Progress Report (July 1, 2014 – November 10, 2014)

Title: Modeling geomorphic response to large wood introduction as a strategy to restore fish habitat in managed forest watershed.

Investigators: PI: Catalina Segura, OSU FERM; Co-PIs: Christopher Lorion (ODFW), and Stacy A. Polkowske (ODFW)

Report Written by: Russel Bair and Catalina Segura

Project duration: July 1, 2014 – June 30, 2016

Objectives:

1) classify channel types in the alluvial stream network of the Mill Creek Watershed
2) characterize the fluvial regime of three reaches before and after LW
3) develop a watershed scale model of channel geomorphic response to LW additions,
4) investigate the relations between this model and the available biological information.

Study Site: This investigation is undergoing in three 120m long plane bed stream reaches of Mill Creek, OR a tributary of the Siletz River. The watershed is located in the Coast Range of Oregon, which is primarily underlain by marine sandstone and siltstone, commonly referred to as the Tyee formation. However some areas are underlined by Miocene volcanic intrusions. The three study reaches are located in 2 tributaries (Cerine Creek and South Fork of Mill Creek) and in the main stem of Mill Creek draining between 5 and 16 km^2 (Figure 1).

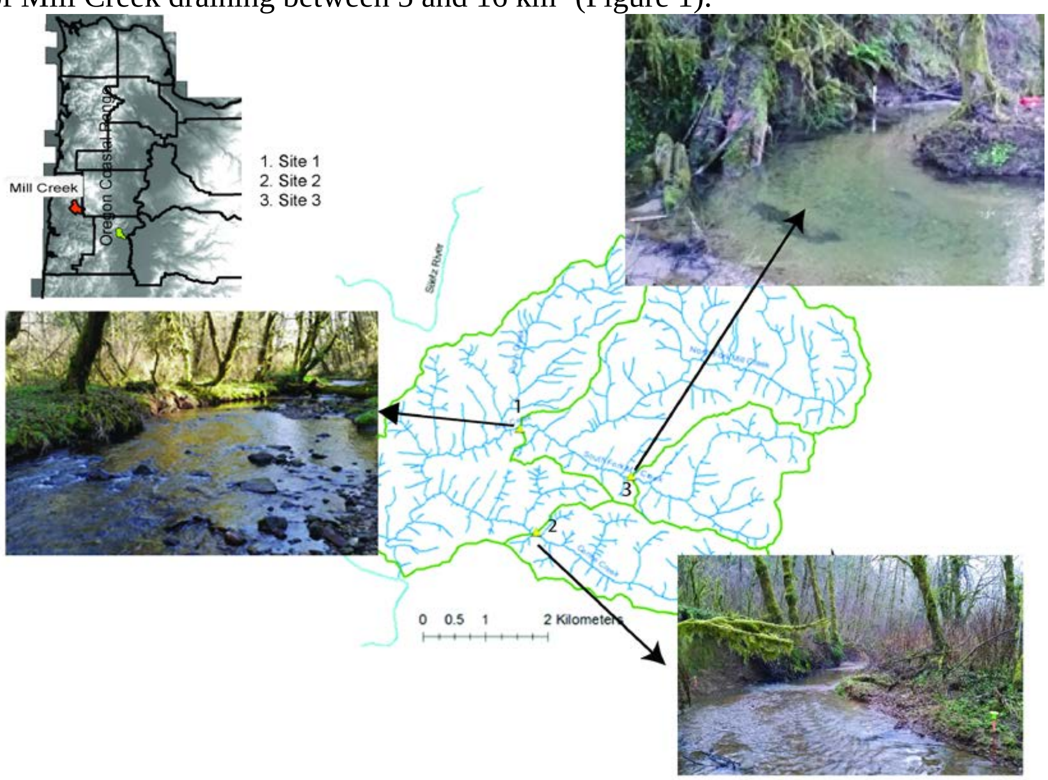

Figure 1: Location of study sites in Mill Creek Watershed-Siletz Tributary, OR.

Summary of accomplishments toward objectives

Geomorphologic characterization: During the summer of 2014, we surveyed the topography of the 3 reaches including 20-30 cross-sections per reach spaced approximately ½ bankfull width apart. The channel slope was also calculated from water surface elevations (WSE) over a length no less than 15 times the bankfull width in each site. The topographic data was used to calculate channel topography for each entire reach at a resolution of 1m^2, bankfull dimensions, and one-dimensional estimates of bank full discharge (Q_{bf}) and shears stress (Table 1).

