Westside Type F Riparian Prescription Monitoring Project- Exploratory Field Study Findings Report

Answers to Six Questions from the CMER/Policy Interaction Framework Document

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Riparian Scientific Advisory Group (RSAG)

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Type of Product in Review:

Prospective Answers: ☐ Charter ☐ Scoping Document ☐ Study Design

Retrospective: ☒ Completed Exploratory Study Phase ☐ Completed Final Study Report

Brief Project Description:

Timber harvesting rules for private and some state-owned timberlands in western Washington State require that riparian buffers be left along all fish-bearing waters. The buffers (Riparian Management Zones, or "RMZs") required by rules have various widths, which depend on the local tree-growing potential of the site and the width of each stream. There are 25 possible configurations of RMZ buffers prescribed for fish-bearing streams in western Washington with buffer widths ranging from 90 to 200 feet. The RMZ consists of three zones, two of which allow some level of timber harvesting under certain circumstances. All stream Type F/S RMZs have a 50-foot no-harvest Core Zone, a variable width Inner Zone that ranges from 10 to 100 feet, and an Outer Zone, which makes up the balance of the Type F RMZ. The RMZ rules allow for various configurations of tree thinning in the two outer (beyond 50 feet) zones of the buffers with the objective of accelerating the development of desired mature forest conditions with large trees capable of providing shade and the potential for large wood recruitment to adjacent stream channels.

Riparian prescriptions and rules are very different from Eastern to Western WA for Type F waters. While CMER has tested the effectiveness of Eastside Type F riparian prescriptions and the Forest Practices (FP) shade rule, the current Westside rule remains based on untested assumptions that riparian prescriptions are functioning as intended. There is a need for a Westside Type F Riparian Prescription Effectiveness study to fill this knowledge gap and complement the Eastside Type F Effectiveness Study results. The purpose of this Exploratory Study was to produce information needed to focus and design the Westside Type F Riparian Prescription Effectiveness BACI study.

The objectives of the exploratory study were:

1. To evaluate post-harvest riparian stand conditions and riparian ecological functions across prescription variants with and without inner zone harvest.
2. To evaluate the extent to which post-harvest riparian forest stands are on trajectory to achieve Desired Future Conditions (DFC) targets at sites with and without inner zone harvest.

The Westside Type F Riparian Effectiveness Exploratory Study provides a coarse-level assessment of post-harvest riparian stand conditions under the current forest practices rules and is focused on addressing scientific uncertainty surrounding the sensitivity of riparian functions to application of rule

prescription variants. This study examined 106 study sites that were randomly selected from the Forest Practices Activity Review System database; approximately 10 for each of the 11 most-commonly-implemented prescriptions identified in a preliminary (Phase 1) desktop FPA analysis study. Stand characteristics and riparian function data were collected 3 to 6 years after harvest to allow early post-harvest windthrow to stabilize. We characterized the riparian forest buffer stands and the level of riparian functions of shade, wood recruitment, erosion control, and sediment filtering. Measured riparian stand data were input to the DNR DFC calculator to assess whether riparian buffer stands are on trajectory to meet the DFC basal area target defined in the FP rules when the stands are 140 years old. We report the levels and rates of tree mortality and on the geographic distribution of windthrow mortality.

CMER Standard Questions:

1. Does the study inform a rule, numeric target, Performance Target, or Resource Objective?

Yes.

2. Does the study inform the Forest Practices Rules, the Forest Practices Board Manual guidelines, or Schedules L-1 or L-2?

The study results inform the FP Adaptive Management Program about how RMZs left by the current rules relate to the following L-1 objectives and targets:

- Performance target for shade in Type F & S streams
- Functional objective for LWD (i.e., Develop riparian conditions that provide complex habitats for recruiting large woody debris and litter)
- Westside Type F Desired Future Conditions (DFC) projected basal area performance target
- Performance target for sediment; Streambank/equipment limitation zone disturbance

Given the inherent limitations of an after-impact study, it does inform L-1 objectives and targets, but the results of this exploratory study do not directly answer questions of causation from forest practices in meeting most resource objectives outlined in Schedule L-1 (defined as functional objectives and performance targets). This study does not directly test whether the functions provided by the RMZ buffers respond to forest practices, with the exception of whether stands with managed inner zones are on a pathway to meet DFC targets.

