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MEMORANDUM

May 29, 2024

TO: TFW Policy

FROM: Lori Clark, Adaptive Management Program Administrator (AMPA)

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SUBJECT: Eastside Type N Riparian Effectiveness Project (ENREP) extended monitoring request - Cooperative Monitoring, Evaluation, and Research (CMER) Committee and Eastside Scientific Advisory Group (SAGE) Recommendation

An Eastside Type N Riparian Effectiveness Project (ENREP) extended monitoring request was approved by SAGE in March 2024 and shared with CMER for consideration. The request was to extend monitoring an additional 5 years beyond the study design previously approved by CMER, Independent Scientific Peer Review (ISPR) and TFW Policy for a total of 7 years post-harvest at the ENREP sites. The extended monitoring would be conducted with a reduced suite of variables to monitor the persistence of the observed changes and the recovery dynamics. The request was initially discussed at CMER in March and there was no consensus for a recommendation to TFW Policy to continue this monitoring effort at that time. The Principal Investigator (PI) attended the April CMER meeting to provide additional details to inform discussion for CMER to make a recommendation to TFW Policy.

There was a CMER/TFW Policy workgroup (2019) that, at the request of the Forest Practices Board (Board), developed an extended monitoring request process which was approved by TFW Policy and delivered to the Board. There was also a request for the workgroup to develop a guidance document which was not completed. The extended monitoring process is not in the CMER Protocol Standards Manual (PSM). Following this circumstance, this process will be finalized and added to the PSM to ensure that CMER is following a consistent and transparent process for these types of requests.

At the April 2024 CMER meeting, a motion was approved that the ENREP project team, SAGE, and CMER follow the extended monitoring request process directed by the Board in 2019[1]. The Project Team and SAGE worked diligently to prepare the additional materials, including an updated Prospective 6 Questions document, in time for CMER's May 2024 meeting for consideration. The decision for the ENREP Extended Monitoring request is important if TFW Policy would like SAGE and the PI to begin extended monitoring immediately to ensure continuity of data at the sites beyond the initial study design objectives. In addition, as outlined in the extended monitoring request process, extension proposals should be completed at the time of annual Master Project Schedule (MPS) review to allow consideration of implications of the extension (cost, staffing, timelines, added certainty) in context of impacts to other priorities. Given that TFW Policy is considering the 25-27 biennium budget, it is optimal to have a decision on the ENREP extended monitoring request at the June TFW Policy meeting.

Background

1 Workgroup Report on Extended Monitoring, Board minutes, Nov 2019 (pg 197-199)
2 Stratigica, Lean report to the Forest Practices Board 2012
3 Eastside Type N Riparian Effectiveness Project (ENREP) Project Update 2019
4 Eastside Type N Riparian Effectivenss Project (ENREP) update, Forest Practices Board February 2020 (p. 293)

The ENREP study, targeted by the Board as a "Lean" Pilot project[2], aimed to maximize efficiencies in CMER project completion by eliminating non-value-added review steps. This study design was approved by CMER, ISPR, and TFW Policy based on at least 2 years of pre-harvest and 2 years of post-harvest monitoring to achieve the study's objectives and purpose, as outlined in the charter, scoping document, and best available science alternatives analysis.

In 2019, due to unforeseen delays and projected budget increases during ENREP's project implementation and site selection process, the Board requested TFW Policy direct CMER to find project cost savings. This was to meet the Board's fiduciary responsibility without compromising the scientific rigor of the study design approved by ISPR. In response, SAGE/CMER made recommendations to TFW Policy on ENREP cost savings in a memo[3] that was approved by TFW Policy yet, it seems, was never formally presented to the Board. At the February 2020 Board meeting[4], the TFW Policy update included a summary of the ENREP evaluation and budgetary considerations. TFW Policy considered removing certain study elements (macro invertebrates, sedimentation, orphaned Np streams) to reduce costs, but there was no motion made to reduce those elements, so the study continued as previously approved.

The ENREP Project Team has been implementing the study as approved by CMER and ISPR at the five study sites. Within the current study design, the post-harvest period will conclude at two of the study sites this year. The ENREP Project Team prepared recommendations for extended monitoring (Attachment, Eastside Type N Riparian Effectiveness Project Team Memorandum), which was approved by SAGE in March 2024. The ENREP Project Team also developed an updated Prospective Answers to the 6 Questions, in accordance with guidance on proposing extended monitoring, as described in the Workgroup Report on Extended Monitoring[1] (approved by CMER and TFW Policy in 2019). The Prospective 6 Questions document has been updated as part of that process with information that pertains to the proposal for five years of additional monitoring (on top of the 2 years post-harvest) of a limited suite of variables for ENREP totaling 7 years post-harvest monitoring of those variables. SAGE approved (May 2024) the Prospective 6 Questions document and on May 28, 2024, there was unanimous CMER support for the recommendations outlined in the attached memo and the ENREP Extended Monitoring Prospective 6 Questions document.

