4d. Rationale for the Plan

During development of the Forests and Fish Report, policymakers consulted and considered the available scientific information when crafting the management recommendations that later became forest practices rules. A summary of some of the more important scientific and technical information used to develop the forest practices rules and associated FPHCP protection measures is included in the following sections.

4d-1 Rationale for Riparian Conservation Strategy

The Riparian Strategy consists of three separate but related sets of protection measures:

1) riparian and wetland management zones that provide woody debris recruitment, shade and other ecological functions through tree retention

2) limitations on equipment use in and around waters and wetlands to minimize erosion and sedimentation and maintain hydrologic flowpaths

3) streamside land and timber acquisitions for the long-term conservation of aquatic resources

Many of the protection measures in the Riparian Strategy reflect standards initially proposed in the FFR (Appendix B). The FFR had multiple goals, including ensuring compliance with the Federal ESA and CWA, restoring and maintaining riparian habitat to support a harvestable supply of fish and keeping Washington's timber industry economically viable. Policymakers and technical advisors from each caucus group involved in the FFR negotiations relied heavily on research findings to craft a set of standards that would meet all FFR goals. The following sections present scientific and technical information used in the development of some protection measures initially proposed in the FFR and later adopted as forest practices rules.

4d-1.1 Riparian Management Zones: Providing Large Woody Debris and Shade

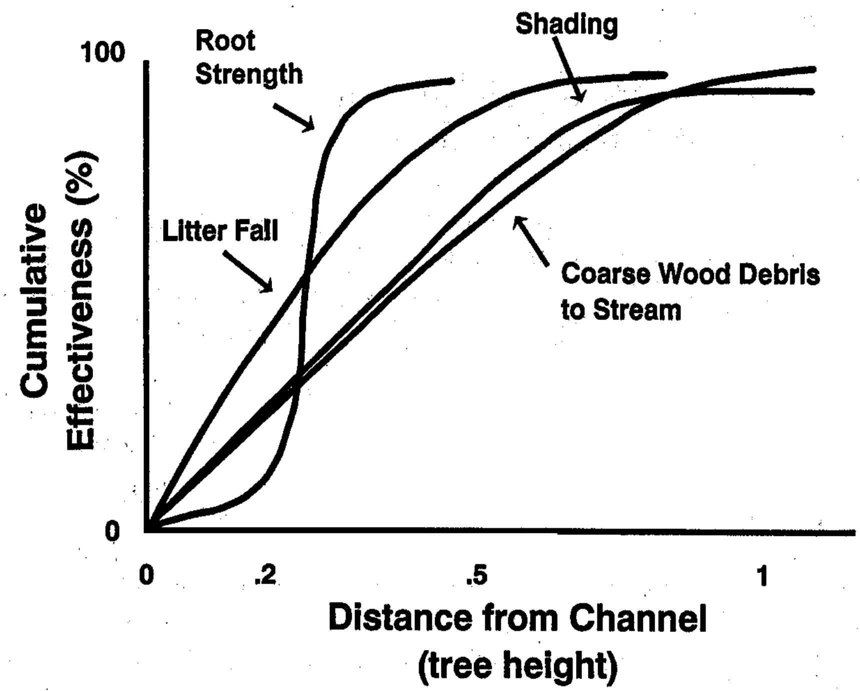
The FPHCP requires the retention of trees within RMZs adjacent to Type S, Type F and Type Np waters. The RMZ width and the number of leave trees vary between and within water type classes (See Section 4b-3). RMZ requirements are designed to maintain important ecological processes and provide levels of LWD, shade and other riparian functions adequate to meet conservation objectives. The requirements are based on research into riparian ecological processes, habitat needs of covered species and forest management effects. This section uses the processes of LWD recruitment and riparian shading to explain the rationale for the RMZ requirements. While providing for all riparian functions is necessary, maintenance of these two processes is particularly important to the conservation of covered species.

The degree of riparian influence on the aquatic environment decreases with increasing distance from the water (Forest Ecosystem Management Assessment Team

(FEMAT) 1993). Therefore, trees closer to the water generally provide greater ecological benefit compared with trees farther away. This relationship can be illustrated as a curve where the cumulative effectiveness of a given riparian function is related to distance from the stream or wetland edge (Figure 4.8). The relationship is function-specific and is often expressed as a proportion of tree height.

Since species, age, and site productivity all affect tree height, the generalized function-distance relationships in Figure 4.8 change as forest stand characteristics vary across time and space. Riparian management zone requirements under the FPHCP have been designed to account for differences in the function-distance relationships that exist within and between sites. Differing levels of allowable management within RMZs and variable RMZ widths between sites reflect recognition of complex site- and landscape-scale differences in riparian processes. RMZ requirements are designed to ensure that important ecological functions such as large wood recruitment and shade are maintained at levels that provide for the long-term conservation of covered species.

Figure 4.8 Relationship between cumulative effectiveness of various riparian functions and distance from the stream channel. Distance from channel is expressed as a proportion of tree height. From FEMAT (1993).



LARGE WOODY DEBRIS

Large woody debris is a critical component of riparian and aquatic habitat in forests of the Pacific Northwest. It was not until the 1970s that researchers began to understand the structural and functional role woody debris plays in forest ecosystems of the region (Gregory and Bisson 1997). In wetland and riverine environments, woody debris traps and stores sediment and organic material, stabilizes streambeds and banks, dissipates stream energy, creates pool habitat, provides hiding cover and serves as a food source for aquatic insects (Bisson et al. 1987). In riparian areas, woody debris creates habitat for a wide range of terrestrial species and is an important component in the cycling of nutrients (Harmon et al. 1986). Because woody debris is a key element in the creation and maintenance of in-stream and riparian habitat, the recruitment and retention of wood in these areas was a primary consideration in developing the width and leave tree requirements for RMZs.

Recent research into woody debris recruitment has helped shape the recruitment-distance relationship illustrated in Figure 4. 8. In a study of first- through third-order streams in western Oregon and Washington, McDade et al. (1990) found that 70 percent of in-stream debris pieces recruited from mature conifer forests, and 90 percent of debris from mature hardwood forests, originated from within 15 meters (50 feet) of the stream bank (Figure 4.9). Source distances of 20 meters (66 feet) and 30 meters (100 feet) corresponded with 80 percent and 90 percent total recruitment, respectively, for debris from mature conifer forests (McDade et al. 1990). In a similar study, Murphy and Koski (1989) found that 90 percent of in-stream debris recruited from old-growth forests in southeast Alaska had source distances of 50 feet or less from the stream edge (Figure 4.10). McKinley (1997) found that 95 percent of woody debris originated from within 15 meters (50 feet) of the stream bank for small streams bordered by second-growth forests in northwest Washington (Figure 4.11).

