# Beta Test of "Science to Policy Framework" for EMC-2015-001

## 1. Does study fulfill requirements of the funding?

**Yes**. The study was able to achieve study objectives in the timeframe specified, with an additional contract extension.

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

**Yes**. The study informs rules and resource objectives.

## B. Does the study inform the Forest Practice Rules?

**Yes**. The study informs the rule language in 14 CCR § 916.9 [936.9, 956.9] (c)(4), which states that:

> Class II-L watercourses can have greater individual effects on receiving Class I watercourse temperature, sediment, nutrient, and large wood loading than Class II standard (Class II-S) watercourses due to larger channel size, greater magnitude and duration of flow, and overall increased transport capacity for watershed products.

It also informs 14 CCR § 916.9 [936.9, 956.9] (g)(1)(a)(1 and 2), which states:

> **(A)** A Class II-L Watercourse is defined as a Class II Watercourse having either of the following characteristics:
> **1.** A contributing drainage area of ≥100 acres in the Coast Forest District, or ≥150 acres for the Northern and Southern Forest Districts, as measured from the confluence of the receiving Class I Watercourse.
> **2.** An average Active Channel width of five feet (5 ft.) or greater near the confluence with the receiving Class I Watercourse. Where field measurements are necessary to make this determination, Active Channel width measurements shall be taken at approximately fifty foot (50 ft.) intervals beginning at the point where the Class II Watercourse intersects the Class I WLPZ boundary and moving up the Class II Watercourse for a distance of approximately two-hundred feet (200 ft.). The combined average of these five (5) measurements shall be used to establish the average Active Channel width. Measurement points may be adjusted based upon site-specific conditions, and should occur at riffle locations and outside the influence of Watercourse crossings to the extent feasible.

Furthermore, it also informs 14 CCR § 916.9 [936.9, 956.9] (v) which allows for site-specific measures or nonstandard operational provisions as an alternative to the ASP requirements.

## 2. Is the study scientifically sound?

### A. Was the study carried out pursuant to valid scientific protocols (i.e., study design, peer review)?

**Yes.** The broad scale assessment was published in Hydrological Processes in 2020 (Pate et al., 2020). The longitudinal temperature study was submitted to Hydrological Processes in January 2021. The paper was rejected, but reviewers encouraged a resubmittal if modifications were made to the paper. Modifications are currently in process.

## 3. Is the study scalable?

### A. What does the study tell us? What does the study not tell us?

**Findings**
For the broad scale assessment study, a total of 101 Class II stream reaches were surveyed above their confluence with Class I watercourses. Ten or more cross-sections were measured for each watercourse and evenly spaced across the reach length that was 20 times the bankfull width of the channel, or approximately 60 meters in length. At each cross-section, the presence of surface flow was determined along with channel dimensions and grain size information. Watercourses were classified as:

- "Connected" if the last cross-section before the Class I confluence/transition was flowing water (Figure 1); and/or
- "Perennial" if all cross-sections were flowing water (Figure 1).

