CMER/Policy Interaction Framework Six Questions:
Westside Type N Buffer Characteristics, Integrity and Function (BCIF) Study-
Extended 10-Year Post-Harvest Report.
November 15, 2019

The results from this study are found in the following report:

Schuett-Hames, D., Steward, G., 2019. Changes in Stand Structure, Buffer Tree Mortality and Riparian-Associated Functions 10 Years After Timber Harvest Adjacent to Non-Fish-Bearing Perennial Streams in Western Washington. Prepared for the Washington State Department of Natural Resources

1. Does the study inform a rule, numeric target, performance target, or resource objective?

Yes. (See question 2 below).

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

<u>Forest Practices Rules.</u> This study informs Forest Practices Rule WAC 222-30-021*(2) Western Washington Protection for Type Np and Ns Waters, specifically (a) Equipment Limitation Zones, and (b) Sensitive Site and RMZs Protection Along Type Np Waters.

<u>Schedule L1 Resource Objectives, Functional Objectives and Performance Targets.</u> This is an effectiveness monitoring study that informs Schedule L-1 Key Question 2:

> *"Will the prescriptions produce forest conditions and processes that achieve resource objectives while taking into account the natural spatial and temporal variability inherent in forest ecosystems"?*

This study addresses the Schedule L-1 functional resource objectives for:

- Heat/water temperature (i.e. maintaining shade)
- LWD/organic inputs (i.e. recruiting large woody debris)
- Sediment (i.e. protecting streambank integrity and providing vegetative filtering).

This study addresses the Schedule L-1 performance target for streambank disturbance.

<u>CMER Work Plan Critical Questions.</u> This study informs the following critical questions for the Type N Riparian Prescriptions rule group in the CMER Work Plan:

- How do survival and growth rates of riparian leave trees change following Type Np buffer treatments?
- Are riparian processes and functions provided by Type Np buffers maintained at levels that meet FP HCP resource objectives and performance targets for shade, stream temperature, LWD recruitment, litter fall, and amphibians?
- What is the frequency and distribution of windthrow in forest practices buffers?

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

Yes. The study design and final report were reviewed by RSAG and CMER as well as the Independent Scientific Peer Review process.

4A. What does the study tell us?

This report presents the 10-year post-harvest results from the Westside Type N Buffer Characteristics, Integrity and Function (BCIF) study conducted by Washington's Cooperative Monitoring, Evaluation and Research Committee (CMER). The study documents the magnitude of change in stand structure, tree mortality, wood recruitment, shade, wood cover and soil disturbance when the riparian prescriptions for Westside Type Np (perennial non-fish-bearing) streams were applied in an operational setting.

Treatment sites were randomly selected from approved forest practice applications. Three components (treatments) of the Westside Type Np Riparian Prescriptions were evaluated: unbuffered clear-cut harvest to the channel edge (CC treatment), 50-foot wide no-cut buffers (BUF treatment), and 56-foot radius no-cut buffers around the perennial initiation points (PIP treatment). Unharvested second-growth reference (REF) reaches were located in proximity of the treatment sites. Statistical tests were done to compare the CC, BUF and REF results.

<u>Change in Stand Structure.</u> During the first five years after harvest, density and basal area decreased in BUF, PIP and REF stands because tree mortality exceeded ingrowth of young trees. Mean mortality and associated change in stand structure were greatest in PIP stands, less in BUF stands and least in REF stands. Cumulative mortality as a percentage of live basal area was 48.1% in PIP stands, 27.2% in BUF stands and 9.4% in REF stands. Between years five and ten, stand structure stabilized in PIP and BUF stands due to a marked reduction in mortality rates. Over the entire 10-year post-harvest period, cumulative change in live basal area (trees >4" DBH) was positive in REF stands (+2.7%) and negative in BUF (-14.1%) and PIP (-38.9%) stands, however the BUF-REF contrast was not statistically significant. Wind was the dominant mortality agent in PIP and BUF stands. Mortality in REF stands was dominated by other factors (e.g. suppression); however there was an increase in wind mortality in REF stands during year 4–5 due to a storm with hurricane-force winds. Substantial conifer regeneration (seedling and saplings) was observed in BUF and PIP stands, including buffers with high mortality (see Figure 9). Almost no trees remained in the CC reaches after harvest, but regeneration with planted trees appeared to be successful.

