Type N Experimental Buffer Treatment Project in Hard Rock Lithologies – Report to Policy on Stream-associated Amphibians (Chapter 15)

11 December 201 7– For CMER Review

Study Report

The results from this study are found in the following Study Report:

McIntyre, A.P., M.P. Hayes, W.J. Ehinger, D. Schuett-Hames, S.M. Estrella, G. Stewart, R.E. Bilby, E.M. Lund, J. Walter, J.E. Jones, R. Ojala-Barbour, F.T. Waterstrat, C.R. Milling, A.J. Kroll, B.R. Fransen, J. Giovanini, S.D. Duke, G. Mackenzie, R. Tarosky, J.G. MacCracken, J. Thronton and T. Quinn. 2017. Effectiveness of Experimental Riparian Buffers on Perennial Non-fish-bearing Streams on Competent Lithologies in Western Washington. Cooperative Monitoring Evaluation and Research Report CMER XX-XXX, Washington State Forest Practices Adaptive Management Program, Washington Department of Natural Resources, Olympia, WA.

CMER/Policy Interaction Framework Six 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?** Yes.

The objective of the Type N Experimental Buffer Treatment Project in Hard Rock Lithologies (Hard Rock Study) was to evaluate the effectiveness of the current westside riparian management zone (RMZ) prescriptions for Type N (non-fish-bearing) Waters in maintaining key aquatic conditions and processes affected by Forest Practices. Specifically, we evaluated whether the riparian buffer prescription for Type N streams met the following overall Performance Goals, namely: (1) to support the long-term viability of stream-associated amphibians, and (2) to meet or exceed water quality standards. As part of this evaluation, we assessed the Forest Practices Resource Objectives (defined as a series of Functional Objectives and corresponding Performance Targets in Schedule L-1) for heat/water temperature, large wood/organic inputs, and hydrology.

The overall study design addressed the following CMER Work Plan Critical Questions:

- Are riparian processes and functions provided by Type N buffers 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 do other buffers compare with the FP Type N prescriptions in meeting Resource Objectives?
- How do Type N riparian prescriptions affect water quality delivered to downstream Type F/S waters?

3. **Was the study carried out pursuant to CMER scientific protocols?**

Yes. The study design was carried out according to the CMER and Independent Scientific Peer Review (ISPR) approved study design (including sampling methodologies, statistical

methods, and study limitations). SAGs (RSAG and LWAG), CMER, and ISPR reviewed all of the study chapters and their associated findings, and CMER approved the entire final report in September 2017.

4. **A. What does the study tell us?**

When considering stream network-wide amphibian density in the two years immediately following harvest, we observed an increase in larval Coastal Tailed Frog density in the 100% and FP treatments that differed significantly from the estimated pre- to post-harvest change in the reference and 0% treatment. We also observed an increase in post-metamorphic Coastal Tailed Frog density in the 0% treatment that differed significantly from the estimated change in the reference, 100% and FP treatments. We did not detect a difference in the change of torrent salamander density between any of the treatments. Finally, though not an FP-designated amphibian, we observed a decrease in giant salamander density in the FP treatment that differed significantly from the estimated change in reference, 100% and 0% treatments.

There are no Resource Objectives specific to stream-associated amphibians outlined in Schedule L-1. However, we used the response of stream-associated amphibians to alternative riparian buffer prescriptions on Type N Waters to evaluate the Schedule L-1 Overall Performance Goal of supporting the long-term viability of "other covered species," which includes stream-associated amphibians. There is also a Resource Objective and several Critical Questions for stream-associated amphibians outlined in the CMER Work Plan.

Resource Objective (CMER Work Plan): Provide conditions that sustain stream-associated amphibian population viability within occupied sub-basins.

Critical Questions (CMER Work Plan):

- Is stream-associated amphibian population viability maintained by the Type N 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 prescriptions over time?

