RSAG - Extensive Monitoring of Stream Temperature and Riparian Stand Conditions, Clarifying Questions

July 22, 2022

In June 2022, the Cooperative Monitoring, Evaluation, and Research Committee (CMER) assigned RSAG the task of developing an extensive monitoring proposal for stream temperature and riparian stand conditions. CMER and RSAG have previously submitted multiple documents to Policy outlining options and urging the TFW Policy Committee to assess and discuss what type and resolution of data and what amount of change in riparian conditions would be useful for the Adaptive Management Program in order to clarify research/monitoring needs (CMER/RSAG February 2014; CMER/RSAG March 2019). In his April 2022 memo to CMER, the Adaptive Management Program Administrator (AMPA) forwarded a set of questions and additional considerations from Policy. In the memo, Policy stated that their request was intended to initiate an iterative conversation between TFW Policy and CMER. RSAG project team members have responded to the questions posed by Policy and seek feedback from Policy on said responses. This memo is intended to seek clarity on those questions, outline some off the wide-ranging extensive monitoring options, and to provide critical background documents that are relevant to initiating a meaningful iterative conversation between RSAG/CMER and Policy.

- **What is the distribution of stream temperature in Type F and N streams across FFR regulated lands, and how is the distribution changing over time as the forest practices prescriptions are implemented?**
    1. How important is it to break out stream temperature by the F/N designation? As noted in the February 2014 CMER/RSAG memo, there are unresolved issues with Type F/N breaks and stream network delineation that will make it difficult to evaluate water temperature both accurately and extensively by the F/N regulatory framework. We can probably get you results by stream order but we are unlikely to get extensive water temperatures for Type N waters.
    2. Re: "distribution", are you interested in longitudinal distributions within stream networks (basins), comparative distributions among basins, or both?
    3. Are you looking to establish the relationship of temperature and shade by watershed (more research than monitoring) or just what the temperatures are relative to the FFR targets?
    4. How important is change over time to you? We know that shade from riparian forest has a larger influence on stream temperatures than any other management-related factor (Wondzell et al., 2019) and recent modeling work from the entire Columbia River basin below the Snake River confluence suggests that the current distribution of riparian buffers have reduced mean August stream temperature by an average of 1.07 °C (1.92 °F) over what water temperatures would be without riparian buffers (Fuller et al., 2022). Models suggest that stream temperatures will increase through time with climate change but restoring riparian shade could partially mitigate future warming and help maintain cold-water habitats even under a warmer climate with substantially lower late-summer streamflow (Fuller et al., 2022; Wondzell et al., 2019). If we need to examine historic water

temperatures, we will be limited to the few stations that have good records on FFR lands and we will likely have to model the effects of weather/climate to tease out the relationship to forest practices.

5. Re: changes to these temperature distributions over time, given that we are 20+ years into implementation of FFR with a large percentage of the riparian landscape already having been treated once under the first FFR rotation, and the fact that we have no pre-FFR baseline against which to compare, what trends would you be looking for, or expect to see? The baseline has already shifted substantially. What new major trends would be developing from this point forward, beyond pretty much maintaining the new status quo from here on out?
6. The policy request was for an Extensive Monitoring program (EMP) (which implies a high-level baseline be obtained over a large geographical extent) as opposed to and intensive monitoring program (e.g., greater concentration of measures over a smaller area).
7. This statement suggests that a key metric of the EMP is changes in stream temperatures through time with the ability to assess temperature in Type F and Type N streams. This could be approached in several ways such as randomly selecting sample sites over the landscape (within these two categories) with repeated sampling through time. An alternative, and one I favor, apply a systematic sampling scheme based on the stream networks whereby each stream system is a sampling frame. This would provide the context of the distribution of the stream temperature at a given time.

