CMER/Policy Interaction Framework Prospective Six Questions

Type N Hard Rock Extended Monitoring (Amphibian Demographics) Phase III

Presented to CMER on May 26th, 2020

Type of Product in Review:

Prospective Answers: ☐ Charter ☐ Scoping Document ☐ Study Design

Retrospective: ☐ Completed Pilot/Study Phase ☐ Completed Final Study Report

Brief Description: This is a request for approval of funding allocation to extend monitoring (proposed as Phase III) for amphibian demographics as a part of the Type N Experimental Buffer Treatment Project in Hard Rock Lithologies (hereafter, Hard Rock Study). The Hard Rock Study design was approved by Independent Scientific Peer Review (ISPR) and CMER in 2006. The study is a BACI (Before-After Control-Impact)-designed study that compares buffer effectiveness of the current Forest Practices (FP) Rules for non-fish-bearing perennial streams (Type Np Waters) to buffer alternatives, including no buffer in the Riparian Management Zone (RMZ) and a RMZ buffer along the entirety of the Type Np Water length. These alternative riparian buffer treatments (FP, 0%, and 100% buffers, respectively) were compared to references that were not harvested during the study period. During Phase I of the Hard Rock Study, pre-harvest data were collected 2006-2008, harvest implementation with alternative RMZ treatments was implemented spring 2008 through summer 2009, and post-harvest sampling began immediately after harvest for two or more years from 2009-2011. Findings for Phase I are reported on in McIntyre and colleagues (2018). For Phase II of the Hard Rock Study, we collected additional data from 2011 through 2018. The report outlining those findings has been approved by CMER and is in ISPR review. Additional stream temperature monitoring occurred in 2018 and 2019, and an analysis and reporting of those results is pending. The following prospective six questions are for the proposed Phase III of the Hard Rock Study.

1. **Will the study inform a rule, numeric target, Performance Target, or Resource Objective?**
   Yes.
2. **Will the study inform the Forest Practices Rules, the Forest Practices Board Manual guidelines, or Schedules L-1 or L-2?**

   Yes. The overall Hard Rock Study objective is to evaluate the effectiveness of the current Westside riparian management zone (RMZ) prescriptions for Type Np Waters in maintaining key aquatic conditions and processes affected by Forest Practices. Phases I and II evaluated whether alternative RMZ treatments on Type Np Waters met the following overall Performance Goals: (1) to support the long-term viability of stream-associated amphibians, and (2) to meet or exceed water quality standards (WQS).

   The Hard Rock Study also assessed the Forest Practices Resource Objectives defined for key aquatic conditions and processes affected by forest practices outlined in the Forest Practice's Habitat Conservation Plan (WADNR 2005; hereafter, FPHCP), Appendix N, Schedule L-1. Phase I and II of the study addressed Resource Objectives for heat/water temperature, large wood/organic inputs, and hydrology. One should recognize that not all study responses had corresponding Functional Objectives and Performance Targets in Schedule L-1 (e.g., stream-associated amphibians), and for

these, applicable Resource Objectives and Critical Questions outlined the CMER Work Plan were identified.

This study also addresses the key questions of whether the rules produce forest conditions and processes that achieve Resource Objectives as measured by the Performance Targets, while considering the natural spatial and temporal variability inherent in forest ecosystems?" (FPHCP, Appendix N, Schedule L-1). Finally, the overall Hard Rock Study design addressed CMER Work Plan Critical Questions derived from Schedule L-1, including if riparian processes and functions provided by Type N buffers are maintained at levels that meet Forest Practices (FP) Habitat Conservation Plan (HCP) Resource Objectives and Performance Targets for shade, stream temperature, large wood recruitment, litterfall, and amphibians; how other buffers compare with the FP Type N prescriptions in meeting Resource Objectives; and, how Type N riparian prescriptions affect water quality delivered to downstream Type F/S waters.

Proposed extended monitoring (Phase III) will focus on addressing Overall Performance Goals, Resource Objectives and key questions specific to the response of stream-associated amphibians across study sites in the 14 years following harvest. A Schedule L-1 Overall Performance Goal is supporting the long-term viability of "other covered species," which includes stream-associated amphibians. Additionally, a Resource Objective outlined in the CMER Work Plan is to provide conditions that sustain stream-associated amphibian populations within occupied sub-basins. Finally, Critical Questions in the CMER Work Plan also address whether stream-associated amphibian population viability is maintained by the Type N prescriptions and how stream-associated amphibian populations respond to the Type N prescriptions over time.

3. Will the study be carried out pursuant to CMER scientific protocols?

Yes. The study design was carried out for Phases I and II according to the CMER- and ISPR-approved study design. Phase III monitoring would utilize the same approved sampling designs.