Figure 4.9 Distribution of source distances from origin to stream bank for conifer LWD in old-growth stands and hardwood and conifer LWD in mature stands (as based on field observations) and for trees 40 meters and 50 meters tall (as calculated from a trigonometric model of debris delivery). From McDade et al. (1990).

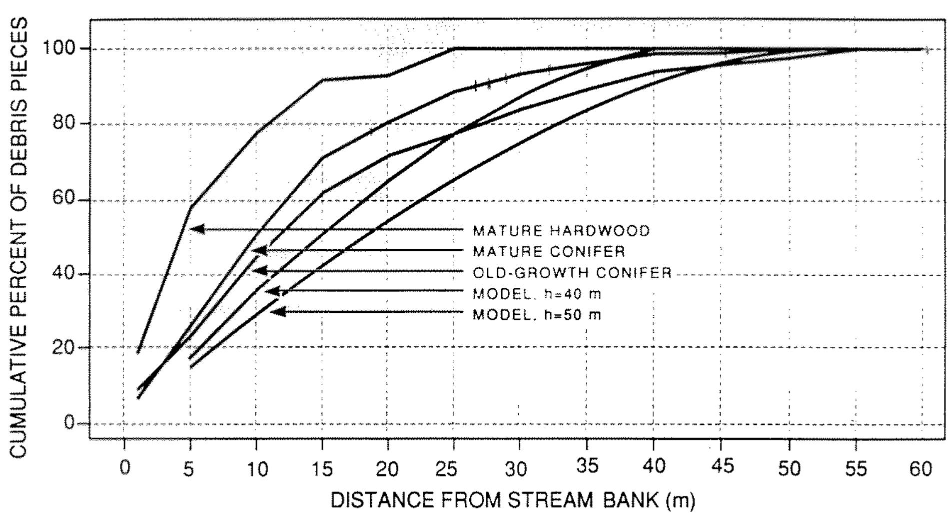


Figure 4.10 Distances from the stream to sources of LWD. Histogram bars show the percentage of all identified LWD sources (n = 861) at given distances from the stream for 32 stream reaches in old-growth forest in southeast Alaska. From Murphy and Koski (1989).

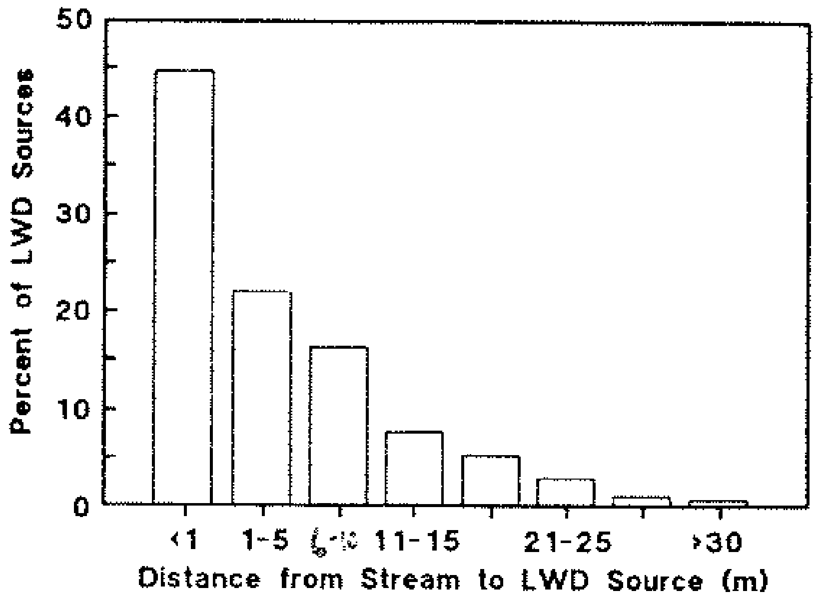
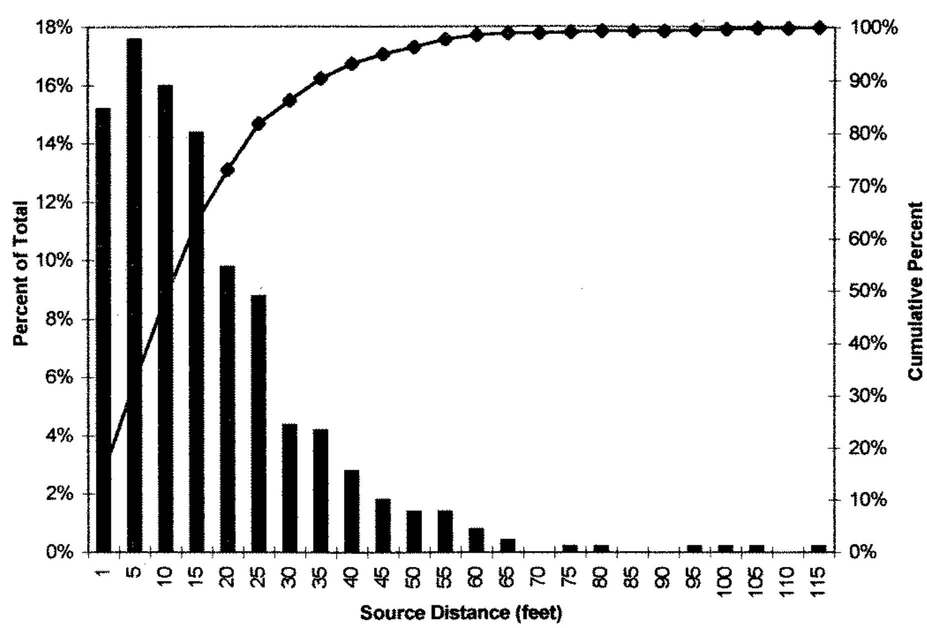


Figure 4.11 Source distance distribution from origin to bankfull edge for LWD originating from second-growth forests in northwest Washington (n = 501). Bar represents percent of debris pieces in each source distance class (≤1 foot, 2-5 feet, 6-10 feet, etc.); line represents cumulative percent of debris pieces. From McKinley (1997).