Table 1: Bankfull dimensions for the 3 study reaches: Slope, width, depth, hydraulic radius (R), shear stress (T), and discharge (Q_{bf}).

Site	Slope	Q_{bf} width (m)	Q_{bf} depth (m)	R (m)	□□ at Q_{bf} (Pa)	Q_{bf} (m^3/s)
1	0.0035	10.5	0.63	0.62	21.3	9.0
2	0.0040	5.44	0.57	0.52	20.4	2.2
3	0.0077	5.2*	0.49*	0.41*	*31	*2.4

*Estimated values based on a subset of cross-sections

During the summer of 2015, the topographic information was enhanced with high-resolution surveys including 1,500-2,000 total station points per reach. This increased the resolution from 1 m^2 to ~0.3m^2, see example in Figure 2.

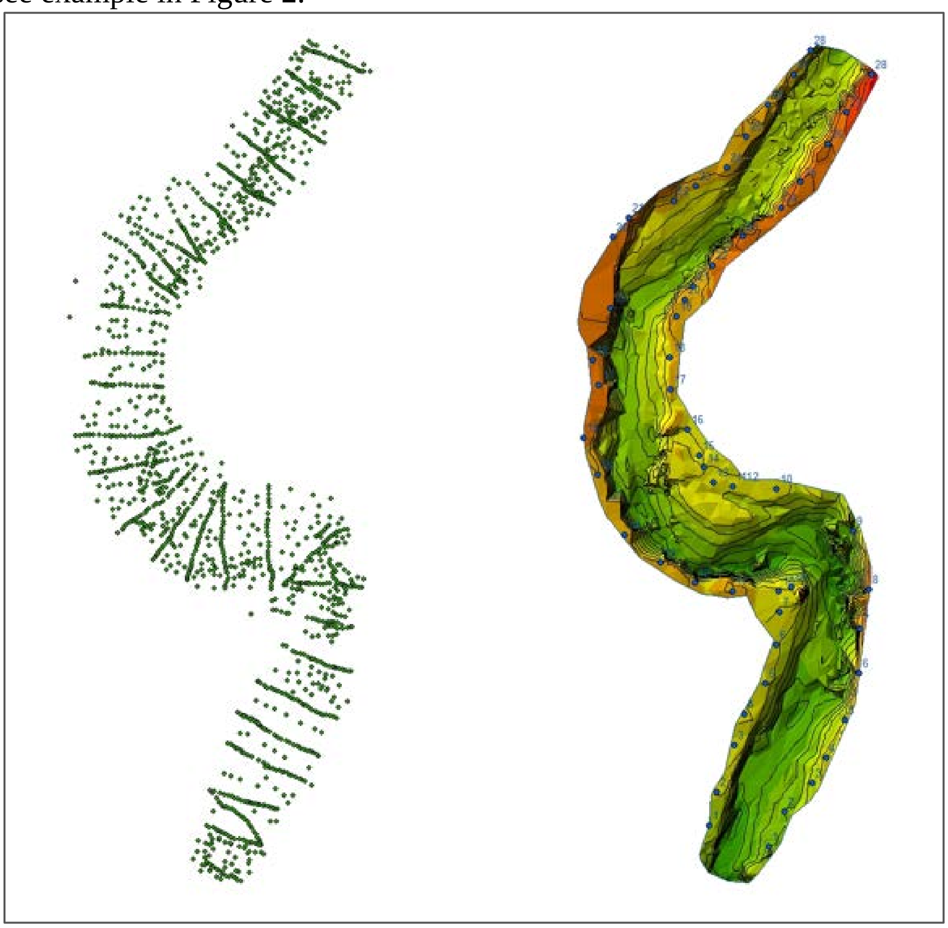

Figure 2: Site 3 survey points and interpolated channel geometry

Channel roughness characterization: During 2014 pebble counts (i.e. sample of 100 rocks) were conducted in all cross sections of each reach to characterize grain size distributions (GSD) of the surface material. Bulk samples of subsurface material were also taken in 2 locations per reach. These samples were sieved into sizes between 0.063 and 90 mm. This effort has recently been enhanced by the characterization of the GSD in patches. In each reach, distinct grain size patches were visually identified and characterized with multiple pebble counts 80-250 particles per patch. On average each reach was divided 10-15 patches. Table 2 presents average grain size results for de 16^{th} , 50^{th} , and 84^{th} percentile of the surface GSD.

