7/26/16

Project Number: EMC-2015-001

Project Name: Class II-L Effectiveness Monitoring

BACKGROUND INFORMATION AND PROBLEM STATEMENT

Conflicts in implementing the original Class II-L rules led to passage of the California Forest Practice Rule Package titled "Class II-L Identification and Protection, 2013" (Revised Class II-L Rules), which went into effect on January 1, 2014. The rule language in 14 CCR § 916.9 [936.9, 956.9] (c)(4) 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.*

The revised methods used to determine a Class II-L watercourse include:

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 (**Area method**); or
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 watercourse and lake protection zone (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 (**Width method**).

The rule language in 14 CCR § 916.9 [936.9, 956.9] (g)(1)(C) also states the following:

> ***The above method for determination of Class II watercourse type shall sunset on January 1, 2019 pending further evaluation of the efficacy of Class II WLPZ widths and operation requirements in relationship to watercourse characteristics and achievement of the goals specified in 14 CCR § 916.9 [936.9, 956.9] subsection (a). The Department shall report to the Board at least once annually on the use and effectiveness of 14 CCR §***

916.9[936.9, 956.9] subsection (g) for as long as the rule section remains effective.

The language above (Sunset Clause) calls for monitoring the effectiveness of Class II WLPZs in achieving the following goals specified in 14 CCR § 916.9 [936.9, 956.9] subsection (a):

1. *Comply with the terms of a Total Maximum Daily Load (TMDL).*
2. *Prevent significant sediment load increase to a watercourse system or lake.*
3. *Prevent significant instability of a watercourse channel or a of a watercourse or lake bank.*
4. *Prevent significant blockage of any aquatic migratory routes for any life stage of anadromous salmonids or listed species.*
5. *Prevent significant adverse effects to streamflow.*
6. *Consistent with the requirements of 14 CCR § 916.9 [936.9, 956.9], subsections (f), (g), (h) and (v), protect, maintain, and restore trees (especially conifers), snags, or downed large woody debris that currently, or may in the foreseeable future, provide large woody debris recruitment needed for instream habitat structure and fluvial geomorphic functions.*
7. *Consistent with the requirements of 14 CCR § 916.9 [936.9, 956.9], subsections (f), (g), (h) and (v), protect, maintain, and restore the quality and quantity of vegetative canopy needed to:*
    a. *Provide shade to the watercourse or lake to maintain daily and seasonal water temperatures within the preferred range for anadromous salmonids or listed species where they are present or could be restored; and*
    b. *Provide a deciduous vegetation component to the riparian zone for aquatic nutrient inputs.*
8. *Prevent significant increases in peak flow or large flood frequency.*

The Sunset Clause also calls for an assessment of the effectiveness of the area and width methods for identifying Class II-L watercourses.

Determining the effectiveness of the Class II-L WLPZ prescriptive standards in achieving the goals outlined above is considered validation monitoring and would require extensive planning, resources, and time. As a result, the validation of the Class II-L WLPZ prescriptive standards will be treated as a separate study.[1] However, determining the effectiveness of Class II-L identification rules can be done in a relatively timely and cost-effective manner. With this in mind, several monitoring questions, along with general approaches for answering these questions, were developed to address the

[1] The third experiment in the South Fork Caspar Creek Experimental Watershed will utilize standard WLPZ requirements and has long-term flow, sediment, and water temperature records. It will serve to provide some information on this topic.

requirements in the Sunset Clause language, including issues of uncertainties identified during the Class II-L negotiation and revision process.

Relationship to the Effectiveness Monitoring Committee and EMC Strategic Plan

The following proposal is associated with Theme 1 (i.e., WLPZ riparian function) of the EMC Strategic Plan. Specifically, it relates to sub-themes 1.6 and 1.7 of the Strategic Plan, with the following priority or monitoring questions:

- Are the Class II-L rules effective in protecting, maintaining, and restoring riparian function (1.6)?
- How effect are the ASP Class II-L definitions in identifying watercourses with summertime flow (1.7)?

CONCEPTUAL APPROACHES FOR MONITORING

Rationale for the Area and Width Methods

The rule language in 14 CCR § 916.9 [936.9, 956.9] (c)(4) (see gray shaded text on page 1) states that Class II-L watercourses have greater individual effects on downstream receiving waters than Class II standard watercourses due to increased fluxes of heat, sediment, nutrients, and large woody debris. The larger fluxes from Class II-Ls are ascribed to larger channel dimensions, greater magnitude and duration of flow, and greater transport capacity for watershed products.