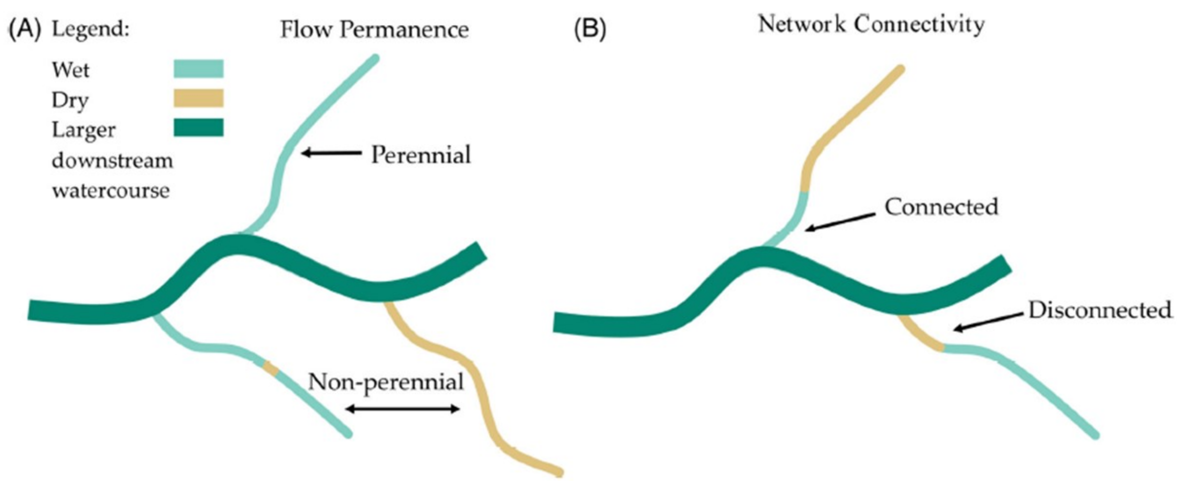


**Figure 1.** Conceptual diagram of (a) flow permanence classifications based on the presence (perennial) or absence (non-perennial) of surface flow at each cross-section throughout the entirety of the stream reach and (b) network connectivity classifications based on the presence (connected) or absence (disconnected) of surface flow within the furthest downstream cross-section of a reach, which drained into a larger downstream watercourse.

Altogether, the study found that the presence of connected and/or perennial streams were most strongly controlled by the amount of precipitation during the winter (Figure 2). Drainage area was positively associated with the presence of connected and/or perennial streams, with larger watershed having watercourses that were either more connected and/or more perennial in nature. Alternatively, the presence of connected and/or perennial streams was not strongly controlled by channel width. In fact, increased channel width was generally associated with less connected and/or perennial streams, which runs counter to the assumptions of the ASP Rules

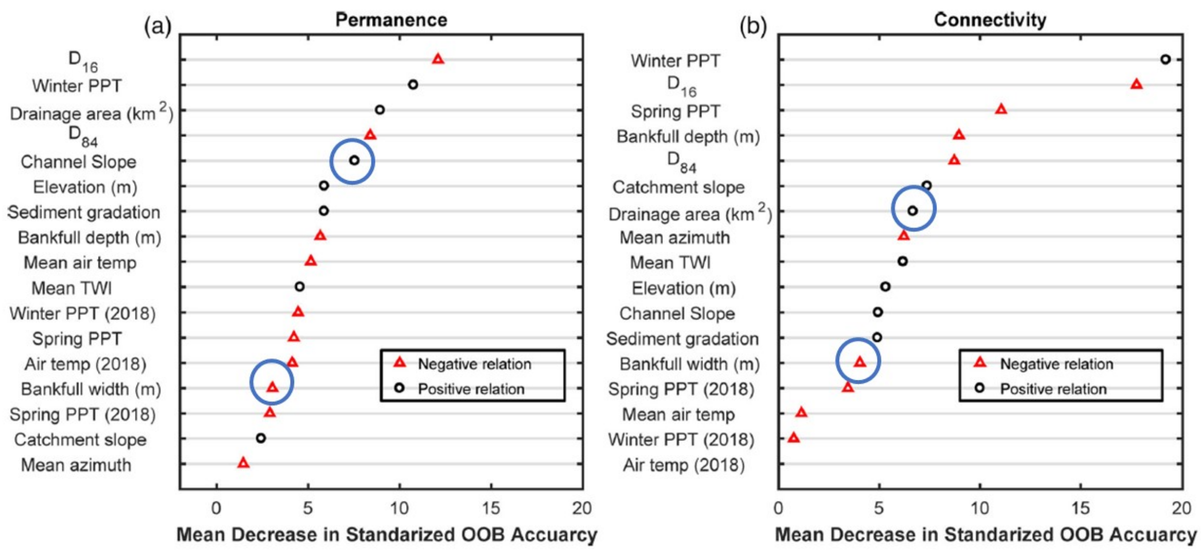


**Figure 2.** Variable importance plots of modelled covariates as a function of standardized mean decrease in out-of-bag (OOB) accuracy for (a) flow permanence and (b) network connectivity. Markers indicate if the relationship between a covariate and the likelihood of a site being perennial or connected was positive or negative as inferred from partial dependence plots.