3. Was the study carried out pursuant to CMER scientific protocols (i.e., study design, peer review)?

Yes. This exploratory study design was developed by a Technical writing and implementation group (TWIG) under the Lean pilot project process, and the design was reviewed and approved by CMER consistent with the Protocol and Standards Manual (2016), and successfully went through Independent Scientific Peer Review (ISPR). The study was implemented with the guidance of a CMER project team.

4. What does the study tell us and not tell us?

a. What does the study tell us?

The exploratory field study assessed riparian stand conditions and selected riparian functions across Western Washington and across a wide range of prescription variants and site conditions. It was an observational study to collect pilot data for riparian prescriptions that are already distributed across the landscape. Study results indicate the variability of stand conditions and the level of riparian function provided by the FFR riparian buffers that are left after timber harvest at a point three to six years after the harvest. The study provides a coarse-level assessment of current riparian conditions and scientific uncertainty surrounding their sensitivity to current forest practices. This study also provides information on whether residual riparian buffers on Type F streams in Western Washington are on track to meet the Desired Future Condition basal area targets three years post-harvest (i.e., after early post-harvest windthrow events).

Overall

- There is very high natural variability in riparian buffer stands. This will make discerning prescription treatment effects difficult in studies attempting to attribute causation.
- All the prescription variants tested (accounting for 90% of the FPA harvest units applied) appear to provide similar and adequate protection to small- and moderate-width Type F streams, particularly with regard to shade.

Residual Stands

- Riparian buffer stands were generally young, dense, and dominated by small conifers in the stem exclusion phase of development. Many RMZ stands also have relic trees left during prior harvest rounds.
- The weighted median (and range) for residual site buffer stem density, basal area density, and QMD 3 to 6 years after harvest were 209.2 trees/acre (range: 47-846), 209.3 ft2/acre (range: 57-406), and 13.8 inches (range: 8.1-26.0). The weighted median relative density was 53 (range: 14-113) (Table 6). There was high variation in stand structure metrics within prescriptions and large overlap among prescriptions.
- Typically buffers had between three and seven different tree species among trees larger than 4" in diameter.
- The basal areas of over 80% of the buffers in this study were dominated by conifer species (i.e, conifer made up more than 50% of the basal area), and the basal areas at half the sites were over 90% conifer. Buffers with high proportions of conifer species tended to have lower species richness overall.
- Sites with Inner Zone harvest were associated with high conifer proportions whereas sites where no Inner Zone harvest was conducted were associated with higher proportions of broadleaf species and greater overall species richness.

DFC Trajectories

- The majority (75%) of all the riparian buffer stands in this study are projected to meet the Desired Future Condition target by age 140 years when modeled 3 to 6 years after harvest (Figure 22).
    - Sixty-seven percent of the sites that had no Inner Zone harvest were on track to meet the DFC target at 140 years old.
    - Ninety-two percent of the sites that did have Inner Zone harvest (Thin From Below/Option 1 or Leave Trees Closest to Water/Option 2) remain on track to meet the DFC basal area target at 140 years old (Table 11).
        - The two Inner Zone Harvest sites that are projected to be below the target were ones that experienced very high windthrow and one site where we happened to sample a hardwood-dominated segment of a very long mixed conifer/deciduous buffer.

Tree Mortality and Windthrow

- Overall mortality was 13.8% of the live trees in the first 3 to 6 years after harvest, and windthrow was by far the dominant mortality agent (76% of all tree mortality).
    - The weighted median site mortality was 8.3% through the early post-harvest period (annual rate between 1.4% and 2.8% per year).
    - Mortality was greater on small streams, and windthrow was the dominant agent on both large and small streams.
    - Nine of the 14 buffers that experienced high mortality still are projected to meet the DFC target and shade requirements.
- Windthrow mortality at individual sites ranged from 0 to 73% and had a weighted median value of 5.9%. Nine sites (8.5%) had high (>= 30%) windthrow.
    - The percentage of sites experiencing windthrow was similar for all the Inner Zone (IZ) harvest treatment categories (Thin from Below, Leave Trees Closest to Water and No-IZ).
        - The highest windthrow occurred at three sites with young stands on small streams that had no Inner Zone harvest.
        - Buffers harvested with the Thin from Below treatment (DFC Option 1; N=9) experienced lower windthrow severity than other prescription variants.
    - The highest windthrow mortalities occurred along the western coastal area of the state at sites that are exposed to the southwest storms that dominate weather in western Washington (report Figure 19).