- **For Type F and N streams, what is the status of riparian stand condition; e.g. stand structure, large wood present (contributing to pools and stream morphology), and shade?**
    1. What are the most important relationships for us to measure? RSAG believes that Policy is most interested in the relationship between riparian stand conditions and stream temperature. If that is true, we are likely to recommend a study that uses remote sensing (e.g., lidar, NAIP) to quantify riparian stand conditions and then relate those conditions to stream temperatures. We would necessarily focus on watersheds (e.g., HUC-12) with good lidar and would probably focus on basins that are largely managed for timber production (e.g., FFR regulated lands). The approaches needed to measure large instream wood and shade are likely to be quite different, but we should be able to use remotely sensed riparian stand data to estimate large wood recruitment potential and shade.
    2. Which of the many potential aspects or elements of "stand conditions" would truly be useful in addressing key uncertainties, specifically with regard to achieving performance targets at the landscape scale? What specific information does Policy need that would help inform the members re: decisions that are or will likely be on their table with regard to stand condition?
    3. Do you want a stand-based riparian forest inventory?
    4. Do you want a riparian forest inventory based on the watershed analysis methodology?
    5. Do you want to stratify the riparian forest into stands?

6. How do you want to characterize riparian stand conditions? Riparian stand condition is a broad category of metrics with different remote sensing and field data collection requirements. Please comprehensively identify which metrics you are interested in. For example, do you need to know:
    - Tree metrics by pixel?
    - Individual tree species?
    - If a tree is a conifer or hardwood?
    - If trees are alive or dead?
    - Individual tree metrics?
    - Forest metrics?
    - Species?
    - Individual tree diameters at breast height?
    - Average tree diameter at breast height?
    - The quadratic mean diameter at breast height?
    - Individual tree heights?
    - Average tree height?
    - The individual tree crown height?
    - The average tree crown height?
    - Individual tree volume?
    - The forest metrics on a per-area of land?
    - The acreage?
    - The clumpiness?
    - The relative density?
    - The site class?
    - The site index?
    - The acreage?
    - The leaf area index?
    - The understory vegetation?
7. Do you need to know if the trees are being damaged by bears, mountain beavers, beavers, elk, deer, fire, wind, bark beetles, campers, or root disease?
8. Are you concerned about large wood on the forest floor or in the stream? When does the tree become large wood? If wood is in the stream it is part of the channel.
9. Currently, functional large wood requires intensive in-stream monitoring rather than Lidar or other remote sensing. If CMER research shows that shade, DFC stocking and crown cover from FFR rules are effective, do you want the in-stream monitoring?
10. What do you need to know about shade? If the riparian forest is well stocked with tall trees and the buffer with is greater than the tallest trees at age 140 years, is that good enough?
11. If we can measure shade, DFC stocking and crown cover, are these sufficient to characterize riparian stand condition and stand structure?
12. This statement suggests that the second key metric for the EMP would be the riparian stand conditions. This could be accomplished using remote sensing data, with "training /validation plots" measured in the field. Metrics that could be measured this way include average stand height, conifer / hardwood composition etc. I suggest that the EMP should be based on the stream network. The network itself can be further defined as a collection of basins (e.g., HUC 12, pre-defined basins by the USGS). A sampling scheme could be developed for each stream network whereby basins are sampled on a rotating panel basis (e.g., 5-10 year resampling schedule). Potential wood recruitment and shade could be estimated using the remote sensing data. Field measurement of stream morphology would be outside the scope of an EMP but could be implied by the wood recruitment potential estimates. For riparian (and basin-wide metrics) to be measured, funding must be available

for the acquisition of remote sensing data of current forest conditions – this would be essential for a successful EMP that considers changes in vegetation over the landscape scale.

What is the variation in stream temperature distribution on FFR regulated lands compared to non-FFR regulated lands?

1. What are non-regulated FFR lands— cities, agriculture, never harvested woodlands, state parks, federal forest lands, woodlands harvested under policies different than the FFRHCP, etc.? How does the comparison to non-FFR lands fit the FFRHCP objectives and standards?
2. Are you wanting monitoring of FFR lands that have not (yet?) been harvested using FFR rules?
3. Why do you care about temperatures on non-FFR lands? There are geographic differences between most FFR regulated lands and most non-FFR lands that affect temperature. For example, most federally managed forest lands (e.g., NPS, Forest Service) are higher elevation than FFR lands. If the purpose is just to be a reference, is the non-managed forest the reference point you really want us to use?
4. There are no performance targets or resource objectives for comparisons of FFR lands against other ownerships and regulatory realms, so this question seems to be entirely outside the scope of the AMP, as well as beyond the scope of our Extensive Monitoring Program.
5. This statement suggests that the design criteria should include the ability to compare to other forest landownerships such as the federal or tribal lands. This would add the landscape-level context to the EMP and the relative performance of FFR lands to other land ownerships can be assessed - an essential EMP result. Since most stream networks containing FFR lands also contain non-FFR lands, it would simply be applying the sampling scheme to the entire network.