A central assumption of the ASP Rules is that stream temperature warms in the downstream direction (i.e., asymptotic warming), and the requirement for more robust riparian prescriptions near the Class I/II transition is based on this assumption. The longitudinal study indicated that not all Class III or II watercourses warmed in the downstream direction. In particular, three of the monitored streams in the LaTour Demonstration State Forest (DSF) cooled in the downstream direction. The assumption of asymptotic warming was met by 4 out of the 5 streams monitored in the Jackson Demonstration State Forest. Results also indicate that the watercourse stream temperature in LaTour DSF were less coupled to air temperature than those from Jackson DSF (Figure 4).

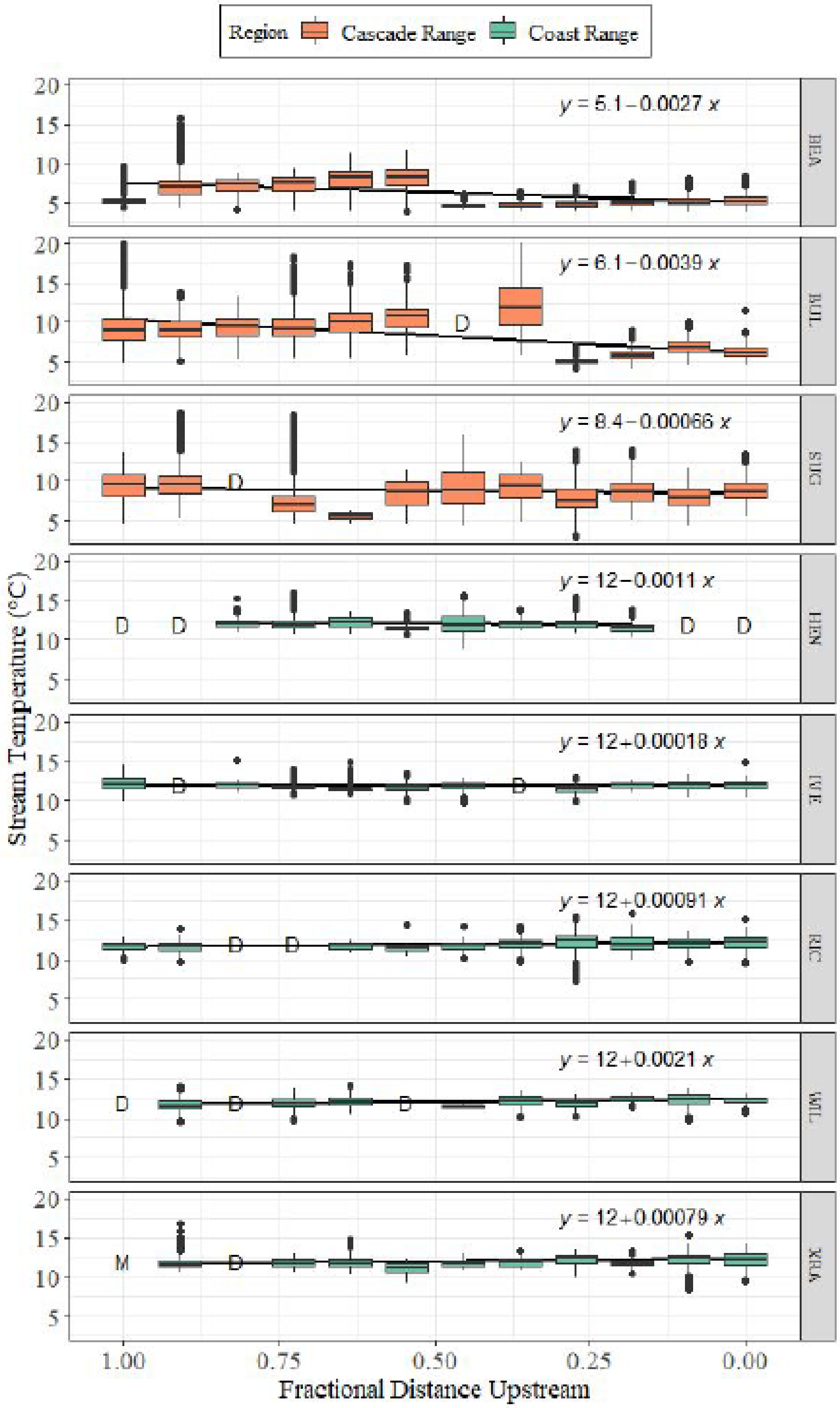


**Figure 3.** Longitudinal distribution of daily mean summer stream temperatures measured along each stream with the longitudinal linear regression equation predicting average daily mean stream temperature from downstream distance (m) shown to indicate downstream warming or cooling.

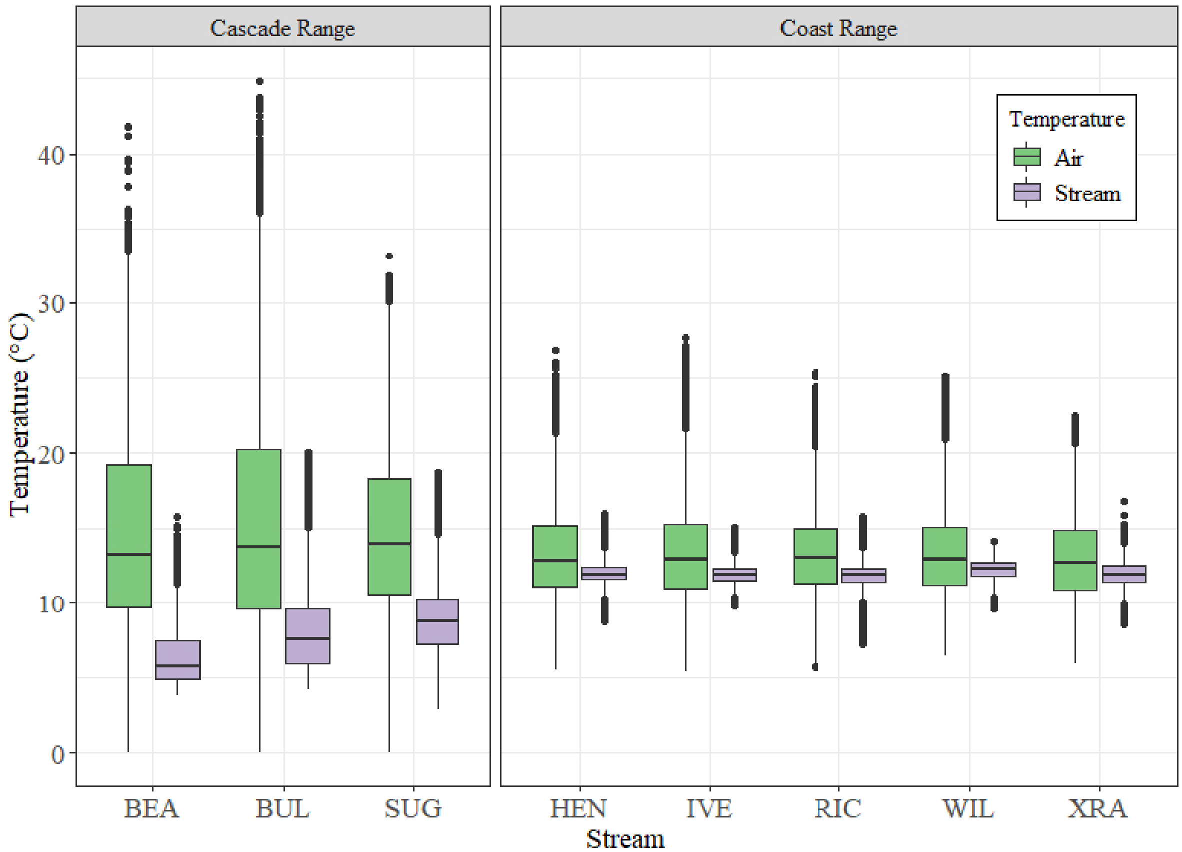


**Figure 4.** Comparison of air and stream temperature distributions among streams in the Coast and Cascade Ranges. Data were pooled from all temperature sensors within each stream. The boxplot central tendency line is the median, shaded boxes represent the interquartile range (IQR), whiskers represent the largest value up to 1.5-times the IQR, and the black dots indicate outliers beyond 1.5-times the IQR.