Variations in the source distance relationships in the aforementioned studies can be largely attributed to differences in tree height and recruitment process. Younger second-growth forests or forests growing on less productive sites have shorter trees as compared to older forests or forests growing on highly productive sites. Riparian forests with shorter trees supply a larger proportion of the total in-stream wood load from a given source distance relative to riparian forests with taller trees (Robison and Beschta 1990a; Van Sickle and Gregory 1990). The relative importance of recruitment processes such as bank erosion, chronic mortality and mass wasting also affects the shape of source distance relationships (Benda et al. in press). Source distance curves for channels dominated by bank erosion tend to be shifted upward and to the left relative to those for channels where wood is recruited via chronic mortality or mass wasting.

Expressing wood recruitment as a proportion of tree height rather than distance from stream enables source distance relationships to be compared across sites and between studies. McDade et al. (1990) reported average tree heights for mature and old-growth conifer forests of 48 meters (157 feet) and 57.6 meters (189 feet), respectively. Using these values to express wood recruitment as a function of tree height indicates that more than 80 percent of woody debris in mature and old-growth conifer forests is recruited from within ½ tree height while over 90 percent originates from within ¾ tree height. Citing Murphy and Koski (1989), Spence et al. (1996), note that 99 percent of LWD in streams of southeast Alaska was recruited within approximately ¾ tree height. The generalized wood recruitment curve presented in FEMAT (1993) and illustrated in Figure 4.9 suggests that at least 80 percent of woody debris originates from within ¾ tree height.

Nearly all the research cited above was available at the time of FFR development during 1997-98. The FFR authors relied heavily on this information when developing recommendations to meet Federal ESA and CWA requirements. FFR recommendations—later adopted as forest practices rules and now included as protection measures in the FPHCP—are intended to provide sufficient LWD recruitment to create, restore and maintain riparian and aquatic habitat for species covered under the plan. Protection measures include variable-width RMZs adjacent to Type S and Type F waters and 50-foot Type Np RMZs. Wood inputs from these RMZs will be supplemented by other protection measures including channel migration zones, sensitive sites and unstable slopes. Such “standard” RMZs will be applied to nearly all covered lands; a relatively small proportion of Type S and Type F waters will experience lower wood recruitment levels associated with the exempt 20-acre parcel RMZ rules. The relationship between the research described above and RMZ requirements is described below.

Type S and Type F Waters

To account for differences in wood recruitment across sites due to natural variations in tree height, RMZ width is based on site productivity for Type S and Type F waters. Forestland is separated into various productivity classes according to the average total height of dominant and co-dominant trees. The average total height that has been or will be attained at a given age is known as the “site index” (McArdle et al. 1961). Site indices are grouped into five broad site classes: site I, site II, site III, site IV and site V. Table 4.14 lists site classes and corresponding 100-year site indices for Douglas-fir in western Washington and ponderosa pine in eastern Washington. Under the FPHCP, RMZ widths for Type S and Type F waters in western Washington equal the median Douglas-fir 100-year site index for each site class (Table 4.14). RMZ widths in eastern Washington equal or exceed the ponderosa pine 100-year site index (Table 4.15). The different site class categories for western and eastern Washington reflect regional differences in site productivity and associated tree growth.

Table 4.14 Site classes for western and eastern Washington and corresponding site indices for Douglas-fir. Western Washington site indices from McArdle et al. (1961); eastern Washington site indices from Meyer (1961).

Site Class	Western Washington 100-year Douglas-fir Site Index (feet)	Eastern Washington 100-year Ponderosa Pine Site Index (feet)
I	190-210	120+
II	160-180	100-110
III	130-150	90
IV	100-120	70-80
V	≤90	60

Table 4.15 Riparian management zone widths for western and eastern Washington by site class. Western Washington RMZ widths and eastern Washington site class I and site class II RMZ widths equal the median 100-year Douglas-fir site index for the corresponding site class.

Site Class	Western Washington RMZ Width (feet)	Eastern Washington RMZ Width (feet)
I	200	130
II	170	110
III	140	90 or 100*
IV	110	75 or 100*
V	90	75 or 100*

* Dependent on bankfull width

The 100-year site indices for Douglas-fir and ponderosa pine, and corresponding RMZ widths for Type S and Type F waters, are approximately equal to ¾ site potential tree height. That is, the average height of Douglas-fir and ponderosa pine at 100 years of age represents about 75 percent of their maximum height growth (McArdle et al. 1961; Meyer 1961). As stated earlier, data from western Washington and Oregon indicate that more than 90 percent of in-stream woody debris is recruited from a distance equal to 75 percent of the height of mature and old-growth conifers (McDade et al. 1990). Although data are not available for riparian forests of Eastern Washington, it is assumed a similar relationship exists. Therefore, RMZs for Type S and Type F waters encompass the area from which the vast majority of woody debris will be recruited—over the short-term and into the future as riparian forests mature.

Within RMZs for Type S and Type F waters, the core and inner zones make up the primary source area for wood recruitment. Together, the core and inner zones of RMZs in western Washington are managed to achieve basal areas representative of a mature (i.e., 140-year-old) riparian forest. In eastern Washington, RMZ management is designed to maintain riparian stand conditions within a presumed natural range of variability by establishing minimum stand density requirements for different timber habitat types. Because of these density requirements, wood recruitment from RMZ core and inner zones should mimic recruitment under natural conditions.

The combined width of the core and inner zones is influenced by a number of factors, and it ranges from 60 feet to 150 feet in western Washington and 75 feet to 100 feet in eastern Washington. Depending on site class, this represents between ½ and ⅔ site potential tree height (McArdle et al. 1961; Meyer 1961) and the area from which 80 percent to 90 percent of woody debris is derived in mature and old-growth conifer forests (McDade et al. 1990).

The outer zone also serves as a woody debris source area, though the likelihood of debris recruitment from this zone is low compared to areas closer to the water (VanSickle and Gregory 1990; Robison and Beschta 1990b; Bragg et al. 2000). Harvest activities in the outer zone reduce the number and volume of debris pieces available for recruitment, further decreasing the probability of recruitment. Large variations in the number and distribution of trees retained in the outer zone of RMZs throughout the state makes estimating debris recruitment from this area difficult. In areas where all outer zone trees are retained, the outer zone may contribute ten percent or more of the woody debris load expected from mature conifer forests (McDade et al. 1990). Outer zone contributions of woody debris are likely to be lower where harvest activities reduce stand density to forest practices minimums.

Large wood recruitment from RMZs for Type S and Type F waters will be complemented by debris inputs from other protection measures, particularly channel migration zones and unstable slopes. However, the level of additional wood recruitment from these areas cannot be precisely quantified due to the highly variable nature of the size and spatial configuration of these features.