Both the area and width methods are consistent with the concept of hydraulic geometry. Hydraulic geometry assumes that discharge (Q) is the dominant independent variable that drives variations in channel process and form (Leopold and Maddock, 1953). Equations 1 and 2 are well known hydraulic geometry power functions, where Q is discharge, A is drainage area, W is channel width, and b, c, d, and e are empirical constants:

(1) $Q = eA^{d}$

(2) $W = cA^{b}$

The Class II-L identification method uses both drainage area and active channel width to infer channel process and function, as these are strongly related to discharge. Additionally, transport capacity (Q_t) can be defined by the stream power model:

(3) $Q_t = k(\Omega - \Omega_c)^{n\,\Omega}$

where k is an index of material mobility, Ω is stream power, Ω_c is the critical stream power for incipient motion, and n^{Ω} is an exponent between 1 and 1.5 for sediment (Bagnold, 1977). Stream power can be defined as:

(4) $$\Omega = \frac{\rho g A^d S}{W}$$

where ρg is the unit weight of water, A is area, S is channel slope, W is channel width, and d is an empirical constant (Brummer and Montgomery, 2003). Equations 1 through 4 indicate that discharge and transport capacity varies with channel width and drainage area. Both discharge and transport capacity are important controls on the downstream transport of sediment, nutrients, and large woody debris[2] (MacDonald and Coe, 2007), making the identification methods consistent with the rule language in14 CCR § 916.9 [936.9, 956.9] (c)(4) for these watershed products.

Identification of Class II-L Watercourses

The first iteration of the Class II-L identification methods created conflict between regulators and the regulated public, due to the lack of explicit guidance on how to identify Class II-L watercourses. This resulted in disagreement over the classification of Class II-L watercourse. The revised Class II-L Rules were created to reduce this conflict. However, these rules also require a monitoring and reporting element to determine if the new rules are effective in identifying Class II-L watercourses.

General Monitoring Question 1: How are the Class II-L identification methods being implemented and are there still disagreements in watercourse classification between Review Team personnel and the regulated public?

Related Rule: 14 CCR § 916.9 [936.9, 956.9] (g)(1)(C)

General Approach: Answering this question requires us to know about the population of Class II-L watercourses, as well as how they are being identified in the field. A general approach to answer this question would be to do post-PHI surveys of CAL FIRE Forest Practice Inspectors to see how often Class II-L determinations were made, which identification method was used (i.e., drainage area versus active channel width), and whether the classification was disputed during the review phase of the timber harvesting plan (THP), Modified THP, Nonindustrial Timber Management Plan (NTMP), Sustained Yield Plan (SYP), and Program Timberland Environmental Impact Report (PTEIR)/PTHP processes. Alternatively, CAL FIRE's pre-harvest inspection (PHI) reports could be revised to determine if Class II-L were present in the THP area, which

[2] The transport of large woody debris is also strongly dependent upon piece size. Small streams cannot generally move large pieces of wood via fluvial transport (Bilby and Bisson, 1998). For example, past large wood studies have shown that trees that have a length of 1.5 to 2 times bankfull width are likely to remain in place and continue to function (e.g., WFPB 2001).

type of identification process was used, whether watercourse designations were changed in the field, and whether disputes ensued. Both these approaches would be relatively easy, inexpensive, and could yield information to policy makers quickly. The information can be used to update the Board of Forestry and Fire Protection on an annual basis, as per the Sunset Clause.

The Effectiveness of the Area and Width Methods in Identifying Class II-L Watercourses

The identification methods for Class II-L watercourses rely on drainage area or the active channel width to classify Class II-L watercourses. While the width method uses a fixed value of 5 ft to identify Class II-L watercourses, the drainage area method recognizes spatial variation in the drainage area required to sustain Class II-L functions and processes. Specifically, the drainage area method uses ≥ 100 acres for the Coast Forest District and ≥ 150 acres for the Northern and Southern Forest Districts. This is appropriate since precipitation is generally higher in the Coast Forest District than in the Northern and Southern Forest Districts (Figure 1), and the magnitude of precipitation inputs to a watershed can drive many of the processes and functions that characterize Class II-L watercourses.[3] Also, geology is a factor that controls physiography, permeability, and runoff pathways. When considering the variability in precipitation and geology across non-federal forestlands in California, it stands to reason that the drainage area necessary to sustain Class II-L functions and processes might be similarly variable.

