Type N Experimental Buffer Treatment Project in Hard Rock Lithologies: Phase III

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

24 March 2026

Approved by CMER on:

Presented by the: Landscape and Wildlife Scientific Advisory Group (LWAG)

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Type of Product in Review:

Prospective Answers: ☐ Charter ☐ Scoping Document ☐ Study Design
Retrospective: ☐ Completed Pilot/Study Phase ☒ Completed Final Study Report

Brief Description:
This study was designed to evaluate clear-cut harvest of lands managed for timber production with alternative riparian buffers on Type Np streams. Phase III reports on the response of stream-associated amphibians in the 14 and 15 year post-harvest period. The study included four experimental treatments including (1) an unharvested **Reference** (n = 6), and clear-cut upland harvest with three alternative riparian buffers that differed in the configuration of the riparian buffer in the RMZ: (2) **100% treatment** (n = 4), (3) **Forest Practices (FP) treatment** (n = 3), and (4) **0% treatment** (n = 4). Study sites were identified, selected, and assigned to treatment as a part of a feasibility phase of the study, as outlined in McIntyre et al. 2009. Sample sizes presented here reflect the number of sites and distribution across treatments for the Phase I report (McIntyre et al. 2018). See **Table 1** for the harvest timeline and periods of analysis for each study site and analysis period. Note that one reference site in the Willapa 2 block was originally assigned to the FP treatment, but harvest was delayed. Consequently, this site was used as a second reference until its harvest in 2016 when it became an FP treatment site for some analyses, including in this Phase III analysis. Note that two reference sites were harvested in 2020 and were excluded from the Phase III analysis. In FP treatment sites, buffer lengths ranging from 55 to 97% of the non-fish-bearing stream length exceeded the minimum required under Forest Practices (FP) rules. Unstable slopes required buffers wider than the minimum two-sided 50-ft buffers specified under FP rules, resulting in variable width buffers in some sites.

Pre-harvest data collection started in 2006. Timber harvest with riparian buffer treatments were applied July 2008 through August 2009 for all but one site that was harvested in 2016. The Phase III study included the post-harvest response for only stream-associated amphibians across three periods: post-harvest years one and two (Post 1 & 2), seven and eight (Post 7 & 8), and fourteen and fifteen (Post 14 & 15; **Table 1**). For a report on the response of all metrics evaluated through two years post-harvest see McIntyre et al. 2018. For a report on the response of metrics evaluated through eleven years post-harvest see McIntyre et al. 2021.

The results of this Phase III effort will inform resource managers of the efficacy of current FP rules, including how landowners can continue harvesting wood resources while protecting

important headwater habitats and associated species, and meeting resource objectives outlined in the FP HCP (Schedule L-1, Appendix N) "Overall Performance Goals", which states that "Forest Practices, either singly or cumulatively, will not significantly impair the capacity of aquatic habitat to support the long-term viability of other covered species."

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?**

   Yes. The objective of the Hard Rock Study was to evaluate effectiveness of a range of RMZ prescriptions for westside Type Np Waters, including the current rule, in maintaining key aquatic conditions and processes. Specifically, for Phase III, we evaluated whether the current riparian buffer prescriptions for Type Np Waters meet the Overall Performance Goal to support long-term viability of stream-associated amphibians (Schedule L-1).

   This effectiveness monitoring and research study addresses one of the Key Questions for adaptive management, namely, "*Will the rules produce forest conditions and processes that achieve resource objectives as measured by the performance targets, while taking into account the natural spatial and temporal variability inherent in forest ecosystems?*" (FPHCP, Appendix N, Schedule L-1).

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

   Yes. The study design and all final reports were reviewed and approved through the Independent Scientific Peer Review (ISPR) process.

4a. What does the study tell us?

The Phase III study addresses the following resource objectives and critical questions (2025-2027 CMER Work Plan):

Resource Objective: Provide conditions that sustain stream-associated amphibian population viability within occupied sub-basins.

Critical Questions:

- Is stream-associated amphibian population viability maintained by the Type N[p] prescriptions?
- What are the effects of three buffer treatments on stream-associated amphibians two years post-harvest?
- How do stream-associated amphibian populations respond to the Type N[p] prescriptions over time?

