

PROJECT TITLE: Study Plan to Evaluate the Effectiveness of the Current TFW Shade Methodology for Measuring Attenuation of Solar Radiation to the Stream

SCOPE OF WORK

1.01 Background

Problem Statement

As more fish populations have declined and become listed under ESA, especially bull trout whose distributions can be limited by warm stream temperatures, shade and other factors influencing stream temperatures have come under greater scrutiny. Within TFW, shade has historically been defined as canopy cover as measured with a densiometer. The effectiveness of this approach has been questioned because canopy cover, as visually seen through a densiometer, may not actually represent the full component of vegetative canopy which contributes towards attenuation of incoming solar radiation or energy input to the stream, thereby resulting in impacts to stream temperature. The “full component” may include other factors such as density of trees and canopy, aspect, solar angle, etc.

To provide clarification for this study, the following definitions are provided:

- 1) Canopy Cover: The percent of view-to-the-sky obscured by vegetation or topography.
- 2) All Available Shade: As described within the Forest Practices board manual for the purposes of regulating shade within the bull trout overlay, “all available shade” is defined as maintaining post-harvest canopy cover equivalent to that existing prior to harvest, using the current densiometer methodology.

Objectives

The primary research objective is to determine whether the current Forests and Fish “all available shade” riparian rule, which relies on densiometer measurements of canopy cover, is effective at blocking solar energy from reaching the stream and preventing changes in stream temperatures.

The primary research objective is supported by the following list of research questions:

- 1) Does removing trees that don’t qualify as “all available shade” affect solar energy and/or stream temperature?
- 2) Is canopy cover, as defined by the “all available shade” rule, an adequate surrogate for the attenuation of solar energy to the stream to prevent stream temperature increases?
- 3) If canopy cover remains the same pre- and post-harvest, as defined in the rule for all available shade, does the amount of solar energy input to the stream also remain the same?
- 4) If solar energy input to the stream increases after harvest though all canopy cover is retained, do stream temperatures also increase after harvest?

- 5) Do multiple layers of canopy attenuate more solar energy to the stream than a single layer of canopy (as measured with the densiometer)?
- 6) Under what circumstances does solar radiation (direct and indirect) significantly influence stream temperature?

Hypotheses:

- 1) There is no significant difference in solar energy reaching the stream pre- and post-harvest when the “all available shade” rule is applied.
- 2) There is no significant difference in stream temperature pre-and post-harvest when change in solar energy is zero and the “all available shade” rule is applied.
- 3) There is no significant difference in stream temperature pre-and post-harvest when change in solar energy is positive and the “all available shade” rule is applied.

2.01 Description of all project requirements

- 1) Address objectives, research questions and hypotheses described above, as negotiated in final peer reviewed study design.
- 2) Submission of products by specified timelines as described in 4.01, 5.01, and 6.01 below.

3.01 Description of plan to accomplish tasks, study, project, etc

Proposed Study Design

This study will be conducted in conjunction with another research project testing the effectiveness of riparian buffers on stream temperatures within the bull trout overlay where the “all available shade” rule is applied. See attached study design for “*Comparison of Standard F&F Eastside Riparian Prescriptions with No Shade Removal Within 75-ft Prescription (bull trout overlay)*” (BTO Shade/Temp study). See referenced RFQQ# 02-153 which is also currently out for bid. Forty total sites are proposed for the BTO Shade/Temp study, 20 sites specifically for the “all available shade” rule. The same 20 sites selected for the BTO Shade/Temp study will be used for this solar radiation study. It is likely that all 20 sites may not be available within the first year, any may have to be started in the 2nd year. The study sites will be 600 meters in length, consisting of an upstream untreated reference reach of 300 meters and an adjacent downstream treatment reach of 300 meters. With the BTO Shade/Temp study, two years of baseline data collection is proposed prior to treatment and two to three years of data after treatment. The treatment will consist of timber harvest on both sides of a fish-bearing stream, but retaining all trees within 75 feet of the stream that provide shade and following all other riparian leave tree requirements. Stream temperature and canopy cover measurements (using a densiometer) will be collected at each site for the BTO Shade/Temp study.

