

To: TFW Policy Committee

From: Aimee McIntyre, Dave Schuett-Hames, Reed Ojala-Barbour, Timothy Quinn

RE: Supplemental Findings Reports for Type N Hard Rock Study

Cc: Howard Haemmerle, Hans Berge

Date: 21 May 2018

The TFW Policy Committee (hereafter, Policy) requested supplemental Findings Reports for the Type N Experimental Study on Hard Rock Lithologies (hereafter, Type N Study). The request was for four supplemental reports in addition to the overall report, which has been provided to Policy by CMER and study principle investigators (PIs). Supplemental reports were requested for the following chapters: (1) Stand Structure and Tree Mortality Rates in Riparian Buffers (Chapter 5), (2) Wood Recruitment and Loading (Chapter 6), (3) Stream Temperature and Cover (Chapter 7), and (4) Stream-associated Amphibians (Chapter 15). PIs developed the four supplemental reports, which have been through the CMER review and approval process, and are now available to Policy.

In addition to providing the supplemental Findings Reports, PIs were asked to address comments raised by Policy during their review of the overall Findings Report. To facilitate addressing Policy comments, PIs compiled them into a matrix, which are available now (see attached). As suggested by the AMPA, PIs will make themselves available in-person at a Policy meeting to discuss study findings in the event that a response to any comment is not clear.

In general, Policy comments fell into six categories: (1) effectiveness of FP rules, (2) extended response, (3) study design/scope of inference, (4) between-site variability, (5) within-study site information, and (6) general comment/technical edit. We put PI responses to Policy comments in a comment matrix. Below, we provide a generalized response to each of the six categories of comments.

Effectiveness of FP rules

One comment requested more discussion of the effectiveness of FP rules in meeting resource objectives and performance targets for stream temperature and stream-associated amphibians.

- Stream temperature: Functional objective for Heat/Water Temperature is to provide cool water by maintaining shade, groundwater temperature, flow and other watershed processes controlling stream temperature. The Performance Target for stream temperature is to meet or exceed Water Quality Standards (WQS) – current and anticipated in next triennial review. The Performance Target mirrors the Forests and Fish Report's overall Performance Goal of meeting or exceeding water quality standards. The Type N study demonstrates that the FP rules were not effective in preventing significant stream temperature increases in clearcut streams. In fact, expanding the protections provided by the two-sided 50-ft buffer under current FP rules (i.e., $\geq 50\%$ of the Type N stream length buffered) to cover the entire Type N stream length did not prevent significant increases in stream temperature. However FP buffer rules resulted in smaller temperature increase than streams with no riparian trees (0% treatment).
- Amphibians: We evaluated the response of four of the seven FP-designated amphibians Coastal Tailed Frog (hereafter, tailed frog), and Olympic, Columbia, and Cascade Torrent Salamanders (hereafter, torrent salamanders) in this study. In the two years immediately following harvest, we detected a significant increase in larval tailed frog density in the FP

treatment under the current FP rules. We did not see a similar response for post-metamorphic tailed frogs in the FP treatment. We saw no significant difference in torrent salamander density in clearcut basins under FP rules. We did not detect a negative response to harvest for tailed frogs or torrent salamanders in any of the three riparian buffer treatments. In fact, the density of focal FP-designated amphibians did not decline in any buffer treatment, including in the 0% treatment, where the July-August 7-DADMax increased by 3.2°C in the two years post-harvest. We remind Policy that study results are limited to the two year post-harvest interval and that results are applicable over a longer period. We can only understand the scope of potential long-term response with longer-term monitoring that addresses issues such as the possibility of a delayed response to the reproductive success of stream-associated amphibians that could impact amphibian density over a longer time. Our preliminary results through eight years post-harvest indicate a significant decline in tailed frog density in all riparian buffer treatments.

Study design/scope of inference

There were several comments related to study design and or scope of inference. One comment had to do with the range of physical characteristics in study sites compared with other sites throughout western Washington. Scope of inference should be limited to the range of conditions used during the site selection process. We limited selection of sites to non-fish-bearing 1st-, 2nd- and 3rd-order streams underlain with competent lithologies and located within the Olympic Mountains, Willapa Hills, and South Cascades (south of the Cowlitz River) physiographic regions. Basin areas were restricted to those between 12 and 54 ha (29 and 133 ac), with stream gradient between 5 and 50% (3 and 27 degrees). Elevation of study sites was restricted to <1,067 m (3,500 ft) in the Olympic region and <1,219 m (4,000 ft) in the South Cascades region; there was no elevation limit in the Willapa Hills region. Based on our GIS basin selection exercise, these criteria reduced the total number of non-fish-bearing basins within our geographic scope from 35,957 to 6,125 (or 17% of western Washington). Please refer to the Type N Feasibility Study Final Report (McIntyre *et al.* 2005) for detailed information on the site selection process for this study.

One question had to do with the duration of the study monitoring relative to the duration/cycle of natural processes that influence response metrics (or, in the commenters words, temporal context). In terms of the temporal context, we currently we have data for most responses through eight year post-harvest, which is substantially shorter than the typical harvest rotation time in western Washington (which ranges closer to 30 to 60 years). Further, the current study report only outlines the response through two years post-harvest, which we caution may not be representative of the potential response over time. Many metrics were monitored through eight years post-harvest and shade and temperature have been monitored through nine years post-harvest. This is longer than any experimental, replicated study on streams of a comparable size. The expectation was that shade and temperature would be similar to pre-harvest levels by now, but this is not the case for the FP treatment. Further, as previously stated, it appears that there was a delayed response in amphibian density, with a significant decline in tailed frog density in seven and eight years post-harvest in all buffer treatments that was not observed in the two years immediately following harvest.