It is crucial to preserve the institutional knowledge of discussions and decisions made with Adaptive Management Program (AMP) participants over the years. While there is no intent to reverse prior decisions, understanding the context of these decisions and the basis for potential concerns is essential for making informed choices. ENREP began scoping in 2012 and has a long history of collaboration, negotiations, and adjustments among the Project Team, SAGE, CMER, and TFW Policy to meet AMP goals and objectives. The ENREP Extended Monitoring request was submitted to continue monitoring the sites, observing the persistence of observed changes and recovery dynamics. The CMER/ ISPR -approved study design establishes that two years of post-harvest monitoring will provide the necessary data to meet the study's objectives to inform TFW Policy on ENREP's critical questions:

- Are riparian processes and functions provided by Type Np buffers maintained at levels that meet FPHCP resource objectives and performance targets for shade, stream temperature, LWD recruitment, litterfall, and amphibians?*
  *Litterfall and amphibians are not included in the Study Design.
- Do different types of Type N channels explain the variability in the response of Type N channels to forest practices?
- What is the effect of buffering or not buffering spatially intermittent stream reaches in Type Np streams?

TFW Policy approved the existing study with the understanding and agreement that 2 years post-harvest monitoring would be enough to inform their decision-making process. TFW Policy now has the opportunity to consider approving extended monitoring to gather additional information that may help the AMP better understand recovery dynamics in these watersheds. As ENREP is a priority Clean Water Act (CWA) project for the AMP, the consideration of the extended monitoring request should acknowledge that any additional monitoring will not delay completion of the 2 year post-harvest final report deadlines and the timelines for TFW Policy decisions based on the findings report outlined in the AMP Board Manual, Section 22.

Attachments:

- Eastside Type N Riparian Effectiveness Project Team Memorandum (SAGE approved)
- ENREP Extended Monitoring - Prospective Answers to the 6 Questions from the CMER / Policy Interaction Framework Document.

March 4, 2024
TO: Cooperative Monitoring Evaluation and Research (CMER) Committee
FROM: Eastside Type N Riparian Effectiveness Project Team
SUBJECT: Reduced ENREP Extension Recommendation

The Eastside Type N Riparian Effectiveness Project (ENREP) is collecting data "to determine if, and to what extent, the prescriptions found in the Type N Riparian Prescriptions Rule Group are effective in achieving performance targets and water quality standards, particularly as they apply to sediment and stream temperature in eastern Washington" (ENREP Project Charter). The study consists of 5 sets of watershed pairs using a before-after, control-impact (BACI) experimental design with a minimum of 2 years of pre- and post-harvest data. The post-harvest period concludes this spring at two of the watershed pairs (Springdale and Tripp's Knob). The project team is recommending a limited project extension with a reduced suite of variables that balance critical information with cost efficiency to accomplish the core objectives of the original study. The objective of this memorandum is to provide a draft set of recommendations and approximate cost estimates for discussion. If there is interest in the reduced extension, the project team will work with the WA DNR to draft a formal workplan and refine and parse the budget by fiscal years. The rationale for the recommendations includes the following:

1) Preliminary data suggest that summer stream temperatures at Tripp's Knob have remained elevated (~ +2 to +6 °C) above baseline conditions in the second year following harvest, consistent with similar studies (e.g. Hardrock, Softrock, Mica Creek). Although stream temperatures initially increased at Springdale (~ +3 to +4 °C), by the second-year post-harvest they recovered to below (~ -1 to -2 °C) baseline conditions. Post-harvest canopy density at Tripp's Knob and has remained consistently ~35% below pre-harvest conditions whereas at Springdale, canopy density fully recovered in the second year after harvest. The specific reasons for the variations and the duration of the temperature increases are unclear given the relatively short post-harvest period. We hypothesize that elevated temperatures at the Tripp's Knob basin should exhibit a declining trend toward baseline once low herbaceous vegetation is established in the riparian zone. We hypothesize that the temperature decline below baseline noted at the relatively arid Springdale site may be due to relatively large changes in stream discharge post-harvest. Temperatures are hypothesized to trend upwards toward baseline as vegetation re-establishes throughout the watershed, evapotranspiration increases, and streamflows subsequently decline. Sustained temperature changes are likely to affect aquatic life, therefore the project team recommends continued monitoring of the response variables detailed in Table 1.