The definition of population viability is the ability of a population to persist and avoid extinction. The rules do not designate a metric for evaluating amphibian population viability. We used population density as an indicator of viability; however, to address amphibian population viability adequately, longer-term study is required.

Though we did not design the study to address occupancy or reproduction on the reach scale, we do have data that can inform the following additional Critical Questions:

- Do stream-associated amphibians continue to occupy and reproduce in the patch buffers?
- Do stream-associated amphibians continue to occupy and reproduce in ELZ-only reaches?

The forest practices-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).

Results:

- The post-harvest change in stream network-wide larval Coastal Tailed Frog (*Ascaphus truei*) density differed among treatments ($P < 0.0001$). Density increased in intermediate treatments (i.e., 100% and FP) relative to both the reference and 0% treatment. We detected significant post-harvest increases in the 100% and FP treatments that were 4 ($P = 0.02$) and 8 ($P < 0.0001$) times greater, respectively, than the post-harvest change in the reference. The change in the 0% treatment did not differ statistically from the change in the reference, but did differ from the change in both the 100% ($P = 0.01$) and FP ($P < 0.001$) treatments.
- The post-harvest change in stream network-wide post-metamorphic Coastal Tailed Frog density differed among treatments ($P = 0.10$). We detected a post-harvest increase in the 0% treatment that was 6 times greater than the change in the reference ($P = 0.07$), an increase that was significantly greater than the change in the 100% and FP treatments ($P = 0.02$ and 0.03, respectively).
- We saw no difference in torrent salamander (*Rhyacotriton*) density among treatments using one method of determining density. However, when we applied another method where we included animals that were encountered in wood-obstructed reaches, we detected a post-harvest increase in torrent salamander density in the 0% treatment that was 3 times greater than the change in the reference ($P < 0.01$).
- The post-harvest change in stream network-wide giant salamander (*Dicamptodon*) density differed among treatments ($P < 0.01$). Giant salamander density decreased by 82% in the FP treatment relative to the reference ($P < 0.001$), a decrease that was significantly greater than the change in the 100% and 0% treatments ($P < 0.01$ and $P = 0.02$, respectively). We did not note a significant change in density for any other treatment, including the reference.
- We found all genera in clearcut RMZs with wood-obstructed reaches covered by dense matrices of wood, organic debris (e.g., leaves and needles) and fine sediment. Densities in these reaches were sometimes quite high with values as high as 3, 20, and 6 animals per stream meter for tailed frog, torrent and giant salamanders, respectively.
- We observed egg masses for all three genera in harvested streams, including in the 0% treatment and in the wood-obstructed reaches of clearcut RMZs.
- We had no evidence of a treatment effect on body condition for any species, though we were unable to include tailed frog post-metamorphs in our analysis due to a small sample size.
- 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.

Conclusions:

- The Type N prescriptions maintained tailed frog and torrent salamander density within occupied basins two years after harvest in all riparian buffer treatments.

- The very high densities of torrent salamanders observed in some wood-obstructed reaches explains the differing results that we obtained when we did and did not include density estimates from these reaches in our overall stream-network wide density analysis.
- Though it is not an FP-designated species, post-harvest conditions did not sustain giant salamander density within the FP treatment in the two years after harvest. The negative response of giant salamanders in the FP treatment is inconsistent with study findings for the other stream-associated amphibian species. Further, the lack of a statistically significant difference in the pre- to post-harvest change between the reference and the 0% treatment leads us to suspect that the response to the FP treatment may not be driven by treatment *per se*, but may reflect complex ecological interactions, including site-specific factors.
- In theory, body condition reflects an animal's energy reserves and can be associated with environmental characteristics such as habitat quality and prey availability. We did not observe an effect of treatment on body condition for any species.
- We used the presence of egg masses as a sign of reproduction. Although sample sizes were limited, we concluded that all genera continued to occupy and reproduce in stream reaches with buffered (i.e., patch buffer) and clearcut (i.e., ELZ-only) RMZs in the two years following harvest.
- Evaluation of a genetic response requires generational turnover of amphibian populations that will require a minimum of seven to eight years after treatment implementation. Consequently, we report the results from this component of the study separately. A report evaluating the response of measures of amphibian genetic diversity has been through CMER review and is currently in ISPR review. The genetics response can be used to inform further the degree to which meeting the overall Performance Goal of long-term viability is being met.
- An evaluation of a response of amphibian population viability to the Type N prescriptions will require study over a longer temporal scale that reflects reproductive success through time. Analysis of amphibian demographic data collected seven and eight years post-harvest (after one generational turnover) will provide our first opportunity for understanding the true impacts to long-term amphibian viability, though continued monitoring even beyond one generational turnover would be more informative.