It can be argued that the active channel width is possibly a more effective indicator of Class II-L functions and processes than drainage area, since channel width scales more directly with discharge and sediment transport capacity than drainage area. However, as demonstrated in Eq. 2 and in Figure 2, there is a relationship between drainage area and channel width. A refinement of the area and width methods would ideally relate drainage area to active channel width so that there is consistency between the two metrics.

[3] The rational method predicts peak runoff as a function of drainage area, runoff coefficient, and rainfall intensity; the USGS Magnitude and Frequency regional regression equations predict peak flows using mean annual precipitation, drainage area, and in some cases, elevation.

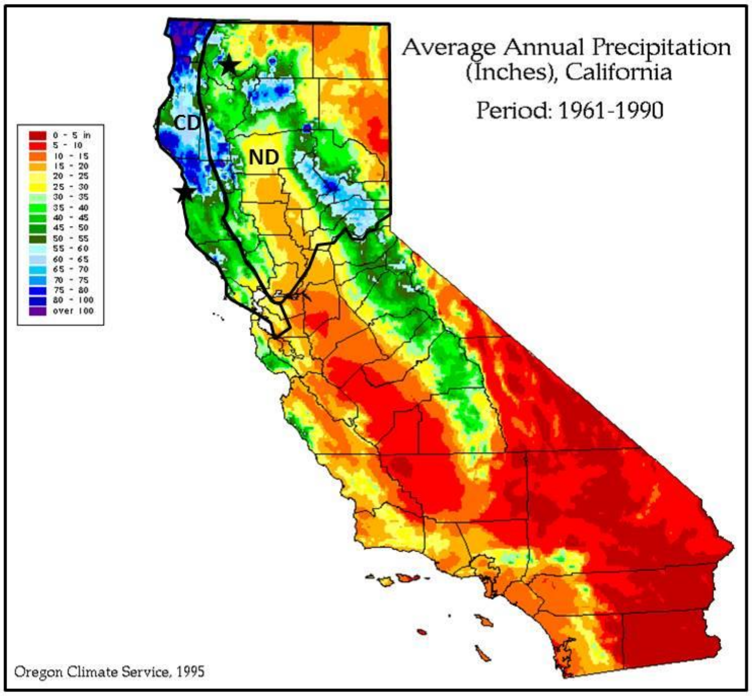

Figure 1. Mean annual precipitation for California for the period between 1961and 1990 (taken from www.wrcc.dri.edu). Polygons represent the approximate boundaries for the Coast (CD) and Northern (ND) Forest Districts. Stars represent the approximate geographic area where the channel width-drainage area surveys in Figure 2 took place.

General Monitoring Question(s) 2: Are the area and width methods effective in identifying Class II-L watercourses, and do the rule metrics adequately represent the spatial variability in the areas affected by the Class II-L requirements?

Related Rule: 14 CCR § 916.9 [936.9, 956.9] (g)(1)(A)

General Approach: More surveys relating drainage area to active channel width will be performed in the Coastal and Northern Forest Districts. Figure 2 indicates that the drainage area necessary to sustain an active channel width of 5 feet can vary by approximately a factor of 2.5 between Forest Districts. However, Figure 2 represents a very limited sample. Additional sampling will attempt to capture a range of precipitation and geomorphic provinces. Statistical analysis (e.g., discriminant analysis) can be used to determine the appropriate drainage area based on multiple environmental factors.