<u>Tree fall and Wood Input to Streams.</u> Tree fall and wood recruitment was driven by mortality; consequently rates were highest during the first five years post-harvest. Cumulative recruited wood pieces/100 feet in the PIP reaches (includes Ns portion of stream above PIP) (11.2 pieces) was nearly double that in the REF (6.2 pieces) and BUF (7.0 pieces) reaches over the entire IPH-YR10 period. Cumulative recruited wood volume in the (BUF) and (PIP) reaches was double and four times the REF volume, respectively. Most recruiting fallen trees came to rest above the channel where they provided cover but did not interact with flowing water. Consequently, few newly recruited pieces provided sediment storage or formed pools, steps or debris jams. Wood recruitment was minimal in CC reaches during the IPH-YR10 period due to lack of trees, following slash input (primarily branches and tops) during harvest.

<u>Shade/Cover.</u> One year after harvest, canopy closure, an indicator of shade from trees and tall shrubs, was lower in the BUF (76%) and PIP (52%) reaches compared to the REF reaches (89%). By year 10, canopy closure in the BUF and PIP reaches increased to over 85%, similar to the REF reaches, apparently due to growth of shrubs and saplings adjacent to the stream. Mean canopy closure in the CC reaches was only 12% one year after harvest of trees, but increased to 37% by year 5 and 72% by year 10 in response to growth of shrubs and saplings. Buffers in the BUF and PIP reaches prevented slash input from the adjacent harvest unit. Consequently, wood cover was higher in CC reaches due to logging debris input, but decreased over the post-harvest period.

<u>Soil Disturbance.</u> On average, harvest-related soil disturbance occurred on 6.2% of the area within the 30-foot wide equipment limitation zones (ELZ) in the CC reaches. All BUF and PIP reaches met the performance target (<10% of the ELZ area with soil disturbance) but one of eight CC reaches exceeded the target. The average

distance to the stream for erosion features that delivered sediment was 1.0 foot and the maximum was 7.7 feet. Soil disturbance from uprooted trees was twice as frequent in BUF reaches as REF reaches, but the percentage of root-pits with evidence of sediment delivery was greater in the REF reaches (26%) than the BUF reaches (19.8%). Mean horizontal distance to the stream for root-pits that delivered sediment was 8.2 feet compared to 28.0 feet for those that did not deliver.

Effectiveness in Meeting Forest Practices Habitat Conservation Plan Resource Objectives The unbuffered CC treatment was least effective in meeting the Forest Practices Habitat Conservation Plan (FPHCP) resource objectives. Clear-cut harvest to the edge of the stream resulted in greater initial disturbance during harvest compared to reaches where buffers were provided. There was substantial input of logging slash in clear-cut reaches, but almost no additional post-harvest wood input occurred and cover from woody debris decreased during the first ten years after harvest. Clear-cut harvest resulted in the initial loss of canopy shade, but shade from growth of streamside herbs, shrubs and saplings increased over time. We predict that clear-cut harvest on a typical rotation schedule of 40–50 years will result in a continuous cycle of disturbance and rapid changes in stand structure and shade and long-term reductions in large wood loading due to lack of input from large trees.

The RMZ and PIP buffers (the BUF and PIP treatments) were more effective in providing shade and wood recruitment after harvest than the unbuffered CC treatment. Although there was an incremental loss of shade and wood recruitment potential associate with harvest of the adjacent stand beyond the buffer, 50 foot RMZ buffers provided the majority of the shade and wood recruitment potential found in unharvested second-growth reference sites. More shade and wood recruitment potential would be provided by wider buffers or by variable width buffers that leave additional trees in areas where benefits to shade and potential wood recruitment would be greatest.