Another comment had to do with Best Management Practices (BMPs) and how representative our study sites were of sites typically harvested under FP rules. In general, we

believe that the site and stand conditions in our study basins reflect the stands that landowners typically harvest in western Washington. In fact, the lower size limit for the basin area was driven by landowners, who indicated that they would not typically harvest a unit less than 12 ha (30 ac) in size. Forest Practices regulations constrained the upper size limit, which sets a 49-ha (120-ac) upper limit on harvest unit size without review by an interdisciplinary team (WFPB 2001; one study site exceeded this size by 5 ha (13 ac) because field validation of the fish end point resulted in its movement downstream, increasing the basin area). In terms of stand age at harvest, during the site selection process we queried landowners to verify the average minimum age at harvest and most agreed that 30 years was this minimum. The maximum stand age was established as 80 years, since harvest of stands over 80 years is infrequent in Washington State. As a result, we restricted potential study basins to those that would have a stand age predominantly between 30 and 80 years when harvested (April 2008 through August 2009). We do not have access to the data needed to evaluate whether the stand structures of our study sites reflect the range of stand structures typical across the managed landscape in western Washington, however, we have no reason to believe that there were substantial differences.

Finally, one commenter raised the issue of sample size. While a sample size of 17 may seem small, it is actually much larger than many landscape-scale ecological studies of the scope and duration of the Type N Study. CMER sought to develop a study that had the power to detect differences among treatments and we took measures to reduce variability and increase our ability to differentiate between the effectiveness of alternative buffers in our study design. Though sample size may be considered small for some scientific fields, the study design compensates for the small sample size in a variety of other ways. Specifically, we designed an experimental study with a before-after control-impact (BACI) approach that allows us to distinguish time from treatment effects. Further, the limitation of small sample size is often couched in terms of increased risk of a Type II error, or low power to detect a difference when, in fact, one exists. While all research must acknowledge the possibility of Type II error, in our study, we did detect a substantial number of statistically significant differences in the pre- to post-harvest change among treatments, demonstrating that our sample size (at least for many responses) was sufficient. In addition, study sites were located throughout much of western Washington to make our results more broadly applicable, and grouped in blocks to distinguish regional effects from treatment effects. We also worked closely with several industry and state agency scientists and statisticians when writing the study plan and analyzing the data. The total number of independent experts likely exceeded 30 individuals from a wide range of scientific fields, including statisticians, and institutions. Finally, the study design and all report chapters went through an Independent Scientific Review (ISPR) process and were approved by ISPR and CMER. In combination, these considerations give our study design, including sample size, some validation in terms of the ability to evaluate treatment effectiveness.

Extended response

One comment requested an evaluation of effectiveness of FP rules over time. Though this request is outside the scope of the findings presented in the Study Report at this time (which is only through two years post-harvest), we can provide a preliminary answers for stream temperature and amphibians through eight years post-harvest based on a report we are currently writing. Importantly, these results have not been through CMER or ISPR review, and a report is currently under development.

- Stream temperature: The FP rules were not effective in maintaining pre-harvest stream temperatures over the extended monitoring period. At seven years post-harvest, stream temperatures were significantly elevated in the spring and fall in all FP treatment sites and in the summer in two of the three FP treatment sites.
- Amphibians: We detected a significant decline in tailed frog density through eight years post-harvest that was not evident in the two years immediately following harvest. This decline was observed in all three riparian buffer treatments, including the FP treatment. For stream network-wide larval density the decline was greatest in the FP and 0% treatments, though we also saw a significant decline in the 100% treatment. For stream network-wide post-metamorph density, we noted the greatest decline in the FP treatment, though there was also a significant decline in the 100% treatment. Though the decline in the 0% treatment was not significantly different than the reference in the eight years following harvest, it was a significant decline compared with the density observed in the 0% treatment in the two years immediately following harvest.

Between-site variability

One comment had to do with the variability in response to treatments between sites. We remind Policy that all else being equal small sample size makes it more difficult (lower probability) to demonstrate difference among treatments. We found statistical difference among treatments so exploring between-site variability may be interesting but variability did not preclude us from demonstrating differences. Between-site variance may be useful if one is attempting to understand the lack of statistical difference in the overall BACI test for a treatment effect. That said, we presented site level information throughout the final report. Site means are frequently presented along with treatment means for responses. Though not all site-level information is presented in the results sections, we do present standard errors and confidence intervals, which can be used to understand variability between sites. Finally, site means are frequently presented by year and/or period (pre- and post-) in chapter appendices. Site mean information is specifically available for Chapter 5 - Stand Structure and Tree Mortality Rates in Riparian Buffers, Chapter 6 – Wood Recruitment and Loading, and Chapter 7 – Stream Temperature and Cover.

One specific comment asked how often stream temperatures exceeded pre-harvest levels and by how much. Post-harvest temperature was higher most of the year, compared to pre-harvest, with the magnitude varying by time of year and buffer treatment. There are many ways to present these data, and in order to provide this information PIs require more specific instruction from Policy. Much of the stream temperature data on a site-by-site basis have been provided in Chapter 7 (see chapter appendices).

Within-study site information

One comment addressed the role of the PIP buffers in providing habitat for amphibians and the effectiveness of the PIP buffers in maintaining amphibian populations. While data do exist to evaluate amphibian use within sites, these analyses have not been done and would require substantial consideration in terms of statistical approach (considering how our stream network-wide density estimates take into account detectability on a taxa-basis, and including other covariates). This requested comparison/analysis is outside of the scope of the current study design and objective; however, we do have data on a finer scale (within-site) that could be evaluated at that scale if Policy designates it as a priority.

General comment/technical edit

The remaining comments were of a general or technical editing nature and we respond to these individually in the comment matrix.