Importantly, the rules do not designate a metric for evaluating amphibian population viability (i.e., the ability of a population to persist and avoid extinction). Consequently, we used amphibian density at the Type Np basin scale and over the study period (15 years post-harvest) as an indicator of population viability. Given these considerations, the study concluded that the three buffer prescriptions appeared to be inadequate to meet the Overall Performance Goals to *not significantly impair the capacity of aquatic habitat to support the long-term viability of other covered species* (i.e., the FP-designated amphibians; FP HCP, Schedule L-1, Appendix N), at the spatial (Type Np stream basin) and temporal (15 years post-harvest) scales we sampled, with amphibian density used as a surrogate for "viability".

The FP-designated amphibians included in this study were Coastal Tailed Frog (*Ascaphus truei*) and three species of Torrent Salamanders (Olympic, Columbia, and Cascade; *Rhyacotriton olympicus, R. kezeri, R. cascadae*). We also evaluated the response of Coastal and Cope's Giant Salamanders (*Dicamptodon tenebrosus, D. copei*; which are not covered by the FPHCP).

Treatments were designed to compare the current FP riparian buffer prescriptions for non-fish-streams (WFPB 2001) to riparian management zones with less (no buffer) or more (full buffer) protection while holding other aspects of the FP riparian prescriptions as constant as conditions allowed (Hayes et al., 2005). Overall, we did not observe a consistent response gradient across taxa or study phases that aligned with the three buffer length treatments we implemented.

Table 1. Harvest timeline and periods of analysis for each study site included in Phase III of the study. An asterisk (*) indicates sites that were not included in Phase III (Post-harvest years 14 & 15) treatment response. "Pre" indicates the timeframe of data used for pre-treatment (Before) in BACI analyses. A caret (^) indicates that WIL-FP-2 was included as an FP treatment in this Phase III report because it was harvested in 2016.

<table>
<tr><th></th><th colspan="3">2006 2007 2008</th><th colspan="2">2009 2010</th><th colspan="2">2015 2016</th><th colspan="2">2022 2023</th></tr>
<tr><th>Site Code</th><th colspan="3">Pre-harvest Period</th><th colspan="6">Post-harvest Period</th></tr>
<tr><td>OLYM-REF</td><td colspan="3" rowspan="12">Pre 3, Pre 2, Pre 1</td><td colspan="2" rowspan="9">Post 1 & Post 2</td><td colspan="2" rowspan="9">Post 7 & Post 8</td><td colspan="2">Post 14 & Post 15</td></tr>
<tr><td>WIL-REF-1*</td><td colspan="2" rowspan="2">-</td></tr>
<tr><td>WIL-REF-2*</td></tr>
<tr><td>WIL-REF-3</td><td colspan="2" rowspan="6">Post 14 & Post 15</td></tr>
<tr><td>CASC-REF</td></tr>
<tr><td>OLYM-100%</td></tr>
<tr><td>WIL-100%-1</td></tr>
<tr><td>WIL-100%-2</td></tr>
<tr><td>WIL-100%-3</td></tr>
<tr><td>OLYM-FP</td></tr>
<tr><td>WIL-FP-1</td></tr>
<tr><td>WIL-FP-2^</td><td colspan="3">Pre-harvest</td><td>Post 1</td><td colspan="2">Post 7 & Post 8</td></tr>
</table>

CASC-FP				
OLYM-0% WIL-0%-1 WIL-0%-2 CASC-0%		Post 1 & Post 2	Post 7 & Post 8	Post 14 & Post 15

- We observed substantial declines for Coastal Tailed Frog larvae in all buffer treatments fourteen and fifteen years post-harvest. During the same period, torrent salamander densities declined in both the FP and 0% treatments, where harvest occurred to the stream in at least part of the RMZ.

- Results for all density estimates are presented as the within-treatment estimate of the pre- to post-harvest proportional change after controlling for temporal changes in the reference over the same period.

- Fourteen and 15 years post-harvest (Phase III; this phase), we observed a severe decline in Coastal Tailed Frog larval density in all three buffer treatments (71%, 95%, and 70% decline in the 100%, FP, and 0% treatments, respectively). This pattern was not evident in the first two years post-harvest (Phase I) but was revealed during the seven and eight years post-harvest monitoring period (Phase II). The following figure (Figure 5 from the Final Report) shows the trends in the proportional change across all study periods.