B. What does the study not tell us?

One should consider a number of study limitations when interpreting and generalizing the results.

Spatial Scope of Inference: 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). One should not assume that the results apply equally to other lithologies. Additional considerations include the fact that sites were located in second-growth forests and ranged from approximately 12 to 53 ha (30 to 130 ac). See McIntyre and colleagues (2009) for a summary of the site selection process.

Temporal Scope of Inference: The temporal scope of inference can only be made to the two year post-harvest interval. Do not assume that the results are applicable over a longer period. One can only understand the scope of potential long-term response with longer-term monitoring. For example, there will be opportunities for a delayed response to the reproductive success of stream-associated amphibians, among other things. In fact, preliminary findings for Coastal Tailed Frog response through eight years post-harvest indicate a significant decline in tailed frog density in all three riparian buffer treatments that we did not observe in the two years following harvest.

Riparian Buffering/BMPs: Application of clearcut timber harvest included buffers for sensitive sites and unstable slopes, and followed other best management practices (BMPs), ultimately, influencing the level of buffering in the FP treatment sites. CMER did not design this study to examine directly the influence of specific rules or BMPs, but rather to evaluate the overall influence of the FP buffer strategy as it is applied under real world circumstances. 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. Since the proportion of the stream length buffered in FP treatment sites was more than the minimum required under Forest Practice's rules, some consistent results between the 100% and FP treatments may reflect the fact that the stream length buffered was more similar between these treatments than between the FP and 0% treatments.

Stream-associated amphibians: We selected study sites based on specific criteria, including the presence of stream-associated amphibians. Sites chosen tended to have cooler pre-treatment stream temperatures than are typical of Type N streams in western Washington. We do not know whether amphibian presence is a reflection of cooler than average temperatures; however, this creates some uncertainty around the application of results broadly across the westside-managed landscape. The study cannot tell us if specific taxa would respond differently in Type N streams with warmer pre-harvest temperatures. Additionally, the precision of our scales may have limited our ability to detect a statistically significant change in amphibian body condition if changes to individual body weight were small, i.e., less than 0.1 g. Also, since our methodology focused on instream sampling, impacts to terrestrial post-metamorphic Coastal Tailed Frog and Coastal Giant Salamanders were not adequately addressed in this study.

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

The results from the Hard Rock Study, BCIF Study, Soft Rock Study, Shade Study, and Amphibian Recovery Project in combination are expected to provide a thorough assessment of riparian prescription effectiveness for westside Type N Waters. They 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 (with the exception of terrestrial Dunn's and Van Dyke's Salamanders) are being met.

- Buffer Integrity – Shade Effectiveness (Amphibians) Project [Shade Study, underway]: 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. This study can be used to supplement the findings for the Hard Rock Study, especially for results related to amphibian response to treatment.