Mortality from wind is a complicating factor in evaluating the effectiveness of the RMZ and PIP buffers. Mortality was variable, but extensive mortality occurred at some sites. About one-quarter of the RMZ buffers and two-thirds of the PIP buffers had substantial mortality (>5%/year), resulting in reduction of density, canopy shade and wood recruitment potential, but tree fall from wind supports the resource objectives by providing a pulse of large wood. Most fallen trees came to rest suspended or spanning above the channel where they provide cover but will not immediate influence channel conditions and processes. The majority of fallen trees were uprooted, but sediment input from soil disturbance was limited to trees in close proximity to the channel. Conifer regeneration was observed in sites with elevated mortality, so development of multi-age conifer stands is likely in disturbed sites over time.

4B. What does the study not tell us?

The Westside Type N BCIF Study was not designed or intended to address some important aspects of Type N riparian prescription effectiveness, including aquatic resource effects (e.g. amphibians and macro-invertebrates), water quality (e.g. stream temperature and turbidity) or downstream effects on fish-bearing streams. The study was not intended to determine the range of regional and local variation in site conditions or to determine the effect of site conditions on riparian response to the treatments (e.g., stand mortality). The study does not address the effectiveness of the eastside Type N riparian prescriptions.

This study has a number of limitations that should be considered when interpreting and extrapolating the results. The results of the study pertaining to PIP buffers must be interpreted cautiously due to the small (3) sample size, which means the data may not be representative of the entire population of PIP buffers. Also, there were not PIP reference sites for comparison with the PIP treatment sites. Because of the five year timeframe, the study was not able to determine the duration of many of the changes observed, or the timeframe for recovery.

5. What is the relationship between this study and any others that may be planned, underway, or recently completed? a) ***Feasibility of obtaining more information to better inform Policy about resource effects? b) Are other relevant studies planned, underway, or recently completed? c) What are the costs associated with additional studies? d) What will additional studies help us learn? e) When will these additional studies be completed (i.e., when will we learn the information)? f) Will additional information from these other studies reduce uncertainty?***

The Westside Type N BCIF Study is one of three studies in the Type N Riparian Effectiveness Program focused on the effectiveness of the western Washington Type Np riparian prescriptions. This program also includes the Westside Type N Experimental Buffer Treatment Study- Basalt Lithology (the hardrock study) and the Type N Experimental Buffer Treatment Study- Incompetent Lithologies (the softrock study). These studies are before/after control/impact (BACI) studies that include a more comprehensive set of metrics. Both include wood loading, stream temperature, suspended sediment and water quality responses, and the hardrock study included litterfall, amphibian, periphyton and macroinvertebrate components. The hardrock, softrock and Westside Type N BCIF studies documented similar responses for buffer tree mortality, change in stand structure, and large wood recruitment, increasing confidence in results and helping to address concerns about limited sample sizes including increasing the number of PIPs.

This extended 10-year post-harvest report augments earlier findings presented in the Westside Type N BCIF Study 5-year post-harvest report (Schuett-Hames et al. 2012). Related information has been reported in the two-year post-harvest hardrock report (McIntyre et al. 2017). In addition, the extended hardrock report (to eight-years post-harvest) and the 3-year post-harvest report for the softrock study are currently in review, and five year post-harvest data collection for the softrock study will be completed in calendar year 2020.

Two other recently completed studies also provided additional information on shade/temperature in westside Type N streams. The Buffer Integrity Shade Effectiveness Study evaluated the effectiveness of different shade levels on Type N streams in maintaining aquatic conditions and processes, including the response of stream associated amphibians to changes in shade. The Extensive Riparian Status and Trends Monitoring for Temperature in Type F & N Streams for the Westside study documented shade and stream temperature conditions across a random sample of westside Type Np study sites on lands under the Forest Practice Habitat Conservation Plan with varying management histories.

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?

The westside Type N riparian prescriptions and performance targets represent a new approach to management of riparian stands on westside Type N streams. This approach is based on a patch-cut strategy, where a portion of the riparian stands in a Type N basin may be clear-cut, while sensitive sites and at least 50% of the perennial stream length is buffered. This strategy was the result of negotiations that culminated in the Forests and Fish Report (FFR) which were incorporated in the Washington Forest Practices Rules and Forest Practices Habitat Conservation Plan. The FFR riparian recommendations were informed by available research on change in riparian influence on aquatic conditions with distance from channel (FEMAT 1993), large wood recruitment source distances (Murphy and Koski 1989, McDade 1990) and buffer width and shade (Brazier and Brown 1973, Steinblums et al. 1984 and Beschta et al. 1987).