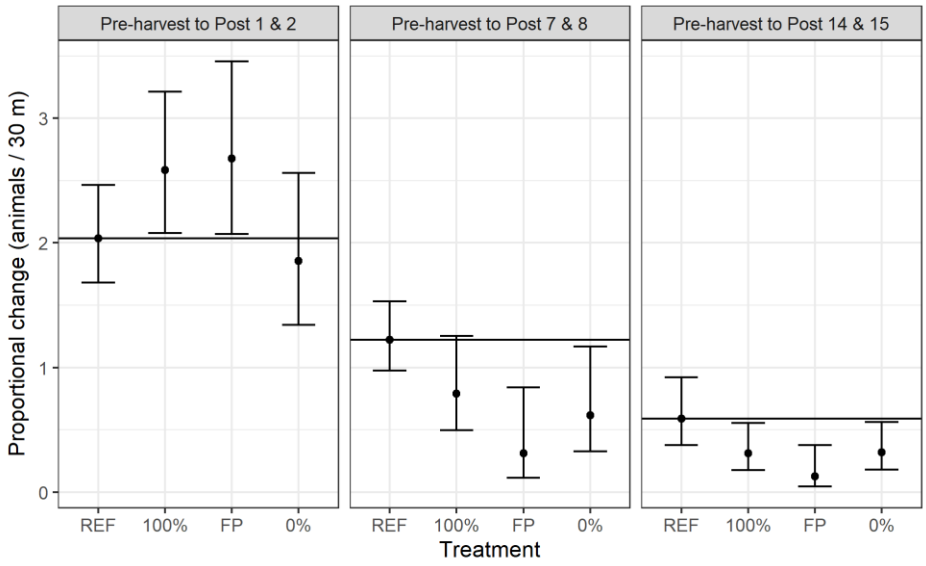

Figure 5 (as numbered in Final Report). The within-treatment estimate of the proportional change and approximate 95% credible intervals for mean larvae Coastal Tailed Frog density between the pre-harvest and post-harvest periods Post 1 & 2, Post 7 & 8 and Post 14 & 15. A horizontal line placed at the reference treatment (REF) value indicates the estimated temporal change under reference conditions.

- Fourteen and 15 years post-harvest, we found evidence of declines in post-metamorphic Coastal Tailed Frog densities across all buffer treatments, with estimated declines of -98%, -97%, and -85% in the 100%, FP and 0% treatments, respectively. We note that estimated declines in the buffer treatments relative to the reference were associated with an increase in densities in the reference in Post 14 & 15 from pre-harvest densities and these estimated declines were not evident in the two years post-harvest. The following figure (Figure 7 from the Final Report) shows the trends in the proportional change across all study periods.

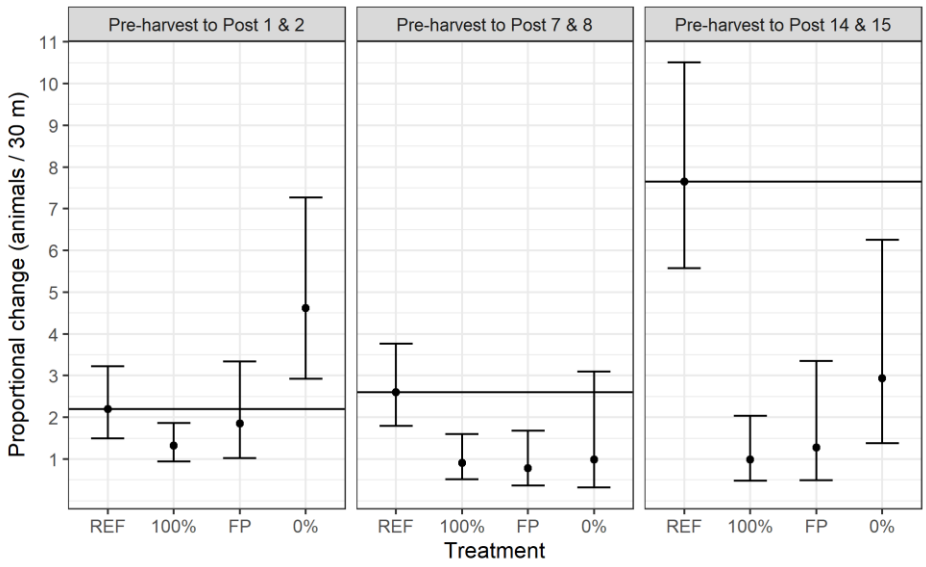

Figure 7 (as numbered in Final Report). The within-treatment estimate of the proportional change and approximate 95% credible intervals for mean post-metamorphic Coastal Tailed Frog density between the pre-harvest and post-harvest periods Post 1 & 2, Post 7 & 8 and Post 14 & 15. A horizontal line placed at the reference treatment (REF) value indicates the estimated temporal change under reference conditions.