- **What other questions can we answer with this effort? Are there cost efficient add-ons can we implement at the same time, such as amphibian presence/absence (eDNA?)**
    1. How do you define a cost-efficient add-on? There are no 'cost-efficient' add-ons unless they answer a relevant question, and for example the sampling scheme for an amphibian presence study is likely to be different than the sampling scheme for a temperature study.
    2. Does this mean we take a grab sample of resource conditions if we happen to go into the field?
    3. What is the fish production, as characterized with decades of redd count and smolt production records, from FFR managed lands?
    4. If landscape-scale status (and trends, if you want to pay for repeat sampling over time) of amphibian genetics and demographics are important to Policy, this work could be done. These data clearly cannot be acquired via remote sensing, and the fieldwork and labwork do not come free of charge, but water sampling for eDNA analysis could be coordinated with

deployment and retrieval of temperature monitoring equipment to capture some efficiency. The question of cost-effectiveness boils down to whether the results from this work would provide relevant "actionable intel" for the AMP and the Board and come at a reasonable cost.

5. See the March 2019 memo from RSAG to CMER in which 13 research questions and associated utility were proposed.

- **Which of the resource targets are able to be collected from various remote sensing options (LIDAR, Landsat imagery, etc…)**
    1. What is meant by "resource targets"? Does this refer to stream temperatures and riparian stand metrics? Resource objectives? Performance targets? Precise language consistent with the terms and definitions widely used and agreed upon throughout the rest of the AMP would be helpful here, so we can respond appropriately and directly to what you're really asking.
    2. The type of questions that can be answered by various remote sensing options was largely answered in the CMER Extensive Vegetation Monitoring – Remote Sensing pilot study (Moskal et al. 2017 Extensive Riparian Vegetation Monitoring - Remote Sensing Pilot). Water temperature on forested headwater streams with overhead canopy cannot be estimated using remote sensing.
    3. Do you want to know:
        - Desired Future Condition (DFC)?
        - Stands on trajectory to meet DFC?
        - Percentage of shade?
        - Stream temperature?
        - Large wood potential?
        - Landslide potential?
        - Bank stability?
        - Economic consequences?

Attribute	**Resource targets and surrogates**
Shade	**L-1, Performance target**: Type F & S streams, except Eastside bull trout habitat: that produced by shade model or, if model not used, 85-90% of all effective shade
LWD: Surrogate - Large wood supply potential of riparian stand and effective recruit width for large wood supply (i.e., how far from stream can trees be recruited given current tree heights)	Surrogate: **L-1 Functional objective**: "Develop riparian conditions that provide complex habitats for recruiting large woody debris and litter"
Litter fall	**L-1 Performance target**: Targets for Westside and Eastside Type S and F streams are a low priority because adequate leaf litter is expected to be a by-product of riparian stand conditions.
Riparian condition: Surrogate - Basal area	Surrogate: **L-1 Performance target**: Westside and high elevation Eastside habitats: riparian stands are on pathways to meet Desired Future Condition (DFC) targets (species, basal area, trees per acre, growth, and mortality).

Sediment: Riparian stand width and percentage cover for sediment filtering	Surrogate: **L-1 Functional objective:** Provide clean water and substrate and maintain channel forming processes by minimizing to the maximum extent practicable, the delivery of management-induced coarse and fine sediment to streams (including timing and quantity) by protecting stream bank integrity, providing vegetative filtering*, protecting unstable slopes, and preventing the routing of sediment to streams. *Vegetative filtering can be measured by riparian vegetation, which is covered under the target for riparian condition under LWD

The following table is an interpretation of Policy questions translated to focused questions that clarify with resource targets and products. Is this what Policy intended for extensive monitoring?