Wood Recruitment and Large Wood

- The rules appear to leave an average of about 55 buffer trees (core and inner combined) per 100 feet of stream channel in all variants/site classes, though there is a large range. This appears to be the case in sites with and without inner zone harvest and across site class and stream width categories. The combined effects of variable core + inner zone widths and stand densities that vary by site class result in consistent linear stand densities (trees/100ft of stream length) within the retained RMZs (Fig 16). After early post-harvest mortality, the average lineal density decreased to about 50 trees/100 feet of stream length.
- Not all trees that died fell, and of those that fell, only some reached the stream channel. A per-site median of 6.3% of the RMZ standing trees that were alive immediately post-harvest at a site fell in the early post-harvest period, and 32% of the trees that fell reached the stream channel and contributed LW.
- Despite the windthrow that occurred in many stands, the small sizes of the trees and the wide (relative to the tree heights) riparian buffer zones combine to result in temporarily low rates of functional wood recruitment at this time.
    - The narrow (60 – 68 ft Core+Inner) site class V buffers are an exception. The heights of trees from those buffers already exceed the inner buffer width with enough length and size to contribute functional wood on small streams from throughout the buffer.

    - In contrast, the trees on the outer edges (i.e., the most likely to fall from windthrow) of the wide high-site-potential buffers are not yet of a size where the trees most distant from the streams can contribute sizable wood.
- As the stands become more windfirm and stem exclusion becomes more important as a mortality agent, the trees near the stream *should* become more important sources of wood to the streams. Moreover, hardwoods that often are found in the Core zone are nearing maturity and senescence and can provide wood for the short-term while the larger conifers continue to mature.
- The weighted median instream wood recruitment at sites was 1.0 pcs/100' (2.8 ft^3/100') and ranged from 0 to 25 pcs/100 ft (0 to 91.6 ft^3/100'). Many sites received no wood inputs.
- The mean dbh of trees contributing LW was 12".
- The mean in/over-channel diameter of the recruited LW was 6.8 inches (weighted median 6.9 in; max 23 in) (report Table A-5). The mean length of recruited LW in or over the channel was 8.7 feet (median 6.1 ft; max 54 ft).

<u>Shade</u>

- The weighted median canopy closure was 96.4% for all variants (range: 35% - 100%).
    - The current high levels of shade in the study streams are consistent with the high shade levels observed in the stem-exclusion phase of early-to mid-successional even-aged riparian forests investigated in other Western Washington and Eastern Washington CMER studies (Cupp and Lofgren 2014; Schuett-Hames and Stewart 2019; Schuett-Hames and Stewart 2021).
- No differences were observed in canopy closure values for sites with and those without Inner Zone harvest (Figure 31).
- The vast majority (89%) of sites exceeded the FPHCP target minimum stream shade requirement of 85%.
- Ninety percent of the sites met the shade-elevation target for their location (see nomograph in Board Manual Section 1).
    - Inner Zone harvest had little, if any, association with whether sites met these targets (Table 14).
    - Shade remains high overall despite generally decreasing basal area with poorer site class. However, low shade was commonly, though not consistently, associated with extremely low basal area values
    - Sites that did not meet their shade requirements tended to be either very wide streams or small streams that experienced high buffer mortalities (Figure 34).
- Ninety-two percent of the sites that had Inner Zone harvest meet their required shade target, even after many experienced high (>30%) post-harvest windthrow (Table 11, Figure 33).
    - Only one site that was projected to be off the DFC target (due to high windthrow) did not meet its shade-temperature curve target (see nomograph in Board Manual Section 1).

- The presence of large Type S stream sites added variability to the results due to the tendency of large streams to migrate and create shifting bars and banks. Two of the six Type S stream sites in this study had extremely low shade values. Although we attempted to avoid sites with channel migration zones, some sites with poorly-developed, ephemeral, deciduous streamside vegetation were included in our sample. The observations in this study suggest the need to consider buffers on very wide streams separately from those on narrow streams in any future work.