2) Conditions in the watersheds suggest that low-growing vegetation at Tripp's Knob is beginning to establish which may contribute to the mitigation of temperature increases in the upcoming years. Conversely, the long-term integrity of the overstory buffers may experience mortality due to lack of support from surrounding vegetation – similar to the 2021 limited blowdown event at the Tripp's Knob study site – which affects temperature, sediment delivery, and flow regime. We hypothesize that temperature, turbidity, and flow changes will continue to moderate as vegetation continues to establish across the study sites, but the rates of recovery are unknown, and the trends may be interrupted in the event of an episodic disturbance such as a windthrow or major rain-on-snow event.

Continued monitoring of canopy density, shade, turbidity, and flow regime will more effectively indicate the rates and stability of recovery trends and mechanisms contributing these trends as harvested areas regenerate.

3) A 5-year extension period is proposed because similar studies on nonfish-bearing streams in the region (Mica Creek) have shown thermal recovery to baseline to take 10 years (Gravelle, unpub. data), with the majority of recovery occurring within 5-10 years. Extending the post-harvest period to approximately 7 years is therefore expected to encompass most of the recovery period. Due to the harvest delay at Fish Creek, the team recommends a 4-year extension period for Fish Creek to balance inter-site comparability and with cost efficiency.

4) Post-harvest monitoring for the Hardrock and Softrock studies was extended to 9 and 6-7 years, respectively. Limited extension of ENREP will therefore increase the comparability of the 3 studies to better inform forest management across Washington.

Substantial investment in monitoring infrastructure (stream gauging stations, automated temperature monitoring networks, and hydrometeorological stations) has been made to date, but continued operation of the automated data collection equipment is relatively inexpensive. The watersheds have also been well-characterized with manual surveys, minimizing the need for additional extensive surveys. The proposed reduced suite of variables therefore focuses on parameters that provide a high value of critical information relative to cost.

Table 1. Proposed Reduced Suite of Response Variables

ENREP	**ENREP Limited Extension**
Streamflow (continuous)	Streamflow (continuous)
Suspended sediment concentration (SSC) (event based)	
Turbidity (continuous)	Turbidity (continuous)
Effective shade (annually)	
Canopy density: Water surface and waist height (annually)	Canopy density: Water surface and waist height (annually)
Stream temperature: all reaches (continuous)	Stream temperature: all reaches (continuous)
Subsurface water temperature: all reaches (continuous)	Subsurface water temperature: dry reaches (continuous)
Wetted channel extent (2x annually)	Wetted channel extent (1x annually, dry season)
Tree stocking (pre- and post-harvest)	Tree stocking (Year 5*)
Large wood (annually)	Large wood (Year 5*)

Sediment pathway analysis (annually)	Sediment pathway analysis (Year 5*)
Stream cross-sections (annually)	
Aquatic life (3x annually)	Aquatic life (1x annually)
Hydrometeorology – automated (precipitation, air temperature, humidity, wind speed, snow depth, soil temperature)	Hydrometeorology – automated (precipitation, air temperature, humidity, wind speed, snow depth)

*Stocking, large wood, and sediment pathways may be re-measured earlier if a major episodic event occurs (e.g. extensive blowdown, major flood), and only at Year 4 for Fish Creek.

Variables, Proposed Changes, and Rationale

1. Streamflow – automated
   Proposal: Continue without change
   Rationale: Critical response variable, inexpensive to maintain, substantial investment in existing infrastructure

2. Suspended sediment concentration (SSC) – automated, manually analyzed
   Proposal: Eliminate
   Rationale: Can be approximated with turbidity based on existing correlations, relatively expensive (lab costs, power management for automated samplers, limited sample storage requiring more frequent field visits)

3. Turbidity – automated
   Proposal: Continue without change
   Rationale: Correlated with critical response variable (SSC), empirical turbidity-suspended sediment concentration curves developed for all sites, relatively inexpensive to maintain, substantial investment in infrastructure

4. Effective shade – manual data collection and analysis (hemiphotos)
   Proposal: Eliminate
   Rationale: Reasonably indexed by canopy density. Data collection and processing are time-consuming and hence relatively expensive

5. Canopy density: Water surface and waist height – manual data collection and analysis (densiometry)
   Proposal: Continue without change
   Rationale: Provides reasonable index of critical response variable (effective shade), relatively inexpensive data collection and analysis procedures.