Type Np Waters

Large woody debris inputs to Type Np waters originate from RMZs that are 50 feet wide. Between 50 percent and 100 percent of the Type Np water length must be protected by an RMZ; the exact percentage is determined by location within the state (i.e., western Washington vs. eastern Washington) and, in eastern Washington, by harvest strategy (i.e., partial cut vs. clearcut). In many areas of the state, protection measures for sensitive sites and unstable slopes complement Type Np RMZ protection, resulting in tree retention levels that exceed minimum RMZ requirements. However, given the large degree of variability in the spatial distribution of sensitive sites and unstable slopes throughout the state, it is difficult to quantify the additional recruitment that results from these features.

Given the many factors that affect tree retention adjacent to Type Np waters, wood recruitment to these streams is likely to vary considerably from site to site. The results of McDade et al. (1990) indicate that 70 percent of in-stream woody debris from mature conifer forests has source distances of 50 feet or less. Since at least 50 percent—and as much as 100 percent—of the Type Np water length will receive RMZs that are 50 feet wide, between 35 percent and 70 percent of the potential LWD supply within each Type Np network will be retained in streamside buffers. Precise recruitment levels will vary according to the proportion of the Type Np network protected. The proportion of potential debris recruitment is likely to be higher in areas that have a high frequency of unstable slopes and/or sensitive sites, because additional streamside trees will be retained to protect these features.

The Adaptive Management program is developing research and monitoring projects that will assess the effectiveness of Type Np buffers in meeting resource objectives (CMER Work Plan, Appendix H).

Exempt 20-Acre Parcels

Riparian management zones along Type S and Type F waters on exempt 20-acre parcels will likely provide less woody debris relative to RMZs on non-exempt parcels. Implementing the RMZ rules for exempt 20-acre parcels in western Washington results in the retention of RMZs that range in width from 29 feet to 86 feet along Type F waters, and 86 feet to 115 feet along Type S waters where Shoreline Management Act requirements do not apply. Where SMA requirements apply, a "Shoreline Management Zone" (SMZ) 200 feet in width must be retained where limited harvest is allowed (See chapter 90.58 RCW). In eastern Washington, exempt 20-acre parcel RMZs range from 35 feet to 58 feet for Type S and Type F waters where the adjacent harvest unit is partial cut. Where harvest units are clearcut, exempt 20-acre parcel RMZs must average 58 feet in width, with a minimum width of 35 feet and a maximum width of 345 feet. SMZs 200 feet in width must be retained where SMZ requirements apply along Type S waters (See chapter 90.58 RCW).

While harvesting to established minimums is allowed if shade requirements can be met, data from the DNR Forest Practices Division indicates harvest within the RMZ is uncommon. In a statewide sample of 37 RMZs established on exempt 20-acre parcels during 2002/2003, 32 (or 86 percent) were treated as no-harvest areas and only two had 15 percent or more of the trees removed from the RMZ (Table 2, Appendix J). Further analysis of an additional, 39 randomly selected FPAs submitted to the Department of Natural Resources during 2004/2005 discovered the same trend. That is, little if any harvest has been occurring within RMZs on exempt 20-acre parcels. In 2004/2005, 90 percent of the FPAs reviewed were treated as no-harvest areas RMZs. Only one had more than 15 percent harvest RMZ (Table 3, Appendix J). This RMZ no-harvest trend is likely the result of: 1) existing riparian conditions not meeting minimum shade requirements, or 2) landowners electing to forego the required shade analysis, and therefore not harvesting within the RMZs.

Depending on water type and bankfull width, RMZs on exempt 20-acre parcels will provide between 45 percent and 95 percent of the potential wood recruitment from mature conifer forests (McDade et al. 1990). Recruitment levels for small Type F waters will be at the lower end of the range while wood inputs for large Type F and Type S waters will be near the upper end.

Shade provided by exempt 20-acre parcel RMZs varies with RMZ width and the species, age, and density of riparian vegetation. Retention of RMZs that are 29 to 115 feet (9 to 35 meters) wide will likely provide between 25 and 85 percent shade or canopy cover. This conclusion is based on data from Brazier and Brown (1973) and Steinblums et al. (1984) (Figure 4.12) and is further supported by the DNR data related to exempt 20-acre parcel RMZs that indicates the vast majority of RMZs are left unharvested. Wider RMZs likely fall into the upper end of this range while narrower RMZs typically fall into the lower end. Generally, narrow RMZs are typically associated with smaller channels where shade requirements can be more easily met, while wide RMZs are typically associated with larger channels where shade requirements are more difficult to meet.

As noted earlier, forest practices rules allow for harvest within RMZs only if existing shade levels exceed minimum requirements. Only trees that provide “surplus” shade can be removed. In cases where existing shade does not meet minimum requirements, no RMZ harvest can occur. Data presented earlier indicate a majority of exempt 20-acre parcel RMZs is left unharvested, primarily due to shade rule requirements. Therefore, even though one set of forest practices rules allow for harvesting within RMZs (WAC 222-30-023), in most cases shade requirements (WAC 222-30-040) eliminate harvest opportunities.

The small area encompassed by exempt 20-acre parcels relative to the total area of lands covered under the FPHCP somewhat mitigates the site-scale effects of reduced wood recruitment from exempt parcels. An assessment of exempt 20-acre parcels by EIS planning region showed that the proportion of stream length on exempt parcels relative to total stream length was less than one percent in eight of ten planning regions (Table 4.16). In the remaining two regions, exempt parcel stream length comprised 1.2 percent (Lower Columbia region) and 5.0 percent (West Puget Sound region) of the total stream length. Because the analysis was limited to tabular tax parcel data when identifying exempt 20-acre parcels, the number of eligible parcels is likely underestimated; however, the number of unidentified parcels is unknown.

Table 4.16 Exempt 20-acre parcel stream length and total stream length by EIS planning region. Data reflects that portion of each EIS planning region where digital, geographic information system-based county parcel data was available. The Columbia and Snake EIS planning regions were considered non-forested. From Rogers (2003).