- Fourteen and 15 years post-harvest, we estimated an 88% and 80% decline in torrent salamander density for the FP and 0% treatments, respectively. We also estimated a 42% decline in the 100% treatment, however, the direction of this effect was uncertain. Two years post-harvest, we estimated increases in torrent salamander densities across the buffer treatments that did not persist into seven and eight years post-harvest. The following figure (Figure 9 from the Final Report) shows the trends in the proportional change across all study periods.

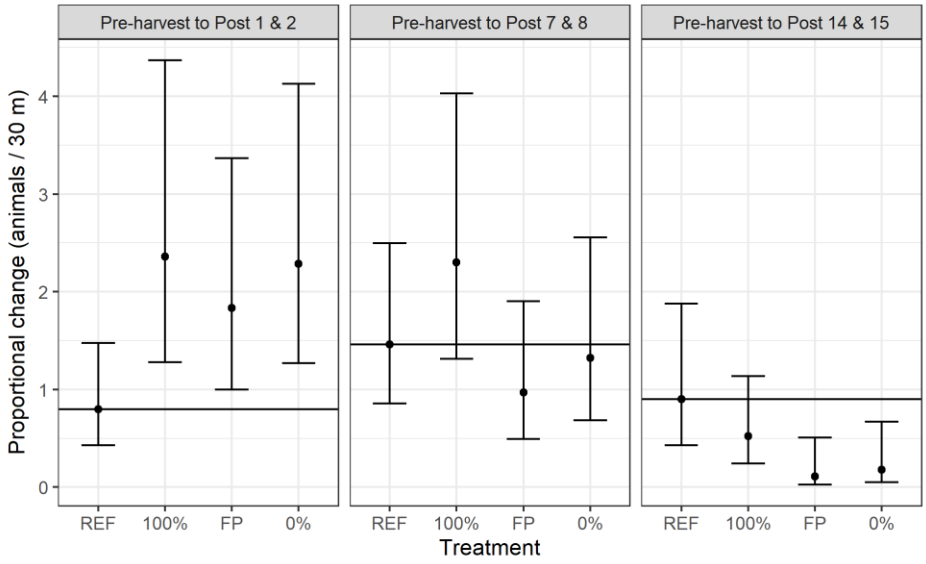

Figure 9 (as numbered in Final Report). The within-treatment estimate of the proportional change and approximate 95% credible intervals for mean torrent salamander density between the pre-harvest and post-harvest periods Post 1 & 2, Post 7 & 8 and Post 14 & 15. A horizontal line placed at the reference treatment (REF) value indicates the estimated temporal change under reference conditions.

- Fourteen and 15 years post-harvest we estimated a decline of 81% in giant salamander density for the FP treatment only. The decline was consistent with results from the previous post-harvest periods with a decline of 65% in Post 1 & 2 and 53% decline in Post 7 & 8. The following figure (Figure 11 from the Final Report) shows the trends in the proportional change across all study periods.

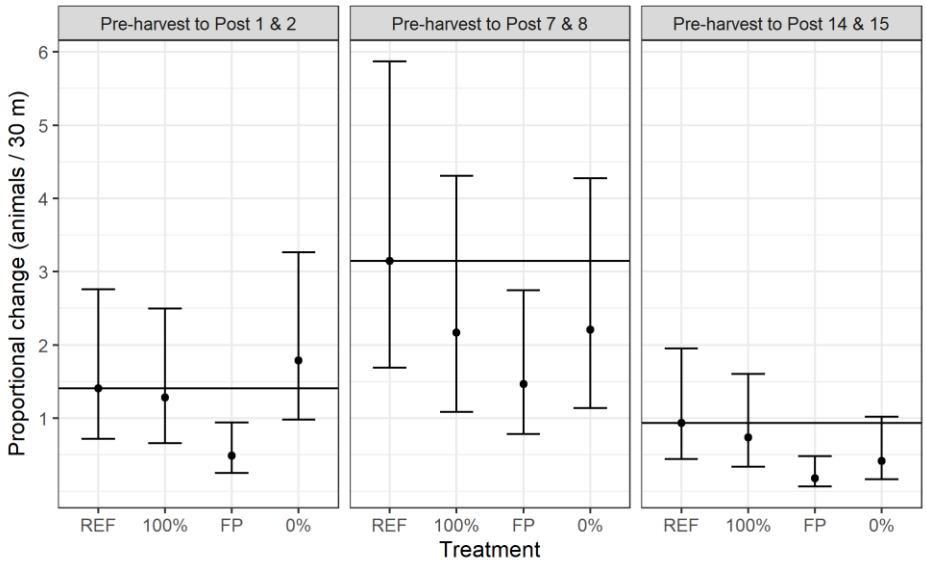

Figure 11 (as numbered in Final Report). The within-treatment estimate of the proportional change and approximate 95% credible intervals for mean giant salamander density between the pre-harvest and post-harvest

periods Post 1 & 2, Post 7 & 8 and Post 14 & 15. A horizontal line placed at the reference treatment (REF) value indicates the estimated temporal change under reference conditions.