This proposed solar radiation study would simply add more instrumentation to better establish links between canopy cover, solar radiation, and stream temperature. The sites where the “all available shade” prescription is applied were chosen for this study because the prescription calls for a constant densiometer reading for both pre-and post-harvest, which is important for testing the assumption that solar radiation will not significantly increase with resultant increases in stream temperature. We propose using paired instruments to measure solar radiation at both control and treatment sites for both pre- and post-harvest conditions. The appropriate instrumentation for measuring solar radiation (i.e. pyroheliometers, pyranometers, canopy

analyzers, light meters, etc.) is yet to be determined. For each control and treatment site, one instrument would be placed on a hilltop above the stream to measure total solar radiation not obscured by canopy or topography; this instrument would stay in place for the full time that associated stream measurements were being taken. The other instrument would take multiple measurements within the stream. Each individual measurement along the stream would need to extend for 24 hours to account for variation throughout the day. The total time frame for measuring solar radiation at each control and treatment site would be 5 days, which would allow for at least 5 measurements for averaging along the stream. The seasonal time frame for taking these solar radiation measurements would occur in July and August to correlate with warmer stream temperatures. For consistency, pre- and post-harvest measurements would occur during the same week of the month for each year sampled.

Data Analysis

Measurements within the stream would be averaged and divided by the total incident solar radiation in order to come up with the solar radiation loading to the stream (or solar radiation attenuated from reaching the stream). A paired t-test would be run to determine the difference in pre- and post-harvest solar loading to the stream. Solar radiation data will be analyzed in conjunction with stream temperature and canopy cover measurements (taken as part of the BTO Shade/Temp study) to test for significant differences in control and treatment sites (as per the hypotheses listed above).

Questions remaining for final study design development:

The following questions remain for the consultant to answer and include within the submitted technical proposal. This information will be used as part of the final work plan.

- (1) What are the critical stream and microclimate variables that need to be measured as part of this study (e.g. upstream water temp, groundwater input, evaporation, convection, conduction, etc.)?
- (2) Which wavelengths should be focused on to most correlate with stream temperatures?
- (3) What are the most appropriate instruments for measuring solar radiation (paired instruments). Possible candidates might include canopy analyzers, pyroheliometers, pyranometers, light meters, etc.? Cost estimates for proposed equipment should be clearly separated out from other cost elements (i.e., salaries, time, travel, etc.) of the proposal.
- (4) Are we adequately addressing and standardizing measurements of solar energy to account for the great deal of variability (e.g. cloud cover, time of day, season, air temperature, etc.)? How can we improve?
- (5) How close of a time period should pre- and post-harvest solar radiation measurements be restricted to minimize seasonal variability? (A week is suggested within the proposed study design.)
- (6) Which period of time (i.e., months) should we restrict the surveys for solar radiation? (July through August is suggested to correlate with higher peak in stream temperatures.)
- (7) Should we refine sites to E/W flowing streams with southern exposure in order to increase sensitivity or detection of change?
- (8) Twenty sites are required for the “all available shade” rule (BTO Shade/Temp study). Is this an adequate number of sites to address the solar radiation component?

- (9) How many years are recommended for pre- and post-harvest? Cost estimates should be broken out by year.

4.01 Project schedule for conduct of work

- June 2002 - negotiate final study design following Scientific Review Committee peer review
- July 1-15 - deploy solar radiation instrumentation and begin implementation of field work.
- January 2003, 2004, and 2005 - progress reports covering work conducted in previous field season.
- January 2006 - submit draft final report for review and comments by BTSAG, and meeting to present results to BTSAG
- June 30, 2006 - submit final report (incorporating BTSAG comments), as well as all maps, data, and field forms.

5.01 Products and Timelines

The contractor shall be responsible for submitting the following reports and materials on the dates specified as follows:

- 1) A yearly progress report due January 31st of each year following field work. The progress reports will be subject to review by the BTSAG before being considered final.
- 2) A draft final report will be due on January 31st following the final year of field work. The report should include project results, including summary statistics, problems encountered, and recommendations for future research. The draft final report will be reviewed by BTSAG, CMER, and the Scientific Review Committee.
- 3) The final report will be due by June 30 after the draft final report has received the required review and incorporation of comments.
- 4) 1:12,000 scale maps showing specific locations for instrumentation will be due concurrently with the final report.
- 5) All data and field forms (data must be error checked and stored electronically in Excel spreadsheets) will be due concurrently with the final report.
- 6) Presentation of final work will be made to the BTSAG at a scheduled meeting prior to June 30 of final year.

6.01. Acceptance Criteria for Products

All progress reports should be considered *draft* until reviewed by the BTSAG. The final report and any proposed publishing of final work is subject to review and approval by the Bull Trout Scientific Advisory Group (BTSAG), the Cooperative Monitoring, Evaluation, and Research committee (CMER) and the Scientific Review Committee (SRC). All comments will need to be addressed by the contractor prior to submitting any reports as *final*.

DNR reserves the right to request additional reports relating to various aspects of the project.