EIS Planning Region	Exempt Stream Length (miles)	Total Stream Length (miles)	Percent of Total Stream Length that Is Exempt
Upper Columbia (upstream of Grand Coulee)	28.8	4,106.8	0.7
North Puget Sound	95.0	10,813.5	0.9
Upper Columbia (downstream of Grand Coulee)	72.9	12,623.7	0.6
Islands	1.1	163.0	0.7
Olympic Coast	26.8	6,631.7	0.4
West Puget Sound	124.8	2,481.8	5.0
Columbia	-	1,460.1	-
South Puget Sound	36.7	5,835.0	0.6
Snake	-	1,160.4	-
Middle Columbia	8.2	11,633.8	0.1
Southwest	105.9	15,411.9	0.7
Lower Columbia	170.4	13,716.1	1.2

Shade

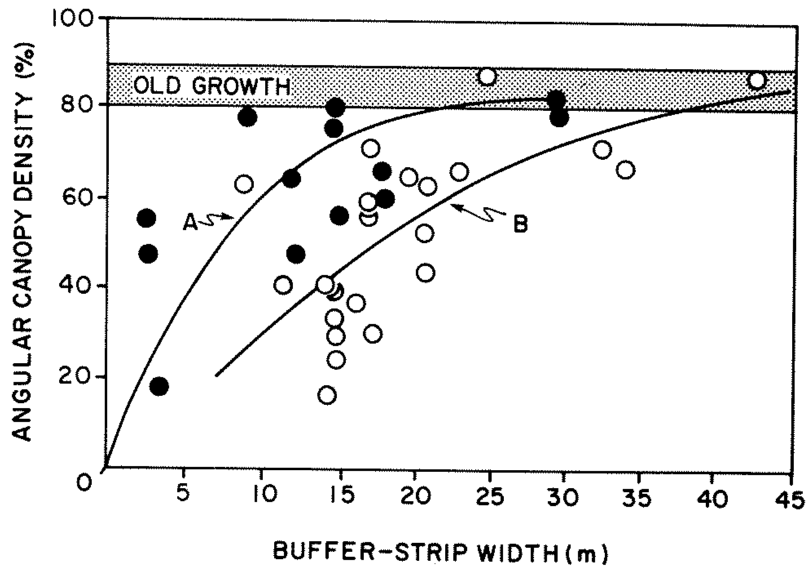
Riparian forests and the shade they provide are key factors affecting the thermal regime of aquatic ecosystems (Brown 1989). Streamside vegetation reduces incoming solar radiation—thereby limiting stream heating—particularly during the summer months. In the winter, riparian canopy cover may help moderate water temperatures by inhibiting energy losses through evaporation, convection and long-wave radiation. Reductions in streamside shade may alter the thermal regime of a stream, causing undesirable changes in primary production and fish metabolism, development and behavior (Beschta et al. 1987).

Research into the effects of riparian timber harvest on stream temperatures during the 1960s and 1970s provided impetus for requiring buffer strips on commercial forestlands in the Pacific Northwest (Brown 1978). While early studies established the link between streamside vegetation loss and water temperature increases, later studies focused on the relationship between riparian stand conditions and stream shading. The use of angular canopy density (ACD) became a popular way of measuring stream shading during this period. ACD is a horizontal projection of the forest canopy measured at the angle at which direct-beam solar radiation passes through the canopy. Although some riparian forests may attain an ACD of 100 percent, research shows the ACD of old-growth stands in western Oregon generally ranges from 80 to 90 percent (Brazier and Brown 1973; Steinblums et al. 1984). Erman et al. (1977), as cited in Beschta et al. (1987), found that ACDs averaged 75 percent along undisturbed streams in northern California.

The degree of shade provided by streamside buffers varies with the species, age and density of riparian vegetation. Buffer strip width is also important, but by itself may not be a good predictor of stream shading (Sullivan et al. 1990). Studies of the relationship between buffer strip width and ACD show a high degree of variability, particularly for buffers less than about 75 feet in width (Brazier and Brown 1973; Steinblums et al. 1984) (Figure 4.12). Nonetheless, ACD is positively correlated with buffer width: as buffer width increases, the level of riparian shade also increases. In the Oregon Coast Range, Brazier and Brown (1973) found buffers approximately 70 feet wide had ACDs similar to that of old-growth stands (Figure 4.12). Steinblums et al. (1984) found that buffers approximately 120 feet wide in the Oregon Cascade Range were necessary to achieve ACDs representative of old-growth (Figure 4.12).

The FPHCP protects shade along Type S and Type F waters by requiring the retention of shade-providing trees within 75 feet of the bankfull width or channel migration zone. The number of leave trees required varies with location. In the bull trout overlay, all shade-providing trees within 75 feet of the bankfull width or channel migration zone must be retained. Outside the BTO, no tree within 75 feet of the bankfull channel or channel migration zone may be harvested if it provides shade necessary to meet minimum shade levels. Minimum shade levels for areas outside the BTO are based on state water quality standards and vary with waterbody class (i.e., Ecology designation of Class AA or Class A) and elevation.

Figure 4.12 Relationship of angular canopy density to buffer strip width in western Oregon. Data for (A) from Brazier and Brown (1973); data for (B) from Steinblums et al. (1984). From Beschta et al. (1987).



RMZ rules also protect shade for Type S and Type F waters. RMZ rules require trees to be retained out to a distance of approximately ¾ site potential tree height. Therefore, streamside buffers along Type S and Type F waters will include all trees necessary to meet shade requirements as well as additional trees needed to meet RMZ standards. The combined shade and RMZ requirements should provide shade levels along Type S and Type F waters at or very near those found in old-growth stands (i.e., 75 to 90 percent ACD) based on research into riparian stand conditions and stream shading (Beschta et al. 1987).

In non-fish-bearing waters, shade protection focuses on perennial (Type Np) waters and associated sensitive sites. Shade protection for Type Np waters varies with location in the state (eastern Washington vs. western Washington), and in eastern Washington, it also varies with harvest strategy (clearcut vs. partial-cut). In western Washington, landowners must retain RMZs that are 50 feet wide along at least 50 percent of the Type Np water length. No harvesting is allowed within these RMZs. In eastern Washington, Type Np protection varies according to the harvest strategy implemented within 50 feet of the BFW. Where the partial cut strategy is implemented, 100 percent of the Type Np length is protected. Where the clearcut strategy is implemented, at least 70 percent of the Type Np length is protected. Buffering of Type Np-associated sensitive sites generally includes the establishment of a no-harvest circular or "patch" buffer around the sensitive site that measures 56 feet in radius. In many areas of the state, protection of stream-adjacent unstable slopes will complement Type Np and sensitive site protection, thus increasing the overall length of buffered waters.

The lower shade retention levels for Type Np waters compared to Type S and Type F waters reflect reduced risk of temperature impacts. Potential Type Np temperature effects include direct effects on water quality and amphibians within Type Np waters and indirect effects on water quality and fish in downstream Type S and Type F waters.