6. Stream temperature – automated
   Proposal: Continue without change
   Rationale: Critical response variable, inexpensive to operate

7. Subsurface water temperature – automated
   Proposal: Reduce to dry reaches only

Rationale: Critical response variable in seasonally dry reaches, relatively uninformative in perennially wet reaches.

8. Wetted channel extent – manual
   Proposal: Reduce from 2x to 1x per year during late season when flows are lowest
   Rationale: Critical response variable (aquatic habitat), relatively inexpensive to collect

9. Tree stocking – pre- and post-harvest
   Proposal: Conduct final sampling in Year 5.
   Rationale: Largest changes immediately after harvest, small expected inter-annual changes, relatively expensive data to collect.

10. Large wood – manual
    Proposal: Conduct final sampling in Year 5.
    Rationale: Systems are well characterized, largest changes immediately after harvest, small expected inter-annual changes, align sampling with stocking and sediment pathway analysis

11. Sediment pathway analysis – manual
    Proposal: Conduct final sampling in Year 5
    Rationale: Systems are well characterized, largest changes immediately after harvest, small expected inter-annual changes, align sampling with stocking and sediment pathway analysis

12. Stream cross-sections – manual
    Proposal: Eliminate
    Rationale: Method only detects large changes, channels have exhibited high degree of stability, expensive data to collect and analyze.

13. Aquatic life (algae and benthic invertebrates) – manual
    Proposal: Reduce sampling from 3x to 1x per year
    Rationale: Critical response variables: Algae and invertebrates are critical components of stream food webs, but sample collection and invertebrate sample processing is relatively expensive. One-time, annual sampling of each study stream during mid-summer or fall will allow us to track algal and invertebrate responses to thermal recovery.

14. Hydrometeorology
    Proposal: Continue without change
    Rationale: Very useful for diagnosing specific events and climatic effects on stream systems, inexpensive to maintain, helpful for field safety, substantial investment in infrastructure.

Approximate Budget

An approximate projection of additional costs for general planning purposes is provided below. The primary expense for the U of I is for a reduced team comprised of a 1.0 FTE staff member and 0.11 FTE Project PI to manage the project and data analysis. A seasonal field crew (2 personnel) is required to maintain equipment and complete reduced surveys. Expenses for USU are primarily for a part time staff member to collect and analyze data and for laboratory fees. The budget does not include cost estimates for data analysis and report preparation. The estimate will depend on the desired scope, magnitude, and format of the final product that will need to be determined in consultation with WA DNR. Projected costs also include demobilization in years 6 and 7. Data analysis and report preparation would begin during Years 6 and 7 to reduce out-year data analysis and reporting costs and expedite preparation of the project report.

If there is interest in pursuing a limited extension of the project a detailed workplan and budget parsed by fiscal year can be developed once variables and sampling frequency have been approved, and all project cooperators confirm that basin pairs will meet the science objectives and that continued monitoring will be permitted.

Approximate Projected Additional Costs ($1000s)

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
$18	$41	$53	$127	$182	$318	$334

Extended Monitoring Request Revised

Prospective Answers to the 6 Questions from the CMER / Policy Interaction Framework Document

May 14, 2024

Project Title: Eastside Type N Riparian Effectiveness Project (Lean Pilot)

Study Design Title: Eastside Type N Riparian Effectiveness Study Design

Background:

The project team proposes five years of additional monitoring (on top of the two years post-harvest) of a limited suite of variables for the Eastside Type N Riparian Effectiveness Project (ENREP) totaling seven years post-harvest monitoring of those variables. The current study design calls for two years of pre-harvest monitoring and two years of post-harvest monitoring among paired basins comprised of control and harvested sites. Since some of the prospective answers were unchanged from the original Prospective Answers to the 6 Questions Document, **information that pertains specifically to the Monitoring Extension proposal of an additional 5 years is indicated in blue text.**

1. Does the study inform a rule, numeric target, performance target, or resource objective (Yes/No)? If Yes, go to the next question. If No, provide a short explanation on the purpose of the study.)

Yes.

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

Yes. ENREP will determine if, and to what extent, the prescriptions found in the Type N Riparian Prescriptions Rule Group are effective in achieving performance targets and water quality standards, particularly as they apply to sediment and stream temperature in eastern Washington.