- Amphibian Recovery Project [completed]: This project evaluated the effects of three buffer treatments on headwater streams throughout coastal western Washington. Riparian buffer treatments in this study differed from those included in the Hard Rock Study and included (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 three years (immediately post-harvest and two additional years beyond that) of post-harvest data were collected; not all metrics were evaluated in every post-harvest year. Fifteen study sites were included, but amphibians were not detected in all study sites so amphibian response was limited to a small sample size (e.g., prior to harvest Coastal Tailed Frogs were detected in only five of 15 sites). Since the treatments in the Amphibian Recovery Project were not designed to evaluate the current Forest Practices prescriptions for Type N streams, direct comparisons of results between this and the Hard Rock Study are only available for what we call the 0% treatment (their clearcut RMZ treatment). Differences in sampling methodologies, especially as they relate to amphibians, must be noted. In particular, the Recovery project did not evaluate amphibian presence/abundance in stream reaches that were inaccessible due to post-harvest wood loading in the form of slash whereas the Hard Rock Study did. See Jackson and colleagues (2001; 2007) and Haggerty and colleagues (2004).

To address the effectiveness of westside riparian prescriptions in maintaining terrestrial salamander populations, CMER would need to complete the Van Dyke's Salamander Project:

- Van Dyke's Salamander Project [underway]: The Van Dyke's Salamander was the only FP-designated amphibian that was not addressed by another CMER study. This study will result in the development of sampling protocols for adequately evaluating Van Dyke's presence and abundance, and if warranted, include a BACI-type manipulative study to compare Van Dyke's populations between harvested and unharvested units. This study will address a gap in information from the Hard Rock Study, which did not include effectiveness of riparian prescriptions in maintaining FP-designated terrestrial amphibians (Dunn's and Van Dyke's Salamanders).

One additional amphibian-focused study that has the potential to inform riparian prescription effectiveness for westside Type N Waters is the Amphibians in Intermittent Streams Project.

- Amphibians in Intermittent Streams Project [planned]: This study will examine amphibian use of the non-fish-bearing stream segments having discontinuous perennial flow, conditions that often occur at or near the origins of headwater streams. It is intended to inform the efficacy of the westside riparian prescription in maintaining amphibian occupancy in intermittent reaches. Data from the Hard Rock Study may be able to inform the importance of completing this project.

These studies will not address the effectiveness of the riparian prescriptions for eastside Type N Waters, for which CMER needs to complete the ENREP Study (underway), Eastside Np

Effectiveness Project (planned), and the Eastside Amphibian Evaluation Project (currently scheduled for FY22).

- Eastside Amphibian Evaluation Project [planned]: The Hard Rock Study focused entirely on managed landscapes in western Washington, because most FP-designated amphibians have westside distributions, and those with eastside distributions are believed to have little overlap with eastside-managed landscapes. The Eastside Amphibian Evaluation Project is an occupancy study intended to address the distribution of FP-designated amphibians throughout eastern Washington, to determine if their distribution on eastside managed landscapes deserves larger study attention. This study will supplement the findings of the Hard Rock study by evaluating amphibians in eastern Washington.

Additional studies related to the Hard Rock Study include:

- SAA Detection/Relative Abundance Methodology Project [completed]: This project was designed to evaluate and develop a standard sampling methodology for stream-associated amphibians (SAA) in headwater forest streams. Results from this study informed the sampling methodology for the amphibian component of the Hard Rock Study. See Quinn and colleagues (2007).

- ***Feasibility of obtaining more information to better inform Policy about resource effects.***

Opportunities exist to better inform Policy with data that have already been collected for the Hard Rock Study through eight years post-harvest (through 2016). The CMER budget for the current biennium includes funding for analyses of these data and report writing. Future and continued data collection is possible if interest exists. However, some reference sites have been or will be harvested for timber in the near future, making them unsuitable for use as references in the study. Statistical options for addressing this loss need to be thoroughly explored. Additionally, opportunity may exist to establish new reference sites. This is a unique long-term data set evaluating applicable riparian buffer treatments in a BACI-designed study. Value exists in continued monitoring of treated sites for interpretation of the longer-term trajectory of change. To date, two reference sites have been harvested, and two are expected to be harvested during calendar year 2019. Due to regulatory constraints, it is unlikely that the remaining two reference sites will ever be harvested.