4b. What does the study not tell us?

In general, when applying these results, or those from any study, one should consider the site selection criteria, applied harvest prescription(s), and time elapsed since harvest. In this experimental study, we selected sites meeting specific criteria so the observed post-treatment effects (e.g., amphibian density) are more likely to be due to the treatment than to inherent differences among the study sites. The study was designed to evaluate categorical treatment effects. As a result, the study does not provide information about mechanisms or analyses of additional covariates (e.g., post-harvest changes in stream temperature or other water quality measurements) that were not manipulated directly. Of note, since our methodology focused on instream sampling, potential impacts to post-metamorphic Coastal Tailed Frog and Coastal Giant Salamanders using terrestrial habitat were not addressed in this study.

The range of experimental treatments may also limit scope of inference if these differ from forest practices in use by landowners. This study manipulated the proportion of channel with a two-sided 50-ft wide buffer, with three buffer treatments. In practice, only the 0% treatment site buffers were relatively uniform, while the 100% treatment varied widely in width and the FP sites varied from 55 – 97% of stream length buffered. Variability in unit lay-out and basin harvest rates may lead to outcomes different than what we estimated in this study. Further, to maximize the effect of the buffer treatments and to reduce confounding effects, we designed the study so that harvest units would encompass the entire Type Np basin where possible. Variability in FP buffers in practice can be even greater than that seen in this study because entire Np basins may be harvested over multiple years, rather than in a single entry.

Spatial Scope of Inference: The spatial scope of inference is limited to Type Np basins dominated by competent lithologies which comprise approximately 29% of western Washington Forests and Fish-regulated lands (personal communication, P. Pringle September 2005, formerly Washington Department of Natural Resources). We selected study sites based on specific criteria, including the presence of focal stream-associated amphibians. One hundred fifteen (115) non-fish-bearing basins within the geographic scope of the study met initial site selection, ownership, and flow condition criteria (McIntyre et al., 2009). Of these, focal amphibian presence was verified at 58 sites; of these, 18 sites were determined to be suitable for inclusion based on landowner and logistic considerations, including timing of harvest implementation (McIntyre et al., 2009). Of these 18 sites, one was dropped during the 2008 economic recession, when the harvest treatment could not be fully implemented as designed due to landowner economic considerations.

The transferability of the study findings to other Type Np basins must be done carefully because the physical characteristics, management history, and harvest intensity among Type N basins, across the landscape, are highly variable. Therefore, extrapolating study results across the landscape requires knowledge of physical and environmental variability among headwater basins to provide a spatial context for inference.

Temporal Scope of Inference: The temporal scope of inference should be relatively reliable for the first 15 years after harvest for basins with similar characteristics. Importantly, this study

offers insights into variation in amphibian densities across multiple post-harvest time periods and includes a longer monitoring time frame than most forest management studies. This study does not quantify responses across a full harvest rotation of ~40 years (the approximate age of the majority of the stands we included in the study).

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

The following relevant studies are either planned, underway or recently completed. For more information comparing specifics between this and listed projects, see the answers to the CMER Six Questions for Policy for the Phase I Report.

Planned Studies:

- Van Dyke's Salamander Project (a literature review was completed, not scoped)
- Eastside Amphibian Evaluation Project (not scoped)
- Coastal Tailed Frog Extensive Status Project (not scoped)

Underway Studies:

- Eastside Type N Riparian Effectiveness Project [ENREP Study]
- Water Temperature and Amphibian Use in Type Np Waters with Discontinuous Surface Flow in Western Washington Project (study design in review)
- Extensive Riparian Status and Trends Monitoring Project (study design in development). TFW Policy directed study design development for an "eDNA add-on" to evaluate stream-associated amphibian occupancy status and trends.