Soil Disturbance and Sediment Delivery

- We found no evidence of streambank destabilization or sediment delivery associated with any of the buffers in this study three to six years after harvest. The 50-foot no-cut core zones plus any of the inner zone widths, along with limitations on yarding corridors, in all the western Washington Type F/S prescriptions appeared to provide adequate protection against streambank erosion and sediment input to stream channels from overland, non-road related sources.
- There were no trends or differences in soil disturbance or sediment delivery observed among the prescription variants, including between those with and without Inner Zone harvest.

b. What does the study not tell us?

Study Scope of Inference and Limitations

The scope of inference is limited to the eleven most commonly implemented harvest prescriptions as represented by the randomly selected study sites from each prescription in the sample frame. We can have high confidence in the comparative findings of riparian stand conditions and functions among the prescriptions sampled because confounding factors were excluded in the site selection, the approximate balance in sample sizes among prescriptions (strata), and the appropriate selection of prescriptions to use in each comparison. However, extrapolation of the findings to the greater population of Type F and S streams with RMZs should be treated with caution because the sample size per prescription variant was relatively small and not inclusive of the wide variability of channel/valley morphologies where Type F and S RMZs are implemented. For example, the study population was not designed to explicitly investigate the influence of physiographic factors (channel form, aspect, valley confinement, etc.) on stand characteristics, windthrow, and wood recruitment. We would have low confidence in making inferences about conditions in unsampled prescriptions, though we do know that the ones not sampled are rarely applied and therefore must represent a small portion of FFR stream buffers. However, we also do not know how the population of FPA prescriptions relates to stream length on the FP HCP landscape, although the Compliance Monitoring Program has a database that might be able to provide data to estimate that.

Importantly, we cannot attribute cause of any given results to a treatment effect based on the data from this study. Although we can say there were differences among the RMZs after applying some prescriptions, we do not have the sampling design and data to be able to state that any differences are

due to the prescription applied. On the other hand, when harvest prescriptions leave functioning buffers that meet a given target of the FP HCP, then we can say the application of a prescription did not result in the level of function falling below that target.

Inferences about the post-harvest proportion of sites on trajectory to meet DFC targets are limited to the short (3-year post-harvest) time frame used for analysis.

Because we did not measure stream temperature, the study did not tell us whether the timber harvests with associated riparian management zones (buffers) caused any change in stream temperature or other water quality parameters.

This study does not address the validity of any of the performance targets, nor does it evaluate the accuracy of the DFC model.

5. What is the relationship between this study and any others that may be planned, underway, or recently completed?

This Type F exploratory study was designed to provide "after impact" (AI) information on riparian conditions 3 to 6 years post-harvest to help focus the next phase of the Westside Type F Riparian Prescription Effectiveness Project. We hypothesized this exploratory study would identify specific prescription variants that may not be meeting key riparian functions and subsequently would provide guidance for designing the more intensive (BACI) effectiveness study. However, the findings indicate that there were not significant differences among prescription variants and that all the prescriptions presently retain riparian stands that meet some of the key riparian function targets and are on trajectory to achieve desired future conditions. As was found by Schuett-Hames and Stewart (2019), riparian conditions and functions might change in the future, so we recommend adding these Type F exploratory study sites to the sampling planned for CMER Extensive Monitoring Program currently being scoped by RSAG. Doing so will allow CMER to continue to monitor the fate of these Type F buffers beyond 3-6 years post-harvest and determine the degree to which key riparian functions are being maintained.

The overall findings from the Westside Type F Effectiveness project (yet to be designed) will be used to compare and contrast those of the CMER Eastside Type F Shade and Temperature Effectiveness Study (Cupp 2014) / Bull Trout Overlay (Schuett-Hames and Stewart 2019a), which tested the effectiveness of Type F riparian prescriptions and the FP shade rule in Eastern Washington. However, the riparian prescriptions/rule are very different from Eastern to Western WA for Type F waters, which needs to be considered in those comparisons and contrasts.

The exploratory survey study is similar to the Eastern Washington Riparian Assessments Project (EWRAP) conducted in 103 Eastern Washington RMZs (Bonoff et al. 2008, Schuett-Hames and Stewart 2015), although EWRAP investigated a random selection of riparian sites rather than targeting locations that had been harvested.