Because the westside riparian Np prescription strategy was untested, the Westside Type N BCIF Study provides the first assessment on the responses in buffer tree mortality, wood recruitment, channel debris, shade and soil disturbance after the application of this prescription strategy in an operational setting. This study reduces scientific uncertainty by: 1) documenting changes in the characteristics of westside Type N riparian stands, e.g. changes in stand density, basal area, and composition, 2) comparing buffer tree mortality rates in the first ten years after harvest with those for reference stands, and documenting the variability of mortality rates between sites, 3) identifying causes of mortality and tree fall, and the effect of wind on riparian buffer survival, and 4) documenting in-growth and tree regeneration. This study also provides the first data on the rates of LWD recruitment, shade and cover and soil disturbance associated with the clear-cut harvest, 50 ft buffer and PIP buffer prescriptions.

Similar, corroborating results from the Type N BCIF, hardrock and softrock studies represent a substantial increase in our understanding of the westside Type Np riparian prescriptions and have substantially reduced scientific uncertainty concerning buffer tree mortality, large wood recruitment and change in stand structure and shade in response to the prescriptions.

Technical implications/recommendations

Policy Issues. Determining the appropriate balance between the resource objectives of the FPHCP and the economic and operational advantages of timber harvest adjacent to Type Np streams is a critical policy issue that must be informed by both science and social considerations. Our findings raise several key policy questions for the adaptive management program.

Clear-cut harvest:
1) Is the level of disturbance and recovery from clear-cut harvest of type Np RMZ (logging debris input, changes to shade/temperature and reduction in large wood recruitment and loading) consistent with the resource objectives of the FPHCP?
2) What proportion of the stream network represents an appropriate balance between buffers for resource protection and clear-cut harvest for economic and operational considerations?

RMZ and PIP buffers:
1) Are the incremental reductions in wood recruitment potential and shade associated with harvest adjacent to the 50-foot RMZ and PIP buffers consistent with the resource objectives of the FPHCP? If not, what buffer strategies would provide the desired level of protection to achieve resource objectives and appropriately balance economic and operational considerations?

Wind mortality:
1) Is the level of wind damage and associated impacts to type Np RMZ and PIP buffers consistent with the resource objectives of the FPHCP?
2) How should sites with high vulnerability to wind be identified and managed?
3) Is there a strategy for protecting sensitive sites (e.g., PIPs) that would be more effective than small patch buffers prone to wind damage?

Research. We recommend proceeding with several additional research projects currently under development by RSAG that would provide information to help validate/adjust the current buffer configurations. The Riparian Characteristics and Shade Response study currently in the study design phase would provide data on shade response to differences in buffer width and leave tree density. The wood recruitment volume and source distances from riparian buffers project would provide data on relationships between buffer width and configuration and wood recruitment volume. Finally the extensive riparian status and trends vegetation monitoring project would provide data on the status and future change in riparian stands on Type Np streams as well as type F and S streams.

Further analysis could be done using the data collected for this project to inform the quantitative assumptions in the HCP (ch. 14, section 4d) that were based on the results in McDade et al regarding the percentage of potential recruitable wood that would remain in a forest practices Np riparian management zone.

Performance Targets. We recommend review and revision of the Type Np performance targets. Some of the Type N performance targets were not very useful in evaluating effectiveness. For example, the shade and litter fall performance targets appear to merely restate the prescriptions, so if the harvest is done in compliance with the rules, the performance target will be met. This issue was also raised in the Hard Rock study findings report. In addition, clarification is needed on whether LWD performance targets apply to westside Type N streams. Once the Type N Experimental Buffer Treatment Study- Basalt Lithology is completed, CMER and the TFW Policy Group should review and evaluate the shade, LWD and litter fall performance targets for westside Type N streams in the context of the results of these studies and other current scientific research, and propose changes to these performance targets and/or new measures where appropriate.

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