3. Was the study carried out pursuant to CMER scientific protocols (i.e., study design, peer review)? (Provide short explanation. Be clear on use of ISPR.)

Yes. This exploratory study design was developed by a TWIG (Technical Writing and Implementation Group) under the LEAN process, and the design was reviewed and approved by CMER consistent with the Protocol and Standards Manual (2016), and successfully went through Independent Scientific Peer Review (ISPR). The only change is that the suite of variables monitored during the proposed five-year extension would be reduced to balance additional information with cost efficiency.

4. What does the study tell us? What does the study not tell us? (This is where the study and its relationship to rules, guidance, targets, etc are to be described in detail. Consider technical findings; study limitations; and implications to rules, guidance, resource objectives, functional objectives, and performance targets; in addition to other information.)

What the study will tell us:

As companion to the Type N Effectiveness "Hard Rock" and "Soft Rock" studies, this study will inform Policy of the quantitative changes in FPHCP covered resources, water quality and aquatic life coincident with forest harvest activities in eastern Washington.

To that end, the study specifically addresses the following critical questions:

1. What is the magnitude of change in water temperature, canopy closure, and stream cover of Type Np channels in the first two years after harvest?
2. What is the magnitude of change in stream flow and suspended sediment export from the Type Np basin in the first two years after harvest?
3. What is the relationship between aquatic life (and their supporting resources) and observed changes in hydrology, sediment, and temperature associated with forest management activity?

This study will use a hierarchical design that incorporates a blocked Multiple Before-After/Control-Impact (MBACI) design with reaches nested within basins to quantify the magnitude of change that occurs as a result of harvest activity. The MBACI design, which is replicated in space and time, controls for natural variability throughout the pre- and post-treatment periods and allows us to estimate the likelihood that observed effects are related to anthropogenic activity (Underwood, 1994; Downes et al. 2002).

By design, the ENREP sites encompass a range of ecological and hydrological conditions (hydroclimatic gradient). Preliminary results indicate that initial responses to harvest is similar to the pattern of Westside Type N Hard Rock and Soft Rock Effectiveness studies with all treatments eliciting reductions in shade and increases in stream temperatures in the first year after harvest (McIntyre et al. 2021, Ehinger et al. 2021). Responses in the ENREP sites varied in the second year post harvest with one site (Tripp's Knob) exhibiting persistent shade reductions and temperature increases and the other (Springdale) exhibiting minimal shade changes and temperature decreases. Extending the post-harvest monitoring period from two to seven years will show whether and where responses to harvest are transient or persist longer than 2 years.

While two years is adequate to capture initial causal changes to streamflow, shade, water temperature, turbidity, suspended sediment concentration, large wood, and channel morphology, other aquatic life variables may not show a response for several years following several reproductive cycles (Leps et al. 2016). A BACI study in the Trask River Watershed in Oregon used four years of post-harvest monitoring and found that invertebrate densities were highly variable on annual basis, which limited their ability to detect a change due to harvest (Johnson et al. 2022). Finally, more than two years of monitoring will provide information on the changes to invertebrate community composition over time, which cannot be measured in only two years (Stone et al. 1998).

While the original ENREP study design will capture the immediate and direct effects of harvest, indirect effects of harvest are best characterized on longer time frames. For instance, increased light penetration to the stream post-harvest could decrease litterfall while increasing periphyton growth, which may influence invertebrate communities. Other indirect effects, such as windthrow or flooding, may also appear in subsequent years after harvest. One example is the Stuart-Takla Fisheries-Forestry Interaction Project, which showed that the loss of canopy cover to windthrow delayed thermal recovery in the first five years following harvest (Macdonald et al. 2003). Another scenario was found in the CMER Westside Type N Effectiveness Hard Rock Extended study where there was a stronger effect on stream temperatures in the first two years, then a weaker effect for the next 2-3 years, as vegetation recovered, followed by a strong effect in the final 2-3 years with the majority of sites never fully recovering to pre harvest stream temperatures following nine years of post-harvest monitoring (McIntyre et al. 2021). Like the Westside Type N Effectiveness Hard Rock Extended report, **extending the ENREP monitoring period to seven years will provide key insights into the direct and indirect effects of harvest as well as revealing the impacts of vegetation recovery.**