Some of the riparian stand characteristics and measured functions from stands in the Type N studies are compared and contrasted with those of stands in this exploratory study. The next phase Type F effectiveness study will also complement the Westside Type N Buffer Condition, Integrity, and Function study (BCIF; Schuett-Hames et al 2012, Schuett-Hames and Stewart 2019) and the recently- completed Westside Type N Effectiveness Studies ("Hard Rock" and "Soft Rock"), which investigated the impacts of harvest that leaves FP rule and non-rule based riparian buffers on Type N streams (McIntyre et al. 2018,

McIntyre et al. 2021, Ehinger et al. 2021). Some of the riparian stand characteristics and measured functions from the stands in the Type N studies, particularly the reference conditions, are compared and contrasted with those of stands in this study.

The 2005 CMER DFC Validation study included collecting field data on characteristics of riparian stands within the DFC target age range of 120 to 180 years old (Schuett-Hames et al. 2005) and resulted in a rule change to the DFC basal area targets in 2009 by the WA Forest Practices Board. We determined the proportion of stands sampled in this study that are on trajectory to meet the resultant revised DFC basal area target in rule 3 to 6 years after harvest.

Shade

The Type F RMZs in this study had very high canopy closures that are similar to those found in other CMER riparian studies in western Washington (Table 1). The median canopy closures (78%; 93%) found in the first-round westside Type S/F and Np extensive monitoring studies (Ehinger 2019) are lower than those observed in this study, likely explained by the inclusion of riparian buffers of any status (not just post- recent harvest under current rules) in the extensive studies. The westside Type N riparian effectiveness studies found canopy closures over 90% at sites prior to upland timber harvest. After harvest at sites that retained wider RMZs (>75 feet, similar to those of the narrowest Type F rules) had canopy closures over 80%. . At sites that retained narrower 50-foot RMZs, the shade was lower.

Table 1. Shade (canopy closures) measured in CMER riparian studies.

StreamType	StateSide	Project	N	Median Canopy Closure
Type F/S	Westside	**Westside Type F Exploratory Study** (specific Rxs, 3-6 years post-harvest)	106	96%
		Extensive - WS TypeF (all riparian stands, regardless of harvest)	61	78%
	Eastside	**Extensive -ES TypeF** (all riparian stands, regardless of harvest)	50	82%
		Eastside Shade and Temperature Effectiveness Study (BTO) (BACI testing specific Rxs)	30	90% (REF); 88%(post)
Type N	Westside	**Buffer Characteristics, Integrity, and Function (BCIF) - 50ft** (BACI testing specific Rxs)	13	90% (REF); 81% (50ft 5 yrs post)
		Type N Effectiveness - Soft Rock (BACI testing specific Rxs)	3 (REF) 8 (TRT)	>95% (REF); >90% (>75ft, 3 yrs post); >85% (50-75ft, 3 yrs post)
		Type N Effectiveness - Hard Rock (BACI testing specific Rxs)	17	91 to 98% (pre/REF) 88 to 85% post
		Extensive – TypeNp (all riparian stands, regardless of harvest)	54	93%

6. What is the scientific basis that underlies the rule, numeric target, performance target, or resource objective that the study informs? How much of an incremental gain in understanding do the study results represent?

a. What is the scientific basis that underlies the rule, numeric target, Performance target or Resource Objective that the study informs?

RMZ requirements for Type F and S Waters were developed to maintain important ecological processes and provide levels of large wood, shade, and other riparian functions adequate to meet conservation objectives. The FPHCP (FPHCP 2005, Chapter 4d – Rationale for the Plan) and the associated environmental impact statement (NMFS and USF&W 2006) provide the scientific bases and rationales for each of the riparian rules. The following sections describe the technical bases for the rules related to

specific functions.

Shade

The development of the Forest Practices rule shade target was based on science that used a different measurement method than that specified for the target. Many studies throughout the 20th century documented the importance of stream shade in maintaining the stream temperatures needed by salmonids covered under the FPHCP (Beschta et al. 1987; Brown 1989; others). 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). The use of angular canopy density (ACD) became a popular way of measuring stream shading during this period (FPHCP EIS, Ch 4 and 5). ACD is a measure of the percent of the sky between the stream and sun covered by the canopy at solar noon (generally held to be the sun angles between 10:00 and 14:00) on a specified day at a specified latitude (Brazier 1973). Studies of the relationship between buffer strip width and ACD show a high degree of variability due to variability in stand composition, structure, and topography, 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.