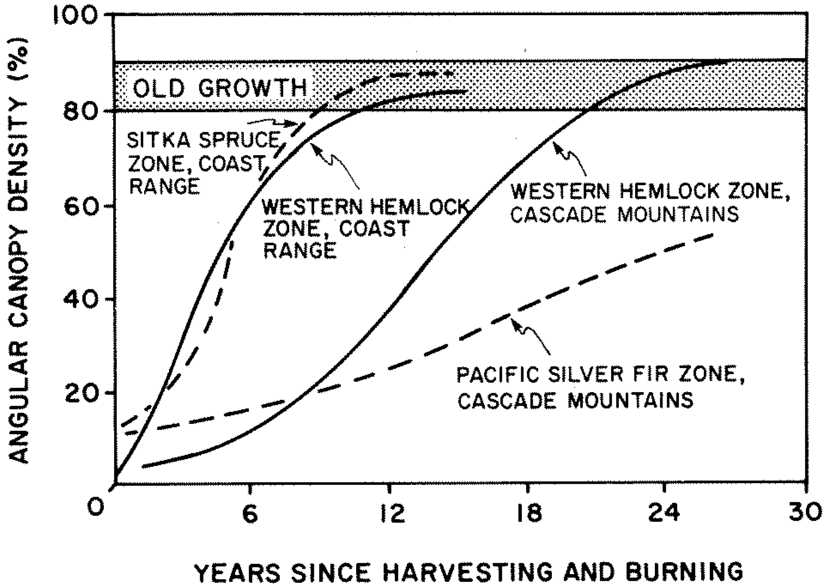
Direct temperature effects in Type Np waters are mitigated through the retention of RMZs and sensitive site buffers. These buffers, which range from 50 feet to 56 feet in width, are expected to provide between 50 percent and 75 percent ACD based on data from western Oregon (Brazier and Brown 1973; Steinblums et al. 1984). Given that a majority of shade-providing trees will be retained in these areas, temperature increases within buffered reaches are expected to be small.

Research into the effects of timber harvest along non-fish-bearing streams suggests temperature increases within Type Np waters are not likely to accumulate in a downstream direction. In a western Washington study, Caldwell et al. (1991) found that temperatures in harvested stream reaches quickly equilibrated once the stream entered a forested downstream (i.e., shaded) reach. In all cases, no measurable temperature effect from the harvested reach was detected within 500 feet of the harvest unit edge. In two similar studies, researchers found temperatures in western Oregon streams either decreased or remained unchanged downstream from clearcuts (Robison et al. 1999a; Dent and Walsh 1997). In cases where temperatures decreased, maximum cooling occurred within the first 600 feet downstream from harvest units (Robison et al. 1999a). Decreases in water temperature in these studies were thought to be attributable to groundwater exchange and mixing.

Under the FPHCP, no-harvest RMZs 50 feet in width must be retain along the first 500 feet of Type Np waters above the confluence with a Type S or Type F water. This requirement along with minimum buffer length requirements for Type Np waters should minimize downstream temperature effects that might negatively impact aquatic resources in Type S and Type F waters.

In cases where temperature increases in Type Np waters occur as a result of timber harvest, recovery to pre-harvest levels is likely to be rapid. In western Oregon, Summers (1983) studied small streams that had been clearcut and burned at various times in the past to assess the recovery of shade. On average, 50 percent of a stream was shaded within 5 years of harvesting and burning in the Coast Range and within 15 years at lower elevations in the Cascade Range (Figure 4.13). Caldwell et al. (1991) made similar observations and concluded that shade reduction along small clearcut streams in western Washington would recover within five years. Since nearly all Type Np streams are small (i.e., <20 feet bankfull width), shade reductions and any associated temperature increases are not likely to persist for long periods. Much of the early recovery in shade levels is attributable to the rapid growth of understory vegetation, which can almost completely shade small streams within a few years after harvest (Summers 1983).

Figure 4.13. Relationship of angular canopy density and stand age for vegetation zones in western Oregon (Summers 1983).
From Beschta et al. 1987.



4d-1.2 Equipment Use – Erosion, Sedimentation and Hydrologic Flowpaths

Protection measures in the FPHCP minimize the risk of accelerated surface erosion and modified hydrology by focusing on log yarding activities and other equipment use in and around typed waters and wetlands.

Forest soils of the Pacific Northwest have very high infiltration rates due to their high porosity. Porosities ranging from 50 to 75 percent of soil volume and infiltration rates of over 200 inches per hour in the upper soil horizons are common in some soil types (Dyrness 1969). Because of these conditions, overland flow and associated surface erosion processes are not common on undisturbed forest soils (Brown 1973).

Forest practices activities that alter forest soil structure through compaction, rutting or removal of the organic layer can modify hydrologic flowpaths, increasing the chances for overland flow and surface erosion. Log yarding activities, the use of ground-based equipment and cable systems and the construction of skid trails have the greatest potential for causing soil disturbance and sediment delivery (Rashin et al. 1999).

The FPHCP includes multiple protection measures to limit the direct physical disturbance of stream channel beds and banks and wetlands. In-stream and wetland protection measures include:

- no removal of woody material within the bankfull width of typed waters,
- no ground-based equipment use within the bankfull width of Type S and Type F waters unless approved by WDFW under an HPA, and
- limited ground-based equipment use in wetlands to low-impact harvest systems during periods of low soil moisture or frozen soil conditions.

Streambank protection measures require that operators avoid disturbing stumps, root systems and logs embedded in the streambank, as well as brush and other understory vegetation rooted in the streambank.

Accelerated erosion in near-stream and wetland areas is minimized in a variety of ways under the FPHCP. No harvest or salvage is permitted in CMZs and RMZ core zones along Type S and Type F waters. As a result, no harvest can occur within 50 feet of Type S and Type F waters in western Washington and within 30 feet of those typed waters in eastern Washington. Type Np riparian management zones are also 50 feet wide, but are not applied to the entire Type Np network. According to FEMAT (1993), trees within one-third tree height from the channel provide rooting strength important for maintaining streambank integrity. Restricting timber harvest within 30 to 50 feet of stream channels meets this standard and ensures adequate protection of streambanks along Type S and Type F waters and buffered portions of Type Np waters. The morphology of Type Np waters will largely determine the extent of bank erosion within unbuffered stream reaches. Smaller streams with low stream power or channels dominated by bedrock or boulder substrates are less likely to be affected by a loss of root strength as compared to larger alluvial channels that may be more prone to bank erosion.