- ***What are the costs associated with additional studies?***

Analysis and report development through eight years post-harvest are a part of the current CMER 2017-2019 biennium budget. A budget placeholder exists in the CMER Master Schedule for future stream-associated amphibian demographic data collection and report writing, currently projected to begin in the 21-23 biennium. We estimate that future resample of amphibian demographics would be approximately $980,000 for two years for all three taxa or $567,000 for one year. We strongly encourage Policy to consider the relative costs and benefits of one versus two years of additional resample. Based on the minimal sample size we obtained for Coastal Tailed Frog seven and eight years after harvest, it is likely that restricting a future resample to a single year would negatively affect our ability to compare density for this species over time. If density remains low (e.g., further decline and/or small increase compared to the current period) it is highly likely that we would not be able to detect trends through time with only one year of resample. However, if tailed frog density rebounds

substantially between now and then, then a single year of resample may be sufficient to detect trends; and, a single year of resample would still allow us to determine if species density remained very low, and/or had declined so much locally that we were not able to detect them in study sites. Finally, while we strongly discourage conducting future amphibian demographic sampling starting any sooner than FY22 due to the timing of generational turnover, future sampling could be postponed for a year or two without substantial consequence.

- ***What will additional studies help us learn?***

Results from the extended study period through eight years post-harvest will provide additional information for understanding the effectiveness of the current Forest Practices rules and buffer alternatives. Additional long-term monitoring will provide a unique opportunity to evaluate the longer-term response of variables of interest to forest practices in a research backdrop where such studies are extremely rare for most variables (e.g., temperature, amphibians). Originally, it was proposed that this cover an entire harvest rotation (i.e., 30 to 40 years in western Washington). Future monitoring would allow us to monitor recovery of response variables that were significantly different from pre-harvest conditions in the years immediately post-harvest (e.g., stream temperature). It would also allow us to detect potential lag effects in response in those variables that did not reveal an immediate impact in the years immediately post-harvest (e.g., FP-designated stream-associated amphibians).

- ***When will these additional studies be completed (i.e., when will we learn the information)?***

CMER anticipates development and approval of reports from the extended period (through eight years post-harvest) during the current biennium (2017-2019) and beginning of the following biennium (2019-2021), with transmission to Policy estimated for the 2019-2021 biennium. Timing of dissemination of findings to Policy for future sampling would depend on the number of responses for which Policy is interested and the timing of field sampling. We highly encourage Policy to consider the benefits of continued or future monitoring throughout an entire harvest rotation.

- ***Will additional information from these other studies reduce uncertainty?***

Future monitoring beyond eight years post-harvest will reduce uncertainty associated with trajectories of potential change. For example, in the case of stream-associated amphibians, no FP-designated species was negatively impacted in the two years immediately post-harvest. However, only longer-term study of the impacts of clearcut timber harvest can provide guidance on the effectiveness of the current Forest Practices rules and their ability to maintain viable populations of the stream-associated amphibians of interest through time. Preliminary results for Coastal Tailed Frog density through eight years post-harvest indicate a significant decline in all three riparian buffer treatments that was not detected through two years post-harvest. Additional study will inform the long-term trajectory of this decline, including the possibility of identifying the time to recovery.

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 management approach for westside Type N riparian prescriptions employs a patch-cut strategy, where a portion of the riparian stand in a Type N basin RMZ may be clearcut, providing that sensitive sites and at least 50% of the perennial stream length is buffered. CMER intended this study, along with BCIF and Soft Rock Studies, to evaluate the effectiveness of this strategy. There are no Performance Targets for stream-associated amphibians defined in Schedule L-1. Critical Questions related to the response of amphibians to the Type N prescriptions were defined by the Type N Riparian Prescriptions Rule Group in the CMER Work Plan after Schedule L-1 was finalized and approved by Policy. Projects related to answering Critical Questions are also identified in Schedule L-2 and include a test of the effectiveness of the Type N prescriptions for westside Type N streams in maintaining the long-term viability of stream-associated amphibians.