The FFR rules and L-1 target range were based on the Beschta et al. (1987) research compilation that found the angular canopy densities of old-growth riparian stands in western Washington forest types ranges from 75 to 90 percent (FEMAT 1993; FPHCP 2005, Section 4d). The L-1 target range for shade specifies the *effective shade* should be within that target range. Effective shade differs from ACD in that it includes shade from topography and considers the solar energy blocked throughout the solar arc over a full (specified) day at a given location (Allen & Dent 2001; Teti &Pike 2005).

However, in practice, the Board Manual, Section 1 specifies using a densiometer to measure canopy closure, as an indicator of effective shade. In this study we used densiometers to measure canopy closure looking into the stream buffer to indicate the ability of the study buffer to block sunlight in an angular wedge projection from directly overhead to 35 degrees above the horizon (Baudry et al. 2014) at any time of year, rather than along the solar path on a particular date and latitude. While this is not equivalent to ACD or effective shade, it relates to both of them and is a useful comparison metric for the purposes of this investigation. The results of this study show that canopy closures in Type F/S RMZs are nearly always over 80% and are more often than not greater than 90% 3 to 6 years after the adjacent timber harvest.

Two FPHCP rules protect shade along westside Type S and Type F waters. The Shade rule (WAC 222-30-040) requires that 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 in western Washington are based on state water quality standards and vary with waterbody class (i.e., Ecology designation of Class AA or Class A) and elevation. The minimum shade required can be found for a given stream using either a model or the temperature/elevation/shade graph provided in the Forest Practices Board Manual (see report Chapter 7 for a discussion of the shade-temperature nomograph).

Shade is also protected by the RMZ rules (WAC 222-30-021). Data reported in Beschta et al. (1987) and

Steinblums et al. (1984) (in FEMAT 1993, in NMFS and USFWS 2006) estimate that 75% site potential tree height provides more than 90% of the shade provided by old-growth riparian stands (FEMAT 1993). Based on this estimate, the FPHCP RMZ rules for Type F and S waters set buffer widths equal to 75% of the overall site potential tree height, which is approximated by the median 100-year Douglas-fir site index (McArdle et al. 1961). The resulting total RMZ widths are greater than 75 feet for all site classes and buffer prescriptions along Type S and Type F waters. Some harvest is allowed in the outer portions of the RMZs, but there is a no-cut "floor" (80 ft or 100 ft, depending on stream width) that exceeds 75 feet on the Leave Trees Closest to Water (DFC Option 2) prescriptions.The only prescriptions subject to the 75-foot shade rule are the Thin From Below (DFC Option 1), which is designed to leave the largest trees, and harvests on small streams in Site Class V land. Therefore, the combined shade and RMZ rules for western Washington were expected to provide shade levels along Type S and Type F waters at or very near those found in old-growth stands.

Large Wood Recruitment

Wood is a key element in the creation and maintenance of instream and riparian habitat, trapping and storing sediment and organic material, stabilizing streambeds and banks, dissipating stream energy, forming pool habitat, providing cover, and serving as a food source for aquatic insects (Bisson et al. 1987). The recruitment and retention of wood was a primary consideration for development of the leave tree requirements for RMZs. Forest Practices rules are intended to provide sufficient large wood recruitment to create, restore and maintain riparian and aquatic habitat for species covered under the FPHCP. Rule buffer widths were based on data from western Washington and Oregon indicating that more than 90 percent of in-stream woody debris in mature and old-growth conifer forests is recruited from a distance equal to 75 percent of the height of mature and old-growth conifers (McDade et al. 1990, in FPHCP 2005).

The authors of the FPHCP EIS performed an analysis comparing the estimated large wood recruitment functionality of the FFR RMZs using the 100-year (75%) site potential tree height as the basis for RMZ widths with RMZs that were based on the full (100%) 250-year site potential tree heights. Their results estimated that the westside Type F and S RMZs implemented in the rules would provide 93% of the wood recruitment that would occur if the full 100-year site potential width allowed no thinning or other entry into the RMZs. It was also estimated that implementing the same RMZ prescriptions but using the 250-year site potential tree height as the RMZ width would result in 90% LW recruitment of the full-width no-harvest potential recruitment. (NMFS and USF&W 2006, App B)

The Desired Future Condition basal area target for RMZ stands is the only RMZ target listed in Schedule L-1 related to large wood recruitment. The current basal area target value of 325 ft2/acre was established based on findings from the CMER DFC Target Validation study (Schuett-Hames et al. 2005) described in Question 5. There are additional in-stream habitat target conditions, but in-stream conditions depend on more factors than the adjacent riparian zones and this study did not include those in this exploratory evaluation.