Finally, in cold regions, interannual variations in climate has been noted to mask snowpack and streamflow responses to forest disturbances (Goeking and Tarboton, 2020). In the snow-dominated ENREP watersheds, interannual variations related to the El Niño Southern Oscillation (ENSO) phases that commonly persist for 1 to 2 years are predicted to exert a strong response on the hydrological dynamics. While this can be partly assessed through the hydrometeorological monitoring that is included in the original study design, it is possible that treatment effects will interact with climate variations to produce distinct responses (e.g., producing more severe effects on water temperature and aquatic life in warmer and drier years with earlier freshet timing than in colder and wetter years with later runoff). The proposed extension will more effectively reveal how climatic variability, including potential variations related to ENSO cycles, interact with the documented landcover changes to affect the critical response variables.

The proposed extended monitoring would reduce potential influence of Type 1 (false positives) or Type 2 (false negatives) on the quality of the findings.

What the study will not tell us:

The study will not directly address alternate prescriptions. It will test a 50’ Type Np buffer consistent with current rule. One of the design goals of the ‘dry’ study was to evaluate the effect of buffering or not-buffering dry reaches. In all the sites where we have over 1000’ of stream that is predominately dry for more than 2 months (e.g., Springdale, BlueGrouse, and their eastern Cascade analogs), we will be working with landowners to clearcut harvest a portion of the dry stream network. This was always a design goal for the ‘dry’ component of the study that was communicated to landowners of those sites, but not well articulated in the approved study design document. We recognize that there was interest by certain members to also see clearcut harvest in perennially wet reaches, and this was discussed as an option in the March 23, 2018 CMER meeting. Clearcut harvest along perennially wet reaches has not been discussed with the landowners, and the decision on where and how perennial reaches are treated will need to be resolved at a later date with the involvement of landowners and their harvest implementation teams to ensure that experimental treatments both meet their scientific and management objectives and are practically feasible. Insights into alternate prescriptions are expected to occur through meta-analyses that incorporate the results of this study and the larger body of research on forestry effects.

The study is designed with only two-years of pre-treatment monitoring and at least two-years of post-treatment monitoring. Two-years is not enough time to capture the full range of effects, especially those that are likely to be episodic. Although the degree of inference will be limited by the relatively short pre and post-treatment phases, this has been shown to be adequate for quantifying the initial changes associated with harvest (e.g., McIntyre *et al.* 2018). Longer-term monitoring will be required to determine the overall trajectory of responses and to capture a broader range of climate conditions and greater potential for episodic changes with less-frequent recurrence intervals (e.g., temperature recovery, sediment export from processes that act over longer time-scales, changes associated with flood or drought events, and delayed response in aquatic communities).

By experimenting at the basin scale, we can examine reach-scale effects within the drainage basin, as well as cumulative exports to downstream fish-bearing waters, but we cannot directly address downstream effects. These sites are not appropriate for evaluating effects on fish and have limited utility for assessing even downstream effects on temperature given that the adjoining higher-order streams the study basins discharge to are influenced by land uses both upstream and immediately downstream of their confluences with the study streams.

The three site pairs identified for inclusion of the study span a gradient of precipitation and channel wetness in the northern Rockies ecoregion and we seek another three pairs in the eastern cascades across a similar gradient of precipitation. Small sample size, relative to observational studies, is an issue for most experimental studies and especially so for field-based studies like this. However, experimental studies are essential to testing the effectiveness of specific riparian prescriptions. Given our limited amount of basin-scale replication, the results of this study should not be viewed solely in isolation, but rather as a part of the larger body of research on forestry effects. Failure to obtain additional sites will reduce power of the study and level of inference, especially as they relate to CMER lands with higher levels of aquifer permeability.

In an ideal scenario, we could monitor each site as it fully recovers to answer the question, "How long does it take for riparian functions to fully recover from harvest?" Adding five additional years of post-harvest monitoring, for a total of seven years, will not accomplish this because all sites are not expected to fully recover to baseline conditions for at least ten years or longer. However, seven years of monitoring may be sufficient to assess whether and where changes are transient or persistent and may indicate the recovery trajectory for the complete suite of hydrological and aquatic life variables that are being monitored. However, we note that the recovery trajectory from the Westside Type N Hard Rock Effectiveness Extended report varied throughout the nine years of post-harvest monitoring making recovery trends less predictable and dependent of the length of post-harvest monitoring (McIntyre et al. 2021).

