperature-sensitive amphibian species, at least 80% shade will be maintained over the aquatic area.

Stream-Associated Wetlands

- Stream-associated wetlands are considered to be components of the aquatic habitat of streams, and will be managed according to the objectives and prescriptions specified for the associated stream.

Table J-4. Management Prescriptions for Estuaries, Bogs, Seeps, and Springs

Estuaries
• Establish a 25-foot no harvest zone, starting from the high water line or estuarine wetland boundary (whichever is greater). • Establish a riparian management area (RMA) of 200 feet from the high water line, or estuarine wetland boundary (whichever is greater). • Manage vegetation within the RMA to achieve and maintain mature forest conditions.
Bogs
• Establish a 25-foot no harvest zone, starting from the high water line or wetland boundary (whichever is greater). • Establish an RMA of 100 feet from the high water line or wetland boundary (whichever is greater). • Manage vegetation within the RMA to achieve and maintain mature forest conditions.
Seeps and Springs
Where possible, these aquatic areas should be incorporated into the RMAs of adjacent streams, and vegetation retention provided according to the stream prescription. In practice, this may simply require adjusting the boundary of a stream's RMA to fully encompass the spring or seep. Other management considerations for some of these areas were described earlier in the section titled "Perennial Type N Stream Special Emphasis Areas."