This study provides a substantial gain in multiple areas (see results and conclusions sections for each response). While previous studies may have evaluated many of the metrics we included in this study as they relate to forestry practices, the Hard Rock Study provides results in context of the specific forest practices rules for riparian prescriptions required on Type N streams in western Washington.

The BACI study design provides a more precise estimate of the response to forest harvest. The inclusion of variable buffer treatments, both more restrictive and less restrictive than the current rules, was established to provide a response curve along a gradient of buffer length.

We expanded on the knowledge base for many metrics included in the study. For example, our results tell us a lot about the baseline densities of stream-associated amphibians throughout managed forest landscapes in western Washington, and our BACI study design expanded on most previous studies that were largely retrospective. For example, previous observations had resulted in the conclusion that torrent salamanders were relatively uncommon on managed landscapes; in contrast, we found torrent salamanders to be the most abundant stream-associated amphibian species encountered both pre- and post-harvest.

We are more confident in many of our findings because we were able to utilize new technology and sampling techniques that were not previously available, because of the duration and/or intensity of sampling, and because we were able to take advantage of more recent statistical methods. For example, a new statistical method allowed us to adjust counts of amphibians by estimates of detection without the need for marking individual animals, for less biased estimates of density than for those based on count data alone.

Technical Implications and Recommendations:

New rule tools or field method development.

- We consistently had a difficult time detecting Coastal Tailed Frogs, especially post-metamorphs, in some sites. In one site, we encountered only a single post-metamorphic individual in a single year. Exploration of alternative methods for detecting the species, including the viability of using tools such as environmental DNA (eDNA) for occupancy and abundance, may prove invaluable for future research and monitoring of stream-associated amphibians, including at our own study sites. We could address the question: How well and under what conditions does eDNA sampling accurately and consistently identify Coastal Tailed Frog presence in headwater streams, and can it be used effectively to estimate abundance?

Research/monitoring suggestions.

We have several recommendations for research and/or monitoring that can help address the effectiveness of Type N riparian prescriptions for protecting and sustaining stream-associated amphibian populations. These recommendations fall into three categories: (1) analysis of existing data, (2) continued monitoring, and (3) new field studies.

Analysis of Existing Data

- Sensitive Site Effectiveness: Data we collected during the Type N Hard Rock Study could be used to do a preliminary evaluation of the characteristics of sensitive sites before and after harvest, under varying buffer strategies (i.e., buffered and unbuffered). While we have sufficient data for some sensitive sites (i.e., side-slope seeps, Type Np intersections and headwater springs), our data for headwall seeps is lacking (N=10) and we did not have alluvial fans in any study sites. We can also evaluate amphibian use of sensitive sites and whether use and/or density differs from that in non-sensitive site reaches and buffers. Results from this evaluation could inform the need for additional investigation in the future.
- Side-slope and Headwater Seep Characteristics: During amphibian sampling for the Type N Hard Rock Study, we collected data associated with side-slope and headwater seeps. These data could be used to answer questions about amphibian use of, and the characteristics associated with, the hydrologic footprints of seep areas. We could also address whether the current definitions for side-slope and headwall seeps are applicable to features used by amphibians? Results of this examination could inform the utility of additional investigation in the future.
- Buffered versus unbuffered Np reach-scale effectiveness: An evaluation of within-stream variability and characteristics between buffered and unbuffered reaches and between wood-obstructed and unobstructed reaches may prove informative for understanding the effects of alternative riparian buffer prescriptions. For example, based largely on retrospective studies, stream-associated amphibians were thought to be mostly absent from areas lacking overstory canopy and covered with dense matrices of wood and stored sediment; however, we found all focal amphibians, and even evidence of reproduction in the form of egg masses, in wood-obstructed reaches filled with fines and organic debris. CMER could address reach-scale effectiveness, at least in part, with existing data from the Hard Rock Study. We recommend an evaluation of reach-scale variability with existing data from this study, which could inform the utility of continued monitoring and/or future projects.

