Findings Report for the Forest Hydrology Study

November 2015

1. Does the study inform a rule, numeric target, performance target, or resource objective?

No.

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

Yes.

The study provides information on the flow characteristics, distribution, and frequency of Type Np streams on the eastside (WAC 222-16-030 Water typing system).
The study provides insight into the Schedule L-2 hydrology question 7: *(H7) Refine the demarcation between perennial and seasonal Type N streams*.

The study also provides information on hydrologic variability, which is a component of the Schedule L-1 key question: *Will the rules produce forest conditions and processes that achieve resource objectives as measured by the performance targets, while taking into account the natural spatial and temporal variability inherent in forest ecosystems?*

3. Was the study carried out pursuant to CMER scientific protocols (i.e. study design, peer review)?

Yes. The study plan went through SAGE, CMER, and ISPR review and the study was conducted in accordance with the study design. SAGE, CMER and ISPR have reviewed and approved the report.

4. What does the study tell us or not tell us?

This study characterized the spatial distribution of headwater stream channels across forested lands of Eastern Washington based on observations made at the end of the summer dry season (July 30 – September 20) in 2012.

a. The study tells us:

i. That headwater channels exist in specific, identifiable parts of the landscape, and that, at the end of the summer dry season, the proportion of headwater channel length with surface water and with evidence of bedload transport varies systematically with certain landscape features.

ii. That digital elevation models and other GIS data (geology, mean annual precipitation) can resolve factors that correlate with channel location and with the proportion of channel length with surface water and with evidence of bedload transport. These correlations can be used to construct GIS-based statistical models to calculate the probability of finding a headwater

channel with or without surface water, and with or without evidence of bedload transport, for any location within the extent of the study area.

iii. That the primary factor determining where channels are found is contributing basin area (drainage area) to the point of observation. At a given contributing area, mean annual precipitation exerts the primary influence on the observed proportion of sites with channels and on the proportion of channels with water. For a given contributing area and mean annual precipitation, locations with greater plan curvature have a higher proportion of sites with channels. In distinguishing channel locations with and without surface water, local topography is again important, but it is gradient, rather than plan curvature, that plays the primary role. Steeper channels are more likely to be dry. The presence of surface water also appears to be related to the average steepness of the contributing area, with steeper basins tending to have fewer channels with water. Landscape position is also important: channels near the valley floor are more likely to have water than channels closer to the ridge top. Geology of a basin was also found to play an important role, but with an influence that varied with basin size and was confounded by correlations between geology and basin topography. In general, crystalline igneous and metamorphic rocks tended to contain a greater proportion of wet channels than other rock types.

iv. That using these GIS statistical models, the total length of channels with and without surface water, or with and without evidence of bedload transport, can be accurately estimated over a population of headwater basins, as shown for the test basins in our sample set, but that estimates for single basins are uncertain, and that the magnitude of this uncertainty can be determined from the range of errors found for the population of sample basins.

v. That these GIS models can also be used to predict the length of contiguous channel type for any location on a headwater-channel network, which provides a means of predicting the type of surface-water connection, in terms of a channel with or without water and with or without evidence of bedload transport, between any two points along a headwater channel. This prediction, in turn, can be used to address a variety of questions about connectivity through the channel network. Examples include the upslope extent of surface water, and the probability of encountering dry channels downstream of channels with surface water.

vi. That the proportion of headwater basins with a particular type of surface-water connection to fish-bearing waters varies systematically with headwater-basin characteristics. For this study, we examined three types of surface-water connections observed at the end of summer: no channel, a dry channel, and a channel with surface water. These observations can be translated to the probability for each type of connection for any individual headwater basin.

vii. One of the stated purposes of the Eastside Type N Forest Hydrology Study (FHS) project was to improve our understanding of the distribution of hydrologic conditions in non-fish bearing streams (Type N) on forest lands east of the Cascade crest (Appendix A). Field data collection techniques used during channel condition and flow assessment revealed that 79% of the length of Type Np channels sampled in the survey had perennial flow and 21% had intermittent flow located downstream of the upper most point of perennial flow as defined by rule (WAC 222-16-031). Of the 101 Type Np basins sampled, 78% had some length of dry channel below the

upper most point of perennial flow, with a median dry channel length of 712 feet (Appendix A, Figure 6).

b. The study does not tell us:

i. Specifically where channels do or do not exist, or which channels do or do not contain surface water, or which channels do or do not contain evidence of bedload transport. Predictions of channel location, surface water, and evidence of bedload transport are in terms of the probability of observing such features, not yes or no determinations. If an accurate yes-no determination of channel type is required, a field visit is required. Note, however, that this study also poses the possibility that subsequent field visits to the same site will find different conditions. For those portions of the channel network subject to stochastically driven change, uncertainty is an intrinsic property of the system.

ii. How management affects the observed proportions of each channel type. Within the constraints of this project, which required that observations from channel surveys be related to GIS data available over the entire study area, we could identify no relationships with data indicative of management history. This does not imply that management effects do not exist; only that we could identify no relationships with the data we had. These data were forest-stand types based on classified 2012 satellite imagery (http://lemma.forestry.oregonstate.edu/data/structure-maps).

iii. This study does not tell us how much the extent of channel length, or the proportion of channel length in each channel type (perennial flow, dry, intermittent), change over time. Observations were from a single season in a single year. The statistical models giving the probability of channel type can be used to pose hypotheses about the degree of temporal variability and sensitivity to changing conditions, but these hypotheses remain untested. However, the model can provide a measure of how likely things are to change.

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

This study was a precursor to the Eastside Type N Riparian Effectiveness project (ENREP) and it provided insight on the occurrence of seasonally dry Np streams.

The study provides predictions and hypotheses that may be tested during ENREP site selection and that may be used to guide future research efforts in eastern Washington.

The study provides a transparent and quantifiable approach for hydrologic grouping of headwaters basins which facilitates the design and testing of hypotheses concerning the effects of riparian BMPs under different flow conditions (perennial, seasonal, mixed). Furthermore, the relative occurrence of flow types within each group can be quantified; providing a way to estimate the relative applicability of study findings across all forested basins in eastern Washington.

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 study presents two novel ideas: 1) developing regression models for predicting probable states of channel and hydrologic conditions (surface flow) at any headwater stream and 2) translating observed distributions of reach lengths to measures of channel-type connectivity. These are both implemented using digital data in a GIS environment, so that predictive results can be applied across all forested basins in eastern Washington. The way the study uses probability theory to predict surface flow and connectivity is unprecedented and results in a spatial-frequency-based channel classification approach that includes both probable channel type and probable channel-type connections up and downstream. This research may provide insight into the likely distribution of water types by geography and channel connectivity based on probability modeling. Validation of the logistic regression was done only in terms of cumulative channel length over a population of basins; for a model that makes predictions in terms of probability, predictions of channel type at a single point in a channel network can only be validated in terms of the proportion of points in a population with a particular channel type. This provides for stratification of a channel network into zones more or less likely to have particular channel types, which serves the study objective to improve the efficiency of finding candidate sites for the Type N ENREP study and initially the Eastside Type Np Extensive monitoring project (the Eastside Type Np Extensive project has since been replaced by exploring the use of more refined remote sensing tools – LiDAR).