Type Np and Type Ns waters receive protection from 30-foot equipment limitation zones, where equipment use is limited and disturbed soils must be treated to prevent sediment delivery. Establishment of ELZs is consistent with recommendations found in Rashin et al. (1999). After evaluating the effectiveness of Washington's previous forest practices rules in controlling sediment-related water quality impacts, the report's authors recommended that buffers "…of at least ten meters should be maintained on all streams in order to avoid chronic sediment delivery and direct physical disturbance of streams from harvest-related erosion." In a similar study, measurable increases in fine sediment levels were not observed in streams where clearcut harvesting and skidding occurred in adjacent riparian areas (Kreutzweiser and Capell 2001). The authors attributed the lack of sediment delivery to the careful use of equipment in streamside areas during harvest and yarding operations.

The FPHCP also includes restrictions on the type, timing and location of equipment use in and near waters, wetlands and riparian and wetland management zones. Requirements include the use of low-impact harvest systems during wet soil conditions, leading-end log suspension during yarding operations, minimizing damage to residual vegetation, limiting the number and frequency of yarding corridors and decommissioning of skid trails upon completion of operations. These requirements are all intended to protect the structure and function of forest soils, thereby minimizing the risk of accelerated erosion and sediment delivery associated with forest practices activities.

4d-1.3 Near-Stream Conservation Easements and Land and Timber Acquisitions

Nearly all protection measures that make up the FPHCP reflect mandatory requirements of the Act and rules. Two exceptions include the Forestry Riparian Easement Program and the Riparian Open Space Program, both of which are voluntary measures designed to protect the most ecologically important forestland parcels on lands covered under the FPHCP.

The Washington State Legislature established FREP and ROSP to provide for the long-term conservation of sensitive habitats and their associated species. Through the FREP, DNR obtains 50-year conservation easements on qualifying timber in riparian and other sensitive areas from small forest landowners. Through the ROSP, DNR acquires a fee interest in—or permanent conservation easement on—lands within CMZs associated with unconfined avulsing streams or rivers.

While both programs target sensitive habitats likely to be used by covered species, FREP funding is reserved for small forest landowners, who are more likely to experience a disproportionate economic impact from the forest practices rules. Concern over small landowners' willingness or ability to keep their lands in forestry prompted the legislature to create the FREP in an effort to decrease the likelihood of small forest landholdings being converted to non-forestry uses (chapter 222-21 WAC). Conversion of forestland to non-forest uses often results in greater impacts to the habitats of aquatic and riparian-dependent species.

FREP easements are acquired for "qualifying timber" or trees that a small forest landowner is required to leave unharvested under the forest practices rules consistent with FFR. Qualifying timber most often includes trees in RMZs. The FREP ensures important ecological processes will continue to function unimpeded during the next 50 years to create habitat for species covered under the FPHCP.

Through the ROSP, DNR acquires what might be considered the most ecologically sensitive habitats on non-federal and non-tribal forestlands in Washington. CMZs adjacent to unconfined, avulsing streams or rivers are dynamic areas where frequent, rapid shifts in channel location create complex habitats for a variety of fish species. These CMZs are source areas for LWD that serves as the primary structural element of riverine habitats. Large wood accumulates in jams that create pools, store sediment, form off-channel habitats and influence the structure and composition of riparian forests (Featherston et al. 1995; Collins et al. 2002). CMZs associated with unconfined, avulsing channels serve as habitat considered critical for the continued survival and recovery of some salmon species such as coho (*Oncorhynchus kisutch*) (Sharma and Hilborn 2001).

The FREP and ROSP support the long-term conservation of habitat for covered species through the acquisition of riparian forestlands and other ecologically sensitive areas. These voluntary programs complement mandatory requirements in the FPHCP by protecting forest parcels that might otherwise be converted to non-forestry uses while providing economic benefits for forest landowners.

4d-2 Rationale for the Upland Conservation Strategy

4d-2.1 Unstable Slopes and Landforms

Mass wasting is the dominant form of erosion on forestlands throughout the Pacific Northwest (Swanson et al. 1987). Forest practices such as timber harvesting and road construction can accelerate the rate of mass wasting and increase sediment delivery to surface waters and wetlands (Megahan 1981; Swanson and Dyrness 1975; Robison et al. 1999b; Millard et al. 2002). High sediment levels can have detrimental effects on aquatic organisms by reducing the quantity and quality of available habitat (Gregory et al. 1987).

Forest practices rules use an administrative review process to protect unstable slopes on lands covered under the FPHCP. The process involves screening and identifying unstable slopes evaluation of proposed activities by a qualified expert, review by DNR staff and affected cooperators and guidance for issuing a decision under the SEPA.

Many parts of the administrative review process represent new and improved ways of addressing unstable slopes issues in Washington. These improvements have resulted from the collective experience of regulators, forest landowners, affected tribes and other interested parties working collaboratively to address unstable slopes issues since the Timber/Fish/Wildlife Agreement of 1987. While scientific research has broadened the understanding of forestry effects on mass wasting, much has been learned through interdisciplinary team reviews of forest practices applications and watershed analysis.

The numerous landslide inventories conducted as part of watershed analysis helped identify regional and statewide trends in mass wasting processes during development of the FFR. The inventories were used to identify common landslide-triggering mechanisms associated with forest practices activities. Recurring triggers such as unstable road and water crossing fills, improper road drainage, lack of road maintenance and clearcut harvesting on unstable slopes are now addressed as part of the forest practices rules. Landslide inventories were used to identify slope and landform types with high landslide frequencies that were also sensitive to forest practices effects. These high-risk unstable slopes were incorporated into the forest practices rules, and proposed activities on these slopes are now subject to review under the SEPA.

The Forest Practices program recognizes that unstable slopes must be detected before they can be protected. DNR's use and development of improved screening tools, combined with unstable slopes training for individuals involved in harvest unit layout and forest practices application review, help ensure that areas prone to mass wasting are properly identified before operations commence.

Once unstable slopes are identified, individuals with expertise in mass wasting processes evaluate and review forest practices proposals. A technical specialist who meets the forest practices definition of "qualified expert" and who is also a licensed geologist in Washington must evaluate activities proposed on unstable slopes. A written report prepared by the qualified expert is submitted with the forest practices application as supplemental information, which DNR considers when evaluating the proposal. Other technical specialists from DNR, cooperating agencies, affected tribes and interested parties also serve as sources of information for DNR regulatory staff. Many of these individuals are also licensed, qualified experts with local knowledge of landslide processes and affected resources. Broad review of forest practices proposals by individuals with forestry and mass wasting experience increases the probability that unstable slopes will be detected, thus reducing the likelihood for adverse impacts.