Continued Monitoring

- Disturbance and recovery trends over time: This study covered only the first two years after harvest, which is not enough time to evaluate fully the duration of harvest effects and the long-term trajectory of response. To understand completely the impacts of the treatments on the managed landscape one would have to monitor the response for a longer period. Substantial amounts of time and money have been invested in this study to date. Currently we have collected data through eight years post-harvest, and a report outlining those findings is in development. Data collection at existing study sites over a longer time will reduce scientific uncertainty about the duration of disturbance and the progress of

recovery in Type N riparian buffers and clearcuts. Considering the amount of time and money that would be required to re-initiate a similar study from the beginning, the best opportunity for evaluating long-term recovery is with continued monitoring in the existing study. Additional data collection may be especially important for evaluating the time to recovery to baseline conditions for amphibians, as preliminary results for amphibian demographics through eight years post-harvest reveal a significant decline in the Coastal Tailed Frog density in all three riparian buffer treatments that we did not observe in the two years immediately following harvest. Continued study for this and other related studies (see **What is the relationship between this study and any others that may be planned, underway, or recently completed**?) would result in a more confident assessment of prescription effectiveness as we monitor response to treatments over time.

New Field Studies

- Investigation of wood loading and amphibian use through time: Even with Forest Practices rules intended to minimize slash input into streams, we observed heavy slash loading in some stream reaches. In the two years immediately following harvest, we observed amphibian use of, and evidence of reproduction (i.e., egg masses) in, these reaches. Future evaluations could assess persistence of these wood-obstructed reaches, including overall stream coverage as a function of time since harvest. We could also address trends in amphibian density in wood-obstructed reaches through time.

Suggested changes to rules/board manual.

A review and evaluation of the Performance Targets for westside and eastside Type N streams, both in context of the results of these studies and other current scientific research, by CMER and the Timber, Fish and Wildlife (TFW) Policy Committee would be appropriate once the studies outlined under #5 are completed. They could propose changes to Performance Targets and/or new measures if appropriate. Specific to stream-associated amphibians, though there is an Overall Performance Goal in Schedule L-1 to support the long-term viability of covered species, there are no Performance Targets specific to stream-associated amphibians. The only target for amphibians is outlined in the CMER Work Plan as a Resource Objective to provide conditions that sustain stream-associated amphibian population viability within occupied sub-basins for covered-species. However, a definition of "viability" and metrics for evaluating viability are not provided.

References

Haggerty, S.M., D.P. Batzer and C.R. Jackson. 2004. Macroinvertebrate response to logging in coastal headwater streams of Washington, U.S.A. *Canadian Journal of Fisheries and Aquatic Sciences* 61(4):529-537.

Jackson, C.R., D.P. Batzer, S.S. Cross, S.M. Haggerty and C.A. Sturm. 2007. Headwater streams and timber harvest: Channel, macroinvertebrate, and amphibian response and recovery. *Forest Science* 53(2):356-370.

Jackson, C.R., C.A. Sturm and J.M. Ward. 2001. Timber harvest impacts on small headwater stream channels in the coast ranges of Washington. *Journal of the American Water Resources Association* 37(6):1533-1549.

McIntyre, A.P., M.P. Hayes and T. Quinn. 2009. *Type N Feasibility Study*. A report submitted to the Landscape and Wildlife Advisory Group, Amphibian Research Consortium, and the

Cooperative Monitoring, Evaluation, and Research Committee. Washington Department of Natural Resources, Olympia. 48 pp.

Quinn, T., M.P. Hayes, D.J. Dugger, T.L. Hicks and A. Hoffmann. 2007. Comparison of two techniques for surveying headwater stream amphibians. *Journal of Wildlife Management* 71(1):282-288.