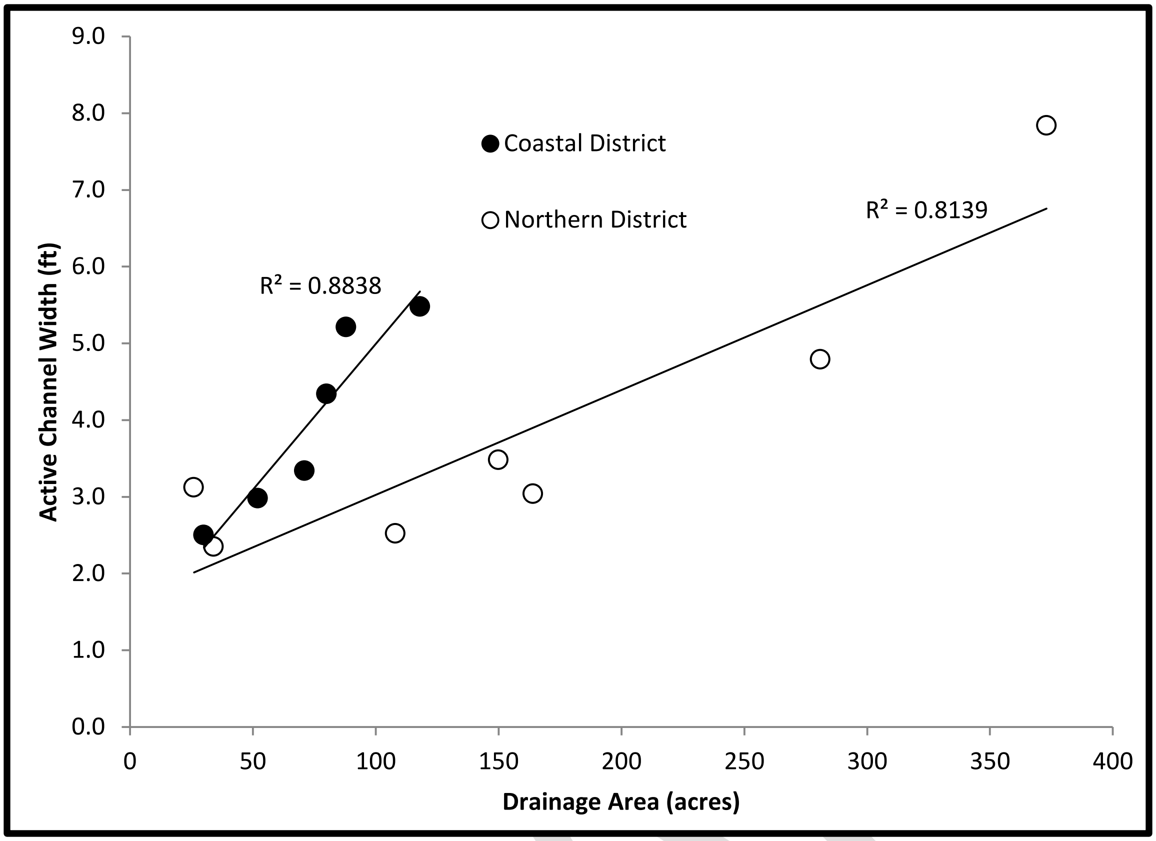

Figure 2. Active channel width versus drainage area for watercourses in the Coast and Northern Forest Districts. Surveys in the Coastal District were performed in the Ten Mile River watershed and Jackson Demonstration State Forest; surveys in the Northern District took place in the Etna and French Creek watersheds.

Effectiveness of Class II-L Identification Methods in Identifying Streams Susceptible to Heat Transfer

The new methods are less certain for identifying watercourses with the potential to transfer heat in the downstream direction. Analytical expressions of hydraulic geometry (e.g., equations 1, 2, and 4) assume a dominant or channel-forming discharge (e.g., bankfull discharge), and are better predictors of channel form and process during higher magnitude discharges. Water temperature increases are typically an issue during the summer months when flows are at or near the annual minimum. As such, it is necessary to determine whether the area or width methods relate to the potential for downstream heat transfer from Class II to Class I watercourses during low flow periods. This was recognized during the Class II-L revision process, where both North Coast Regional Water Quality Control Board and Department of Fish and Wildlife representatives expressed concern that the new rule language did not adequately address thermal impacts.

Thermal inputs, hydrologic inputs (e.g., groundwater and tributary), hydrologic connectivity of surface flows, surface flow magnitude, and the duration of flow during the summertime are determinants for downstream heat transfer. Several studies have looked at the spatial and temporal distribution of perennial low flows for headwater streams (e.g., Roth 2010). The Variable Source Concept (VSC) explains that surface water expands headward during storm events and retreats during recessional flows and baseflow conditions (Hewlett and Nutter, 1970). The VSC suggests that perennial low flow is more likely to be found near the Class II/I confluence. Recent studies from the Pacific Northwest, however, have suggested that perennial flow during the summer months does not follow the pattern suggested by the VSC, and that perennial flow retreats headward towards the channel head (Hunter et al., 2005; Jaeger et al., 2007). Source areas for perennial flow were found to be related to lithology, with sedimentary lithologies requiring less drainage area to sustain perennial flow than basaltic lithologies (Figure 3). Streams draining sandstone lithologies also demonstrated downstream movement of perennial flow as drier conditions developed, whereas perennial flow remained more fixed in place as summer progressed in basaltic streams (Jaeger et al., 2007). The spatial occurrence of perennial flow during the summer months was also strongly tied to precipitation magnitude during springtime (Hunter et al., 2005).