4. A. What will the study tell us?

Preliminary results from data collection through 2017 and outlined in the report that is still in ISPR review indicate a delayed negative response to harvest for some stream-associated amphibian species in some treatments. Focal amphibians included Coastal Tailed Frog, three species of torrent salamanders and two species of giant salamanders (the latter are not covered under the FP Habitat Conservation Plan (HCP)). There was evidence of an increase in density in the two years following harvest for tailed frog larvae in the FP treatment, and post-metamorphic tailed frogs and torrent salamanders in the 0% treatment. However, results for the eight years following harvest no longer indicated an increase for any taxa in any treatment relative to the reference. In fact, a substantial decline (> 50%) was observed in Coastal Tailed Frog densities in all buffer treatment sites in the eight years following harvest. Declines were estimated to be -65%, -93% and-84% in the 100%, FP, and 0% treatments, respectively. There was also a delayed decline of -64% detected for torrent salamanders in the FP treatment. While there was evidence of a decline in giant salamander density in the FP treatment in the two years following harvest, there was no statistical support for a continued decline in the eight years following harvest. Based on these findings, Study PIs and LWAG strongly recommend Phase III monitoring for stream-associated amphibians beginning as soon as the 21-23 biennium.

Focal amphibians are long-lived, with the longest lived, Coastal Tailed Frog, estimated to live up to 15 years or more. Though few data exist on age at reproduction for Coastal Tailed Frog, estimates are from three to nine years depending on sex and location in their range, with a longer time to reproductive maturity estimated for animals towards the northern end of their range (Hayes and Quinn 2015). Consequently, monitoring 1- and 2-years following harvest focused primarily on the amphibian demographic response of individuals that were present in study sites prior to harvest. The sampling done 7- and 8-years following harvest ensured that most individuals surveyed were born in the post-harvest period. Monitoring starting in the 21-23 biennium (~14 years after harvest) or later would be the first opportunity to evaluate amphibian density based on individuals that are predominantly *offspring of individuals that were born in the post-harvest period*. Phase III monitoring will allow us to evaluate long-term trends in amphibian densities in treated sites following harvest. Specifically, with the substantial decline for some amphibian species in some or all treatments, we could evaluate whether declines continued or stabilized, or whether we observe evidence of recovery. Covariate data, including stream temperature, will be collected concurrent with amphibian sampling to provide important information to aid in the interpretation of the amphibian response.

Timing of monitoring beginning in the 21-23 biennium would be ideal and in keeping with the previously established 7- to 8-year interval between post-harvest samples. However, if funding and priorities do not allow for monitoring in the upcoming biennium, then monitoring in any of the next two or three biennia would be valuable and informative. We emphasize the enormous time and cost already invested in this study. A similar repeat effort is extremely unlikely. The potential gain in understanding for a comparably small cost cannot be overemphasized. Because of the longevity and time to maturity for focal amphibians and considering our findings through eight years post-harvest, viability over time and continued occupancy at the sub-basin scale can only be addressed with further study.

B. What will the study not tell us?

One should consider a number of study limitations when interpreting and generalizing the results. CMER designed the Hard Rock Study to evaluate the overall influence of the FP buffer strategy as it is applied under real world circumstances, i.e., as harvest rules are applied operationally in Western Washington. Application of clearcut timber harvest included buffers for sensitive sites and unstable slopes, and followed other best management practices (BMPs), ultimately, influencing the length and width of buffering in treatment sites. Riparian buffers in FP treatment sites were 50 ft wide, as specified in the FPHCP. However, due to BMPs RMZ buffers across all FP treatment sites were longer than the minimum requirement of 50% of the stream length buffered. We do not know if the results for the FP buffers would have been different if only the minimum riparian buffers had been applied. We also do not know how frequently more than the minimum buffer length is applied across the managed landscape. However, given that the response for Coastal Tailed Frog in the FP treatment did not differ from the response in the 100% and 0% buffers, we have no reason to believe that buffers of only 50% would have altered the response, at least for this species. Furthermore, unexpectedly, the negative response for torrent salamanders was observed in only the FP treatment, which was moderate in buffer length to those in the 100% and 0% treatments. Protection of unstable slopes also resulted in wider riparian buffers along some portions in two of four 100% buffer treatment sites, which may have minimized the impacts of this buffer treatment in these sites. Nevertheless, we still observed a negative impact of harvest on Coastal Tailed Frogs in the 100% treatment.

The spatial scope of inference is limited to Type N basins dominated by competent lithologies, which comprise approximately 29% of Western Washington Forests and Fish-regulated lands (P. Pringle, personal communication, September 2005, formerly Washington Department of Natural Resources). One should not assume that the results apply equally to other lithologies. Additional considerations include the fact that all sites, including references, were in second-growth forests and ranged from approximately 12 to 53 ha (30 to 130 ac). The temporal scope of inference will only apply to the fifteen years after harvest. One cannot assume that the results be applicable over a longer period.