Completed Studies:

- Type N Experimental Buffer Treatment Project in Soft Rock Lithologies Project [Soft Rock Study]
- Type N Experimental Buffer Treatment Project in Hard Rock Lithologies Project [Hard Rock Study]: Phase I
- Type N Experimental Buffer Treatment Project in Hard Rock Lithologies Project [Hard Rock Study]: Phase II
- Westside Type N Buffer Characteristics, Integrity, and Function Project [BCIF Study]
- Buffer Integrity – Shade Effectiveness (Amphibians) Project [Shade Study]
- Amphibian Recovery Project
- SAA Detection/Relative Abundance Methodology Project

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?

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

The underlying assumptions of the current rule prescriptions for Type N Waters were based on limited experimental research studies related to riparian ecological processes, habitat needs of covered species and forest management effects on larger streams (as cited in the FPHCP). However, even more limited efforts informed the riparian prescriptions specifically for stream-associated amphibians. Although Schedule L-1 does not articulate a Performance Target for stream-associated amphibians, an Overall Performance Goal is to support the long-term viability of other covered species, which are specifically the seven amphibians listed in the FPHCP. Further, the 2025-2027 CMER Work Plan defines a Resource Objective to provide conditions that sustain stream-associated amphibian population viability within occupied sub-basins. The FP-designated amphibians included in this study were Coastal Tailed Frog and three species of Torrent Salamanders (Olympic, Columbia, and Cascade). We also evaluated the response of two species of Giant Salamanders (Coastal and Cope's) not covered by the FPHCP.

Current RMZ requirements for westside Type Np Waters were developed to maintain important ecological processes and provide levels of large wood, shade and other riparian functions adequate to meet conservation objectives (FPHCP, Chapter 4d – Rationale for the Plan). The management approach for westside Type Np riparian prescriptions employs a patch-cut strategy, where a portion of the riparian stand in a Type Np basin RMZ may be clearcut if sensitive sites are buffered with patch buffers (minimum 56-ft radius) and at least 50% of the perennial stream length is buffered with a two-sided minimum 50-ft buffer. The underlying assumptions of the current rule prescriptions for Type Np Waters reflect limited experimental evidence related to riparian ecological processes, habitat needs of covered species, and forest management effects on larger streams. The following information is based on that found in Chapter 4d of the FPHCP. For discussions that include relevant literature published between the finalization of the FPHCP in 2005 and now, see the chapters for the individual response metrics in the study reports.

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

This study provides a substantial gain in understanding of the degree to which Type Np FP rules meet the Overall Performance Goal in Schedule L-1 of the FPHCP (Appendix N) and the Resource Objective and Critical Questions outlined in the CMER Work Plan to provide conditions that sustain stream-associated amphibian population viability within occupied sub-basins.

The BACI study design is very robust to the extent that it can provide causal linkages between the experimental riparian buffer treatments and impacts to stream-associated amphibians. The study design included variable length riparian buffer treatments to allow for comparison of the current forest practice rule with buffer lengths both more protective (100%) and less protective (0%). The length of the study through fifteen years post-harvest expands on the timeline relative to other similarly rigorous studies, and is especially important as stream-associated amphibians may exhibit a delayed response to the treatments. Our results also provided information about the baseline densities of stream-associated amphibians in occupied sub-basins in 2nd growth, managed forest landscapes in western Washington, and our BACI study design expanded on some previous studies that were largely retrospective.

If not already done so within the answers to the six questions above, provide the technical implications/recommendations resulting from the study.

Technical Implications and Recommendations:

- This study focused on the response of stream-associated amphibians to timber harvest at the sub-basin scale. The Coastal Tailed Frog Extensive Status Project would inform broader-scale status of FP-covered amphibian demographics to evaluate landscape-scale effects of implementing FP riparian prescriptions and document trends in these indicators over time. The Extensive Riparian Status and Trends Monitoring Project – eDNA add-on would also inform landscape-scale status of stream-associated amphibians including Coastal Tailed Frog and torrent salamanders. However, the eDNA add-on would have a more limited ability to assess demographic responses than those proposed in the Coastal Tailed Frog Extensive Status Project.
- Monitoring at the existing study sites over a longer time could provide information about duration of disturbance effects and the progress of recovery of stream-associated amphibians in Type Np basins receiving these riparian buffer prescriptions.
- The Overall Performance Goal in Schedule L-1 for "other covered species" and the CMER Work Plan Resource Objective for stream-associated amphibians use *viability* as a metric for evaluating performance of forest practices rules. However, a definition of "viability" and metrics for evaluating viability are not provided in either document. Further discussion about the interpretation and application of viability in the context of the FPAMP is recommended.

References

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