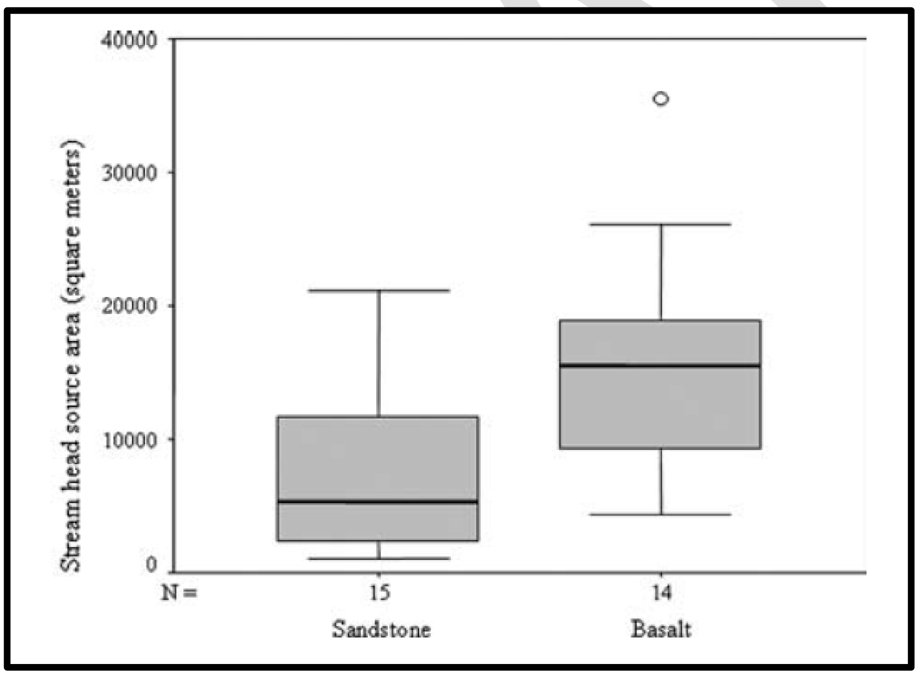

Figure 3. Source area for perennial flow for watersheds underlain by sandstone versus basalt lithologies (from Jaeger et al., 2007). Median source areas varied by approximately a factor of three between lithologies.

Considering that the conceptual framework of the Class II-L identification methods are uncertain for issues related to temperature flux in streams, we pose the following question:

General Monitoring Question(s) 3: Are the Class II-L identification methods effective in identifying watercourses that have the potential to translate thermal impacts to Class I watercourses? Is one method (i.e., width vs. area) better than the other?

Related Rule: 14 CCR § 916.9 [936.9, 956.9] (c)(4); 14 CCR § 916.9 [936.9, 956.9] (g)(1)(A)

General Approach: A general approach to answer this question is to determine whether the drainage area or channel width default can adequately predict the presence of connected perennial flow near the Class I/II confluence during the dry season. A methodology would include the characterization of flow magnitude and connectivity near the Class II/I confluence for watercourses with active channel widths greater than 5 feet or with drainage areas greater than 100-150 acres (Figure 4). The sampling should be stratified by lithology and mean annual precipitation, as these appear to be drivers of perennial flow location and duration. Monitoring should ideally be conducted over multiple seasons to account for interannual variability. A sufficiently robust dataset could be used to determine if either the drainage area or width method is better at predicting the conditions that allow for downstream heat transfer. Depending upon the findings of the study, an alternative identification method can be developed that targets temperature issues. This monitoring approach would require a larger investment of time and resources, but is a necessary step to determine if the existing identification methods take into account the potential for thermal impacts to Class I watercourses.

Resource Benefit

A possible outcome of this proposal is that the Class II-L identification methods under predict the presence of Class II-L watercourses. If policy makers consider revising the area or width methods in response to this under prediction, data from this study can be used to determine the additional costs associated with the increased protection measures (e.g., value of standing timber left in protection zone). This would allow policy makers to consider the economic tradeoffs associated with rule revision.