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

The collective results from the Hard Rock Study, Soft Rock Study, BCIF Study, Shade Study, and Amphibian Recovery Project are expected to provide a thorough assessment of riparian prescription effectiveness for Westside Type Np Waters. They have or will generate data that can be used to determine if the resource objectives for heat/water temperature, LWD/organic inputs, sediment, hydrology and stream-associated amphibians (except for terrestrial Dunn's and Van Dyke's Salamanders) are being met:

Type N Experimental Buffer Treatment Project in Soft Rock Lithologies Project [Soft Rock Study, final report in ISPR review]: The Soft Rock Study expands on the knowledge gained from the Hard Rock Study by evaluating the changes in riparian stand conditions, buffer tree mortality, LWD recruitment, shade and stream temperature, and nutrient and sediment export from westside Type Np basins with sedimentary lithologies. This study differs from the Hard Rock study in that it includes only one riparian buffer treatment that replicates current Forest Practices rules (equivalent to the Hard Rock Study FP treatment). Both the Hard and Soft Rock studies use a manipulative experimental BACI design to compare effectiveness of riparian buffers with unharvested controls. Like the Hard Rock Study, the Soft Rock Study is limited to Western Washington. It also does not evaluate the response of stream-associated amphibians, fish, or litterfall. The Soft Rock Study will provide important confirmation of the effect of forest practices prescriptions on more erodible substrates that are potentially more sensitive to forest practices and that were not included in the Hard Rock Study.

Westside Type N Buffer Characteristics, Integrity, and Function Project [BCIF Study, completed]: The BCIF Study evaluated the magnitude of change in riparian stand conditions, tree mortality, shade and LWD recruitment when prescriptions were applied on a reach-scale at sites selected from a random sample of forest practice applications. The Hard Rock Study expanded on the knowledge gained in the BCIF Study, supplementing the results from the latter by increasing the sample of clearcut, 50-ft buffer and PIP buffer RMZ reaches. These results are particularly helpful in reducing the level of uncertainty in PIP buffer response, increasing the sample size and providing PIP reference data. Findings through five years post-harvest are reported on in Schuett-Hames and colleagues (2011). Findings through 10 years post-harvest are reported on in Schuett-Hames and colleagues (2019).

Buffer Integrity – Shade Effectiveness (Amphibians) Project [Shade Study, completed]: The Shade Study was intended to isolate the impacts of shade reduction from the impacts of potential increased sedimentation related to timber removal in the RMZ. This project examined the effects of shade reductions on stream-associated amphibians, water temperature, primary productivity, litterfall and macroinvertebrates. Findings are reported on in Hayes and colleagues 2011.

Amphibian Recovery Project [completed]: This project evaluated the effects of three buffer treatments on headwater streams throughout coastal Western Washington, including: (1) unthinned riparian buffers, (2) partial buffer, (3) buffer of non-merchantable trees, and (4) clearcut to the channel edge. The study included an evaluation of stream channel characteristics, wood loading, stream temperature, sediment, macroinvertebrates and stream-associated amphibians. One year of pre-harvest and up to three years of post-harvest data were collected. See Jackson and colleagues (2001, 2007), and Haggerty and colleagues (2004).

One additional amphibian-focused study that has the potential to inform riparian prescription effectiveness for westside Type Np Waters is the Water Temperature and Amphibian Use In and Around Type Np Waters with Discontinuous Surface Flow Project (formerly the Amphibians in Intermittent Streams Project; underway): This study will examine stream temperature and amphibian use in and around Type Np Waters with discontinuous surface flow, a condition that often occur at or near the origin of headwater streams. It is intended to inform the efficacy of the westside riparian prescription in maintaining stream temperatures and amphibian occupancy in intermittent reaches. Currently, data from previous CMER-sponsored (e.g., Hard Rock Study) and other studies are being summarized to inform potential need for study on this topic.

What are the costs associated with additional studies?

Study PIs and LWAG propose Phase III amphibian monitoring in two consecutive years beginning as early as the 21-23 biennium. Natural annual variability in amphibian populations is high and counts for some species were small and/or zero for some study sites and years. This was the case for Coastal Tailed Frog in particular, for which we observed the most substantial declines in all buffer treatments in post-harvest years 7 and 8. Including at least two years of amphibian monitoring during each sample period helps account for the effect of natural variability in our estimate of treatment response and increases our chances of obtaining adequate sample sizes at all study sites. Two years of additional monitoring is also supported by the potential loss of reference sites, which will result in a decreased precision in our treatment estimates. However, if funding and priorities do not permit, there remains value in a single year of additional monitoring. Our amphibian sampling methodologies are both intensive and extensive. Even if we detect few or no individuals for some species and sites, we feel confident that we will provide a more robust assessment of amphibian response to Forest Practices Rules in Western Washington than has previously existed, even if we cannot conduct the same statistical analysis as was done previously.