5. What is the relationship between this study and any others that may be planned, underway, or recently completed? Factors to consider in answering this question include, but are not limited to:

- **a. Feasibility of obtaining more information to better inform Policy about resource effects.**
- **b. Are other relevant studies planned, underway, or recently completed? (If yes, what are they?)**

ENREP is a companion to the two westside Type N Effectiveness studies ("Hardrock", "Softrock") and will provide information about how riparian processes and functions provided by Type Np buffers maintained at levels that meet FP HCP resource objectives and performance targets for shade, stream temperature, LWD recruitment, litter fall, and aquatic life in eastern Washington.

In addition, ENREP will address whether different types of Type N channels respond differently to forest practices. It will also address the effect of buffering or not buffering spatially intermittent stream reaches in Type Np streams. The results are likely to empirically inform the Eastside Np

Effectiveness Project, which is listed in the CMER workplan as a literature review related to Ns rule effectiveness.

ENREP is currently the only Type Np Effectives study planned or underway in eastern Washington.

The Westside Type N Buffer Characteristics, Integrity, and Function (BCIF) Project (Schuett-Hames et al., 2012) was a BACI study that employed sites where both sides of an Np stream were harvested. The study monitored riparian stand recovery, large woody debris, shade, and soil disturbance, for five years post-harvest. This study did not measure water quality or aquatic life. The BCIF study also re-sampled riparian vegetation, LWD recruitment, shade and other variables after 5 years of no post-harvest monitoring immediately following the first five years of monitoring. At year 10 monitoring resumed revealing changes in riparian mortality and ingrowth, windthrow, and shade from the first five years (Schuett-Hames and Steward 2019).

The CMER Extensive monitoring project recently prioritized by the Forest Practices Board could also be used for measuring recovery of riparian vegetation post-treatment. While by design, extensive monitoring does not show cause-effect relationships, it can be used to measure long-term trends and whether threshold values are being met (e.g., effective shade, long-term LWD recruitment, riparian stand structure, RSAG/CMER Extensive Monitoring memos to TFW Policy, 2014, 2019, 2022, 2023).

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 rules are based on multiple assumptions regarding the effectiveness of Np riparian buffers and protecting resource objectives. Some of these assumptions appear to hold while others appear questionable based on results from the Type N Experimental “Hard Rock” study in western Washington.

This is the only study that will specifically address Type Np rule effectiveness in eastern Washington, and how responses vary along a spatial, hydroclimatic gradient, and associated gradient of seasonal surface water presence. As such, it is expected to provide a substantial gain in information in the context of other Type Np and related forest research.

The incremental gain in understanding will increase proportional to the number of years of extended monitoring beyond the current ISPR approved study design. Unpredictable episodic events (e.g., windthrow, rain-on-snow flood) may contribute noise and uncertainty to the long-term treatment effect beyond the two years following harvest. Benthic communities may exhibit “lag effects” that do not show up in two years following treatment. Extending the post-harvest monitoring period from two to seven years will enable CMER to track not only the immediate impacts of harvest, but also the recovery of riparian vegetation and concomitant responses of flow, water quality, and aquatic ecological variables. Taken together, this represents a large incremental gain in understanding beyond the initial study plan.

By extending the post-harvest monitoring period to seven years, we expect a substantial gain in understanding of the long-term impacts of harvest and effectiveness of riparian buffers. For instance, the Westside Type N Effectiveness Hard Rock Phase II report (McIntyre et al. 2021) showed that water temperature response was strong in the first 2 years following harvest, followed by a weaker response in the next 2-3 years, and ending with a strong response in years six through nine. Indirect effects of harvest, such as windthrow or floods, could be missed in the first two years following the harvest and impact study results (McDonald et al. 2003).

Extending the post-harvest monitoring period from two to seven years will enable CMER to track not only the immediate impacts of harvest, but also the initial recovery of riparian vegetation and concomitant responses of flow, water quality, and aquatic ecological variables. While we may not be able to quantify the full recovery of each riparian function over seven years, we will be able to characterize the recovery trajectory that each site is on and assess whether trajectories are similar or different across sites. Taken together, quantifying harvest impacts as well as recovery represents a large incremental gain in understanding beyond the initial study plan.

Works Cited:

Downes, B. J., L. A. Barmuta, P. G. Fairweather, D. P. Faith, M. J. Keough, P. S. Lake, B. D. Mapstone, and G. P. Quinn. 2002. *Monitoring ecological impacts: concepts and practice in flowing water.* Cambridge University Press, New York, New York, USA.