**Study Limitations**

While the studies have advanced our understanding regarding the controls on surface water connectivity during summer low flows for Class II watercourses, as well as downstream temperature dynamics under varying lithologies, there are several limitations to the study.

1. **Mitigation of Thermal Impacts is Only One Aspect of the ASP Rules –** The ASP Rules were put into place not only to protect against the downstream transmission of disturbance-induced temperature increases, but were also crafted to maintain, protect, and restore key processes and functions related to sediment, nutrients, and large woody debris. While this study suggests that the width criteria does not effectively distinguish perennial or connected watercourses, the width criteria may correspond to other processes like large woody debris and/or sediment transport.

2. **The Broad Scale Assessment May Not Adequately Characterize Spatial Variability Across the Range of the ASP Rules –** The field work for the broad scale assessment occurred over 10 weeks, with over 1000 cross-sections characterized. For logistical reasons, many of the surveyed watercourses were clustered. Also, access to private timberlands was very difficult. Hence, many areas subject to the ASP Rules were not surveyed. It is uncertain whether the findings would change if additional streams were surveyed in an area with significantly different climate, geology, or physiography.

3. **The Broad Scale Assessment May Not Adequately Characterize Temporal Variability Across the Range of the ASP Rules –** Surveys were only conducted during one summer season. For the North Coast and Klamath provinces, precipitation was 26-38% lower than average, while it was close to average in the Cascades. It is unclear how findings related to the width and drainage area criteria would change if watercourses were surveyed following a much wetter winter, although findings from the current study suggest that there would be more downstream connectivity and perennial flow.

4. **The Longitudinal Study is a Case Study and May Not Reflect Downstream Temperature Dynamics Across the Entire Range of ASP** – The longitudinal study documents downstream temperature dynamics in two geomorphic provinces of the ASP area (i.e., North Coast and Cascades). However, we lack data from the Klamath province, where differences in climate and underlying geology may affect downstream temperature response.

**Implications for Rules**

Findings from the broad scale assessment provide evidence that the width criteria in 14 CCR § 916.9 [936.9, 956.9] (g)(1)(a)( 2) does not adequately distinguish between watercourse that are perennial and/or connected versus ones that are dry. This is particularly true for watercourses in the Northern Forest District (Figure 5). As such, a potential option is to simplify the ASP Rules by removing the width criteria. All other factors held constant, larger drainage areas will have a higher likelihood of transporting sediment, nutrients, and large woody debris due to the increase in transport capacity. Drainage area is also a more objective criteria than width, as the width criteria requires the practitioner to select cross-sections, measure channel width, and calculate an average of the measurements. The data suggests that the coefficient of variation for channel width ranges from approximately 25 to 40%, indicating that channel width is moderately variable.

A potential outcome regarding the removal of channel width as a potential diagnostic criteria for Class II-Ls, is that a smaller length of Class IIs will receive Class II-L protection. This is because a drainage area of 150 acres in the Northern Forest District generally results in a channel width greater than 5 feet. This will likely result in either less length or fewer streams receiving Class II-L protection.

The longitudinal study validates some of the concepts in 14 CCR § 916.9 [936.9, 956.9] (v) “Option V”, which allows for the customization of riparian prescriptions as an alternate to standard ASP prescriptions.  Anecdotal evidence suggests “Option V” has been used sparingly due to substantial time and resource investment to craft a site-specific plan, and the time it takes to approve the site-specific plan during the review period.