Budget estimates and proposed timing for Phase III amphibian monitoring across Type N Hard Rock study sites:

Phase/Component	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**Total**
Amphibian Monitoring – two years (Ideal – see justification)	$130,000	$412,000	$349,000	$82,000	$20,000	$993,000
Amphibian Monitoring – one year (suitable)	$130,000	$349,000	$82,000	$20,000		$581,000

Proposed monitoring could be pushed into the future. However, once initiated, we do not recommend a break in funding. The best justification for not having a break in sampling between monitoring years is two-fold. Most importantly, the purpose of multiple years of sampling is to get an increased level of accuracy for the current amphibian densities for a snapshot in time, while accounting for spatial and temporal variability. The two years are considered in combination in the analysis. More than a year break between monitoring years has the potential to add unwanted variability from either a change in the amphibian response through time, and/or environmental stressors that cannot be controlled. Second, there is a cost associated with reestablishing transects at study sites, and it would not be efficient or costly to invest in this activity multiple times in a short period. A final consideration is that the sampling season (June to September) spans fiscal years, so funding is required for field monitoring in adjacent fiscals regardless of whether Policy supports one or two years of additional field sampling.

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 Hard Rock Study is a unique, long-term study evaluating applicable riparian buffer treatments in a BACI-designed study. Considerable value exists in continued Phase III monitoring for interpretation of the longer-term potential change. We feel confident that Phase III monitoring will enable a broader perspective of the impacts of current FP-rule effectiveness on stream-associated amphibians, especially as it relates to population viability at the basin scale. Longer-term study will also allow us to understand the effects of harvest over a longer temporal scope. However, there are a couple of considerations that may have implications for our statistical analysis approach. Coastal Tailed Frogs were particularly difficult to find in some study sites in post-harvest years 7 and 8, resulting in small counts and/or zeros for some sites and years. This impacted our ability to adjust counts for estimates of detection. Nonetheless, we were able to conduct a meaningful analysis. If populations continue to decline, our ability to conduct some statistical analyses may be affected. If we are unable to detect species with our intensive and extensive sampling approach, then we feel confident this will be an indication of continued declines, even if we cannot quantify it with the same statistical approach we have used in the past.

The incremental gain in understanding will lose some resolution if we continue to lose reference sites to harvest. Two of six reference sites were recently harvested: one was clearcut harvested following FP rules; a second was upland thinned with a continuous RMZ buffer. Timber harvest is also planned for two additional references, currently scheduled for calendar year 2020. Though harvest has not yet occurred, we were informed recently that it is scheduled to begin shortly. Potential issues associated with a reduction in the number of references from six in the Phase I and II periods to only two in Phase III include a loss of precision and replication, though mathematically the data can still be analyzed. The statistician who has supported the analysis of amphibian results to date has offered to estimate the loss of precision with only two references. The loss of replication affects our confidence that our reference sample is representative of the population. If additional references are lost, a statistician could suggest some changes to the model that should help improve estimation efficiency. Clearly, investigation of the best statistical analysis considering the reduction in reference sample size will be required if the two sites are harvested. However, they have not been harvested yet and with the economic downturn some chance exits of a delay. Nonetheless, even if these references are harvested, the long-term nature of the data set, extensive baseline pre-treatment data, and two references that are unlikely to ever be harvested due to regulatory

constraints, gives us confidence that Phase III monitoring will result in meaningful and applicable information that informs the degree of effectiveness of the current Forest Practices rules and buffer alternatives in achieving resource objectives.

The underlying assumptions of the current FP Rules 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 (FPHCP). The Hard Rock Study Phases I and II improved our understanding of the degree to which Type Np Forest Practices rules meet the Resource Objectives and Performance Targets outlined in Schedule L-1 of the FP HCP (Appendix N). Phase III monitoring will focus on the response of stream-associated amphibians approximately 14 years after harvest, providing a rare opportunity to evaluate the longer-term impacts to long-lived FP-designated species. Long-lived species frequently do not respond to disturbance until multiple years after the event. We did not detect a negative impact to Coastal Tailed Frogs or torrent salamanders in the two years immediately following harvest, but we did see a delayed negative response in the eight years following harvest. Phase III sampling will provide our first, and possibly only, opportunity to evaluate the Overall Performance Goal of supporting the **long-term viability** of stream-associated amphibians, the Resource Objective to provide conditions that **sustain stream-associated amphibian population viability within occupied sub-basins**, and the Critical Question of whether stream-associated amphibian population viability is maintained and how stream-associated amphibian populations **respond to the Type N prescriptions over time**.

Citations

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