Types of Monitoring to be Used

The following proposal will utilize baseline, compliance, implementation, and effectiveness monitoring.

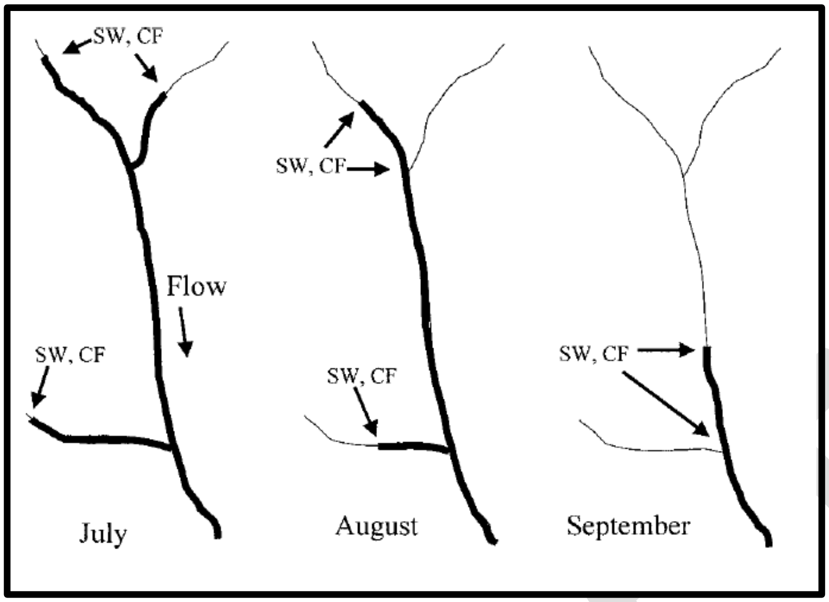

Figure 4. Graphic representation of the spatial incidence of surface water (SW) and connected perennial flow (CF) for a channel network over time (from Hunter et al., 2005). Connected perennial surface flow is more likely to transmit heat downstream. Similar methods to Hunter et al. (2005) and Jaeger et al. (2007) can be used to determine whether Class II-L identification methods are sufficient to identify streams with the potential to transmit heat during summer months.

Timeline

The goal is to finish the draft methods by Fall of 2016 and beta test the methods during winter through summer of 2017. Monitoring question 1 will have reportable metrics by the end of 2017. Data to answer questions 2 and 3 will likely be available by 2018.

Funding

It is possible to implement this monitoring with in-kind staff and equipment contribution. However, formal study design and data collection can likely be performed faster if the work is contracted to an outside party.

References

Bagnold, R.A. 1977. Bed load transport by natural rivers. Water Resources Research. 13(2): 303-312.

Brummer, C.J. and D.R. Montgomery. 2003. Downstream coarsening in headwater channels. Water Resources Research. 39(10), 1294. Doi:10.1029/2003WR001981.

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Hewlett, J.D. and W.L. Nutter. 1970. The varying source area of streamflow from upland basins. Proceeding of the Symposium on Interdisciplinary Aspects of Watershed Management. American Society of Civil Engineers. New York, NY, pp. 65-83.

Hunter, M.A., T. Quinn, and M.P. Hayes. 2005. Low flow spatial characteristics in forested headwater channels of southwest Washington. Journal of the American Water Resources Association. 41(3): 503-516.

Jaeger, K.L., D.R. Montgomery, and S.M. Bolton. 2007. Channel and perennial flow initiation in headwater streams: Management implications of variability in source-area size. Environmental Management. 40:775-786.

Leopold, L.B. and T. Maddock. 1953. The hydraulic geometry of stream channels and some physiographic implications. United States Geological Survey Professional Paper 252. 57 p.

MacDonald, L.H. and D. Coe. 2007. Influence of headwater streams on downstream reaches in forested areas. Forest Science. 53(2): 148-168.

Roth, T. R. 2010. Headwater stream characterization: an energy and physical approach to stream temperature using distributed temperature sensing. Master of Science Thesis. Oregon State University, Corvallis, OR. 85 p.

WFPB (Washington Forest Practice Board). 2001. Guidelines for large woody debris placement strategies. Board Manual—Section 26. Olympia, WA. 11 p.