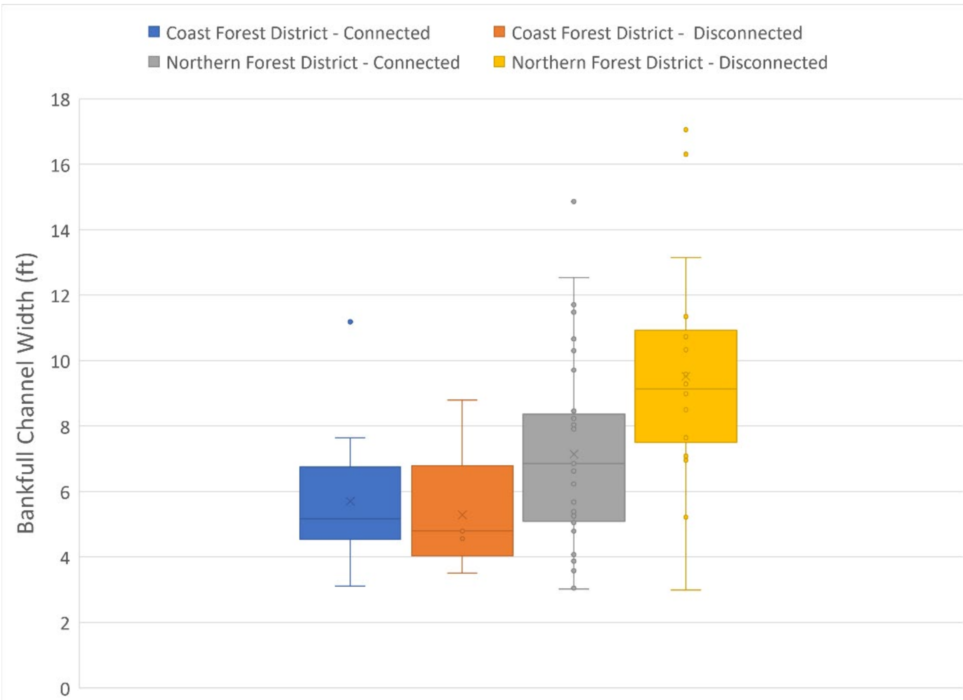


**Figure 5.**  Bankfull channel width for connected and disconnected watercourses by Forest Practice District.  Data suggests that wider streams in the Northern Forest District are less connected than narrower streams.