Over the long term, the unstable slopes administrative review process will be evaluated through adaptive management. The CMER Committee is developing approaches for monitoring unstable slopes at three spatial scales: 1) the site scale (effectiveness or "best management practice" monitoring), 2) the statewide scale (extensive or "status and trends" monitoring), and 3) the watershed scale (intensive or "cumulative effects" monitoring). Critical questions that will be addressed include:

- Are unstable slopes being correctly and uniformly identified and evaluated for potential hazard?
- What is the natural (i.e., background) rate of landsliding on managed forestlands?
- Are the forest practices rules concerning unstable slopes reducing the rate of harvest-related landsliding on lands covered under the FPHCP?

More information on unstable slopes monitoring can be found in the CMER Work Plan (Appendix H).

4d-2.2 Forest Roads

Roads are the largest management-related sediment source on forestlands in the Pacific Northwest (Swanson et al. 1987). Roads are subject to surface erosion processes—including sheet, rill and gully erosion—and in steeper terrain they serve as initiation sites for mass wasting processes, including debris avalanches, flows and torrents (Sidle and Pearce 1985). Roads may also affect hydrology by altering flowpaths and changing the timing and magnitude of streamflows (Wemple et al. 1996). Water crossing structures can create barriers to fish passage by increasing water velocities and altering the longitudinal channel profile (Baker and Votapka 1990).

The forest practices rules are designed to prevent, minimize and/or mitigate road-related effects on sediment delivery, hydrology and fish passage. This is accomplished by screening forest practices applications and notifications for unstable slopes and by implementing best management practices during road construction, maintenance and abandonment operations. BMPs that address sediment-related impacts include constructing stable road prisms and water crossing structures, disconnecting road drainage from stream networks, avoiding the construction of stream-adjacent parallel roads, abandoning existing stream-adjacent parallel roads, limiting the construction of duplicative roads and restricting log haul during wet periods (see WAC 222-24-010(3)). Hydrology-related impacts are minimized through the implementation of BMPs that maintain and restore natural flowpaths and limit road construction in wetlands. Fish passage barriers are corrected as part of the RMAP process for both large and small forest landowners.

Most road-related forest practices rules include outcome-based standards for achieving resource objectives. Outcome-based standards differ from prescriptive standards in that they are generally qualitative (e.g., “disconnect road drainage from stream network”) as opposed to quantitative (e.g., “no harvest within 50 feet of bankfull width”). The Board Manual includes BMPs to achieve many of the standards. The use of outcome-based standards often means that more than one solution exists for a given problem; thus, a particular road standard can be met through a variety of BMPs. For example, disconnecting road drainage from the stream network can be achieved by: 1) outsloping the road, or 2) insloping the road and installing ditch relief structures at critical locations. Either approach may ensure the standard is met. However, the conditions of the site will likely determine which approach is most appropriate. Most outcome-based road standards provide some measure of operational flexibility so that road practices can be tailored to the site while meeting the resource protection objective(s).

Forest practices rules governing road construction, maintenance and abandonment and fish passage will be evaluated through adaptive management. The CMER Committee is developing approaches for monitoring forest roads at three spatial scales: 1) the site scale (effectiveness or “best management practice” monitoring), 2) the statewide scale (extensive or “status and trends” monitoring), and 3) the watershed scale (intensive or “cumulative effects” monitoring).

Critical questions that will be addressed through adaptive management include:

- Are forest practices rules for forest roads effective in meeting performance targets for sediment and water?
- Has implementation of the RMAP program reduced road sediment and runoff and the length of stream-adjacent parallel roads statewide?
- Have the correct performance targets for sediment delivery and connectivity been identified?
- Does the RMAP program correctly identify the stream crossing structures that impede fish passage?
- What is the current state of fish passage on a regional scale and how are conditions changing over time?

More information on roads monitoring can be found in the CMER Work Plan (Appendix H).

4d-2.3 Hydrologic Changes

Relative to other watershed processes, changes in peak flow hydrology resulting from forest practices are poorly understood. Research into the effects of forest practices on peak flows in the Pacific Northwest has produced varying results. Some studies have documented increased peak flows following timber harvest (Harr et al. 1975; Ziemer 1981; Heatherington 1987), while others have observed decreased peak flows (Rothacher 1973; Cheng et al. 1975) or no change (Harr et al. 1975; Wright et al. 1990).

In Washington, it is commonly thought that the greatest potential for forest practices effects on peak flows is through the influence of clearcut timber harvest on snow accumulation and melt rates (DNR 1997). In general, harvested openings have greater snow accumulations and higher wind speeds than adjacent forested areas, leading to faster melt rates and more water available for runoff (Coffin and Harr 1992). How this increased water delivery to the soil is routed to the stream network ultimately determines the effect on peak flows. The physical characteristics of a watershed—including the topography, soils, geology and vegetation—all influence water routing. Therefore, peak flow responses to timber harvesting are likely to be watershed-specific and may vary widely within and among different regions of the state.

Forest practices rules address timber harvest effects on rain-on-snow peak flows directly through watershed analysis and the rain-on-snow rule, and indirectly through the green-up rule. Each of these regulatory mechanisms includes provisions that reduce the potential for harvest-related increases in rain-on-snow peak flows.

Watershed analysis addresses peak flow increases through the development of watershed-specific management prescriptions that typically restrict clearcut timber harvesting by requiring the retention of minimum levels of "hydrologically mature" forest cover. "Hydrologically mature" generally means forests with canopy structures that are effective at intercepting and retaining snow above the forest floor.

Outside areas where watershed analysis has been performed, the rain-on-snow rule gives the DNR authority to limit clearcut timber harvesting in the significant rain-on-snow zone in order to reduce peak flow impacts. DNR-issued guidance for implementing the rule includes a risk assessment method and conditioning strategies for minimizing peak flow increases. While not specifically designed to address rain-on-snow, the green-up rule minimizes its effects by limiting the size and timing of clearcut timber harvesting across the state.

Complementing the regulatory mechanisms described above are other protection measures that will lead to increased tree retention on covered lands. Requirements to protect channel migration zones, riparian and wetland management zones, sensitive sites and unstable slopes will produce a landscape with higher levels of mature forest cover compared to previous regulatory regimes. Increased forest retention will limit the degree to which forest practices alter the hydrologic regime of any given watershed. Road-related changes in hydrology are addressed through the implementation of BMPs during construction, maintenance and abandonment operations.