Policy Question	Source	Focus questions	Target	Products/What it tells us
1) What is the distribution of stream temperature in Type F and N streams across FFR regulated lands, and how is the distribution changing over time as the forest practices prescriptions are implemented?	Field data collection	a) What is the distribution of stream temperature in Type F and N streams across FFR regulated lands?	Temperature criteria	•Cum. freq. distribution, •Mean, min. max. metrics •Prop. & duration achieving targets •Baseline for assessing trends
	Field data collection	b) How is the distribution of stream temperatures changing over time?	Temperature criteria	•Annual variability/trends of 1a products
2) What is the variation in stream temperature distribution on FFR regulated lands compared to non-FFR regulated lands?	Analyses of 1a	c) How does the stream temperature distribution on FFR regulated lands compare to non-FFR regulated lands?	Temperature criteria	•Compares 1a product metrics to existing data from other agencies, but must have similar geophysical match among sites. •Relative difference or similarities among different land uses
3) For Type F and N streams, what is the status of riparian stand condition; e.g. stand structure, large wood present (contributing to pools and stream morphology), and shade.	Remote sensing	a) What is the riparian stand composition (e.g., conifer, deciduous, mixed) and size characteristics (e.g., height, cover, width) along Type F and N streams across FFR regulated lands?	•HCP Riparian Strategy •MDT-Indicator of success	•Riparian stand distribution by composition and size categories •Provide spatial context for the overall extent of FFR which states "RMZs are the primary riparian protection measures for typed waters"

	Analyses of 3a	b) What is the riparian stand potential to provide shade and large wood (LW) ecological functions?	•Schedule L-1, Shade performance target •Large Wood HCP Riparian Strategy	•Cum. freq. distribution of shade and large wood supply potential •Prop. achieving shade target •Riparian effective recruit width for large wood supply •Function effectiveness for given riparian stand conditions
4) What other questions can we answer with this effort?	Analyses of 3a	a) What proportion of riparian stands are on trajectory to reach the Desired Future Condition (DFC) or have reached DFC?	Schedule L-1, Performance target, Type F DFC	Provides a measure for how well we are achieving the goals of FFR.
	Analyses of 3a	b) What proportion of streams dominated by hardwoods?	no target	Addresses questions about the extent of hardwood in RMZs and changes in hardwood dominance over time.
	Analyses of 3a	c) What is the proportion of buffers with disturbances such as windthrow, fire, disease/bugs?	no target	Estimates the extent where buffers have been impacted by major disturbance and the associated loss of functions (e.g., shade and LW) across the landscape.

Listed below are highly relevant documents for a conversation between RSAG and Policy regarding past extensive monitoring efforts and must be reviewed by all parties prior to a joint RSAG/CMER/Policy conversation. If you need access to any of these documents, please contact Alexander Prescott.

- March 2019 memo from RSAG to Policy, 'Extensive Status and Trends Monitoring Background and Guidance Questions'
- February 2014 memo from RSAG to Policy, 'Use of Remote Sensing to Conduct Extensive Riparian Monitoring'
- Extensive Riparian Status and Trends Monitoring – Vegetation, Type F/N Westside and Eastside projects;
    - A pilot study evaluating different scales of aerial photos was completed in 2006;
    - A literature synthesis review to evaluate the feasibility of applying remote sensing to assess riparian stand conditions was completed in November 2015;
    - The Extensive Riparian Vegetation Monitoring Remote Sensing Pilot (see findings report) completed in June 2017, Moskal et al.;

    - The Extensive Riparian Vegetation Monitoring Implementation Pilot (see finding report) completed in September 2018;
    - Extensive Riparian Vegetation Monitoring, Model Transferability Testing Draft Report January 2020, Cooke and Devine.
- 21-23 Biennium CMER Work Plan, 5.2.8 Extensive Riparian Status and Trends Monitoring Program
- Monitoring Design for the Forestry Module of the Governor's Salmon Recovery Plan "MDT Report", July 2002