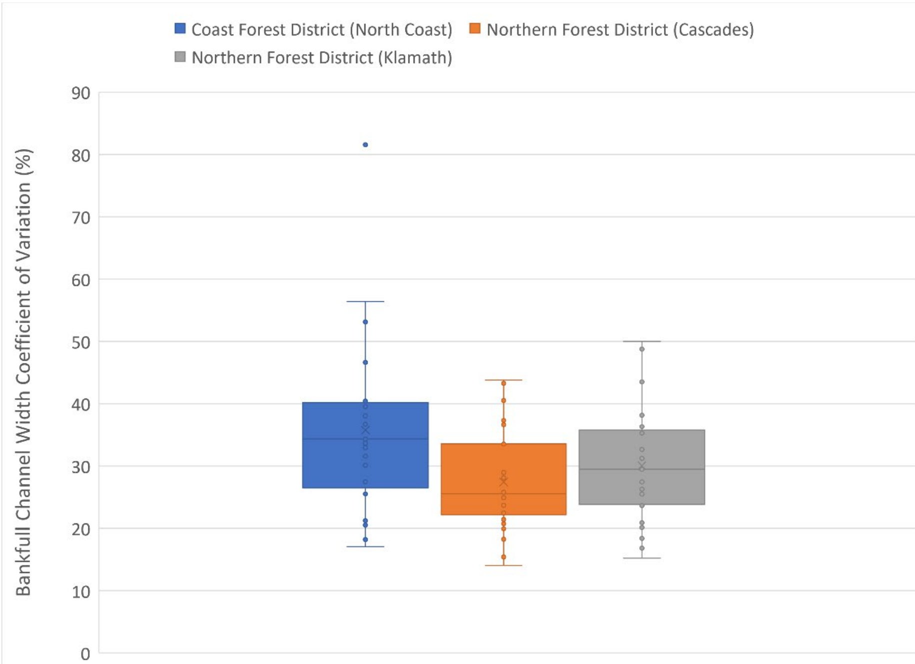


**Figure 6.** Coefficient of variation for bankfull channel width by forest practice district and geomorphic province.

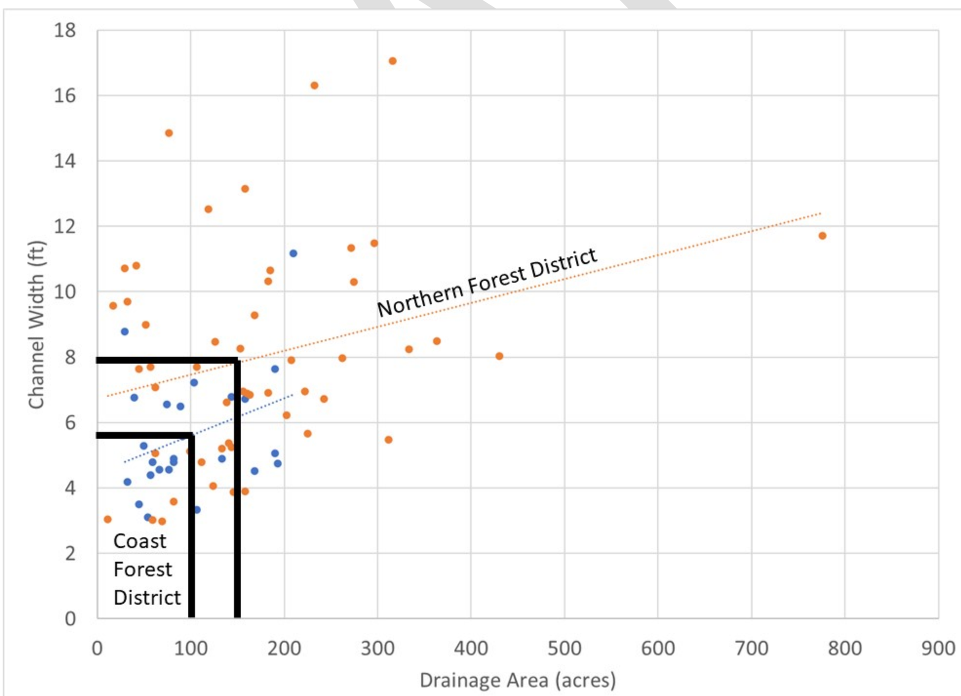


**Figure 7.** Channel width versus drainage area for the Coast and Northern Forest District. Although the relationship between the two variables are very poor, the data indicates that removing the 5-foot channel width criteria will result in less stream length receiving Class II-L protection.

**4. More Research Needed?**
**i. Literature Review Sufficient? – Yes.** The literature review in the paper was sufficient in terms of covering relevenant research on surface water connectivity for headwater streams.
**ii. Further Funding Needed? - Yes.** This particular study addressed one element of the ASP Rules. To further test the effectiveness of the ASP Rules, additional work need to be done to test the effectiveness of the ASP prescriptions on protecting, maintaining, and restoring functions and processes related to sediment, nutrients, and large wood debris.

**A.** This study is related to EMC-2018-006, which seeks to verify the ASP riparian prescriptions for maintaining or protecting canopy closure, water temperature, and primary productivity. Overall, this study will tell us if there is a significant difference in protection afforded by the Class II-L prescription versus a pre-ASP riparian prescription. It will be several years before the results of EMC-2018-006 will be ready.

**5. Scientific Applications**

We learned that the controls on the presence of surface flow during summer months are multi-factored. While the ASP Rules assume that the presence of surface water is a function of watercourse width and/or drainage area, this study indicates that climate, geology, and watershed properties all play a factor in influencing the downstream connectivity of surface waters. Altogether, these variables are able to classify the presence of perennial and/or connected streams 73 to 76 percent of the time, respectively. As such, our understanding of the controls for perennial/connected flow for headwater streams in California has increased substantially.