Ehinger, W.J., W.D. Bretherton, S.M. Estrella, G. Stewart, D.E. Schuett-Hames, and S.A. Nelson. 2021. Effectiveness of Forest Practices Buffer Prescriptions on Perennial Non-fish-bearing Streams on Marine Sedimentary Lithologies in Western Washington. Cooperative Monitoring, Evaluation, and Research Committee Report CMER 2021.08.24, Washington State Forest Practices Adaptive Management Program, Washington Department of Natural Resources, Olympia, WA

Goeking, S. A., and Tarboton, D. G. 2020. Forests and water yield: A synthesis of disturbance effects on streamflow and snowpack in western coniferous forests, *Journal of Forestry*, v. 118, n. 2, 172-192. 10.1093/jofore/fvz069.

Gravelle, J. A. and T. E. Link. 2007. Influence of Timber Harvesting on Headwater Peak Stream Temperatures in a Northern Idaho Watershed. *Forest Science*, 53: 189–205. https://doi.org/10.1093/forestscience/53.2.189.

Karwan, D. L., J. A. Gravelle, and J. A. Hubbart. 2007. Effects of timber harvest on suspended sediment loads in Mica Creek, Idaho. *Forest Science*, 53, no. 2: 181–88. https://doi.org/10.1093/forestscience/53.2.181.

Leps, M., Sundermann, A., Tonkin, J.D., Lorenz, A.W. and Haase, P., 2016. Time is no healer: increasing restoration age does not lead to improved benthic invertebrate communities in restored river reaches. *Science of the Total Environment*, *557*, pp.722-732.

Link, T. E., T. R. Johnson, R. Keefe, and R. Becker. 2020. The effectiveness of Idaho's Class I stream shade rule: Analysis of before-after control-impact effective shade data. Final Technical Report prepared for Idaho Department of Environmental Quality, 95 pp.

Macdonald, J., E. MacIsaac, and H. Herunter. 2003. The effect of variable retention buffers on water temperatures in small headwater streams in sub-boreal forest ecosystems of British Columbia. *Canadian Journal of Forest Research*, 33: 1371–82. https://doi.org/10.1139/x03-015.

McIntyre, A.P., M.P. Hayes, W.J. Ehinger, S.M. Estrella, D. Schuett-Hames, and T. Quinn (technical coordinators). 2018. Effectiveness of Experimental Riparian Buffers on Perennial Non-fish-bearing Streams on Competent Lithologies in Western Washington. Cooperative Monitoring, Evaluation and Research Report CMER #2018.09.25, Washington State Forest Practices Adaptive Management Program, Washington Department of Natural Resources, Olympia, WA. https://www.dnr.wa.gov/publications/fp_cmer_typen_hr_20201119.pdf

McIntyre, A.P., M.P. Hayes, W.J. Ehinger, S.M. Estrella, D.E. Schuett-Hames, R. Ojala-Barbour, G. Stewart and T. Quinn (technical coordinators). 2021. Effectiveness of experimental riparian buffers on perennial non-fish-bearing streams on competent lithologies in western Washington – Phase 2 (9 years after harvest). Cooperative Monitoring, Evaluation and Research Report CMER 2021.07.27, Washington State Forest Practices Adaptive Management Program, Washington Department of Natural Resources, Olympia, WA.

Redding, T. E., R. D. Moore, R. D. Winkler, R. G. Pike, and D. J. Wilford. 2010. Long-term watershed research in British Columbia. Streamline Watershed Management Bulletin Vol.14 / No. 1, pp.1-29. http://www.forrex.org/streamline/.

Reiter, M., S. Johnson, J. Homyack, J. Jones, and P. James. 2019. Summer stream temperature changes following forest harvest in the headwaters of the Trask River Watershed, Oregon Coast Range. *Ecohydrology* 13. https://doi.org/10.1002/eco.2178.

Schuett-Hames, D., A. Roorbach, and R. Conrad. 2012. Results of the Westside Type N Buffer Characteristics, Integrity and Function Study Final Report. Washington State Forest Practices Adaptive Management Program, Washington Department of Natural Resources, Olympia, WA.

Stone, M.K. and Wallace, J.B., 1998. Long-term recovery of a mountain stream from clear-cut logging: the effects of forest succession on benthic invertebrate community structure. *Freshwater Biology*, *39*(1), pp.151-169

Underwood, A. J. 1994. On beyond BACI: sampling designs that might reliably detect environmental disturbances. Ecological Applications 4(1):3-15. https://doi.org/10.2307/1942110