This study provides estimates of large wood recruitment pieces and volume in westside Type F and S reaches and demonstrates that recruitment is currently low (median = 1 pc/100 ft/3 yrs) and consists of "large" wood pieces that are on the small side (mean diameter just under 7 inches). Approximately 80%

of the wood recruited to the stream channels in this study came from trees in the 50-foot-wide Core Zone, which concur with the findings of McDade et al. (1990) and supports the adequacy of the RMZ widths for ensuring a future supply of large wood for streams. We did not collect data in such a way as to validate source distance curves beyond the Core/Inner source zone categorization. However, the one-sided RMZ's retained approximately 50 trees per 100 feet of stream length for future large wood recruitment, and 75% of the RMZs are on trajectories to meet the DFC target basal area when the stand reaches 140 years old.

Streambank Stability and Sediment Filtration

The FPHCP rules minimize the risk of accelerated streambank and surface erosion from log yarding and equipment use activities by BMPs that minimize ground disturbance in and around typed waters and wetlands. Overland flow and associated surface erosion processes are not common on undisturbed forest soils in the Pacific Northwest because of their high porosities and infiltration rates (Dyrness 1969; Brown 1973). However, 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 (Rashin et al. 1999). According to FEMAT (1993), trees within one-third tree height from the channel provide rooting strength important for maintaining streambank integrity. Therefore, no harvest or salvage is permitted in CMZs and the 50-foot wide RMZ core zones along Type S and Type F waters in western Washington with the exception of designated yarding and road corridors. The rules also include 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. 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 (NMFS and USF&W 2006).

No harvest-related erosion within the RMZs was observed in this study.

Desired Future Condition

The Type F/S riparian rules are based on the assumption that the riparian prescriptions will result in riparian forests that are on trajectory to achieve stand structures similar to unmanaged mature forest at age 140. Riparian forest stands having a conifer basal area per acre that meet or exceed the DFC target are assumed to provide riparian stand conditions, inputs and processes that meet the HCP resource objectives for wood and temperature, creating complex habitat to support salmon recovery and to meet water quality standards.

The current DFC basal area targets are based on conifer basal areas measured in an investigation of mature riparian stands on Type F and S streams in forestlands on or comparable to lands covered under the Forest Practices rules (Schuett-Hames et al. 2005).

This study provided empirical evidence that stands in most Type F Riparian buffers (both those that did and did not have Inner Zone harvest) are on trajectory to meet the DFC basal area target.

b. How much of an incremental gain in understanding do the study results represent?

The study results provide empirical evidence that the current Westside Type F Riparian prescriptions maintain target levels of riparian function when adjacent upland timber stands are harvested, lending support to the current rules and underlying assumptions of the HCP.

Technical Implications and Recommendations:

New rule tools or field method development.

None

Research/monitoring suggestions.

Moving forward, we do not recommend investing large resources into testing the effectiveness of the current Westside Type F Riparian rule prescriptions because our findings suggest that the key riparian functions assessed in this study are currently being met by the RMZ stands left by the eleven most commonly implemented RMZ rules. Instead, we recommend using the next phase of the Westside Type F Riparian Study (Phase 3) as an opportunity to test active riparian management to accelerate recovery of desired future conditions and promote large tree growth in riparian stands. Such studies would reduce uncertainties associated with the functions provided by alternative buffer treatments. Further, we could test how various thinning treatments affect forest health, fire potential, future climate change resilience, wood recruitment potential, etc.

The observations in this study suggest the need to consider buffers on very wide streams separately from those on narrow streams in any future work.

Riparian conditions and functions may change beyond the scope of this study (3- 6 years), so we recommend adding these sites to the CMER Extensive Monitoring Program currently being scoped by RSAG.

Suggested rules/board manual sections to review/revise.

None

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