Table 2: Average grain sizes in mm for each site

Site	D16	D50	D84
1	12.1	38.5	97.0
2	7.8	16.7	31.9
3	12.2	28.8	56.6

Rating curves: Each reach was instrumented with a pressure transducer to record water stage every 30 minutes. Discharge measurements were taken in each reach for at least nine different flow levels and used to create a rating curve (Figure 3). This curve allows the generation of a continuous record of stream discharge at each site (Figure 4).

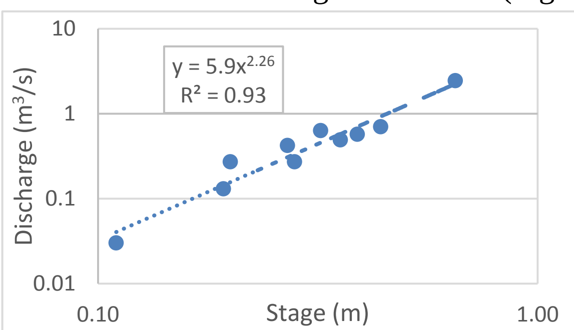

Figure 3: Rating curve for site 2. Given here as an example.

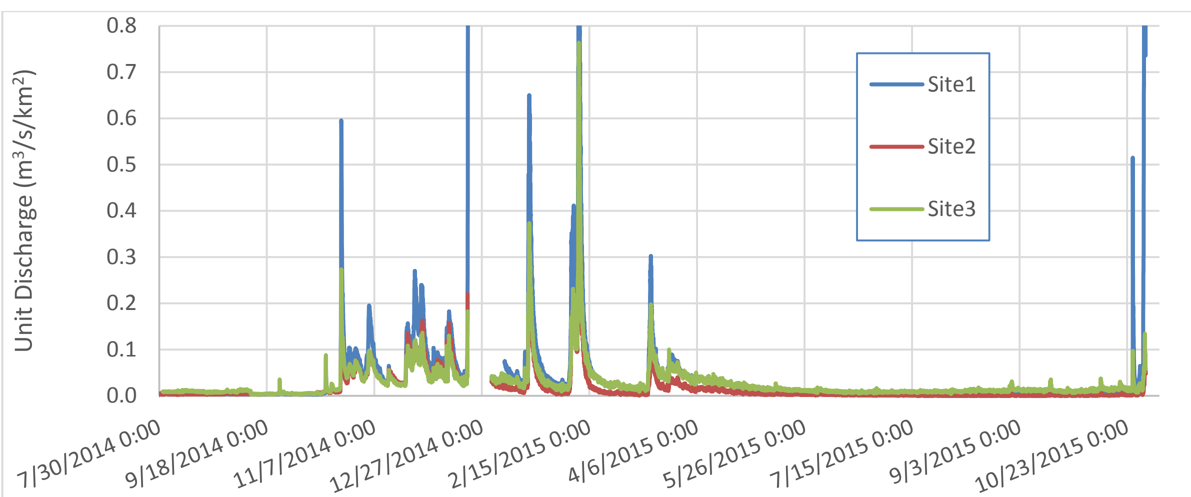

Figure 4: Unit discharge in each reach.

Flow modeling: We are currently in the process of characterizing the spatial variability of flow forces and sediment transport before the addition of large wood based o a 2D hydrodynamic model (iRIC, McDonald et al. 2001, McDonald et al. 2006). The required input data to the model include detailed topographic surveys and detailed measurements of the GSD distribution in the channel. The flow model is calibrated based on observations of WSE and velocity at different flow levels. In order measure WSE we installed staff gauges in all stream cross sections per site.

We have collected information to model 3 flows per site (9 flow conditions) to characterize conditions prior to the addition of the large wood (Table 3).

Table 3: Flows to model/modeled to characterize conditions before the addition of wood.

Site	Flows to model (m^3/s)	RMSE (m)	Progress
1	8.6	0.039	completed
1	4.5	0.032	completed
1	3.6		Not started
2	2.4	0.028	completed
2	0.84	0.028	Completed
2	0.7		Not Started
3	2.17	0.042	In Progress
3	1.08		Not Started
3	0.8		Not Started

So far we have modeled 5 flows (Table 3). The model calibrations yielded mean square errors below 0.042 m providing a robust prediction of flow depth, velocity, and shear stress at a resolution of 35 cm. Figure 5 presents an example of the model output for the spatial distribution of mean vertical velocity and shear stress for 2 flow levels in Site 1.

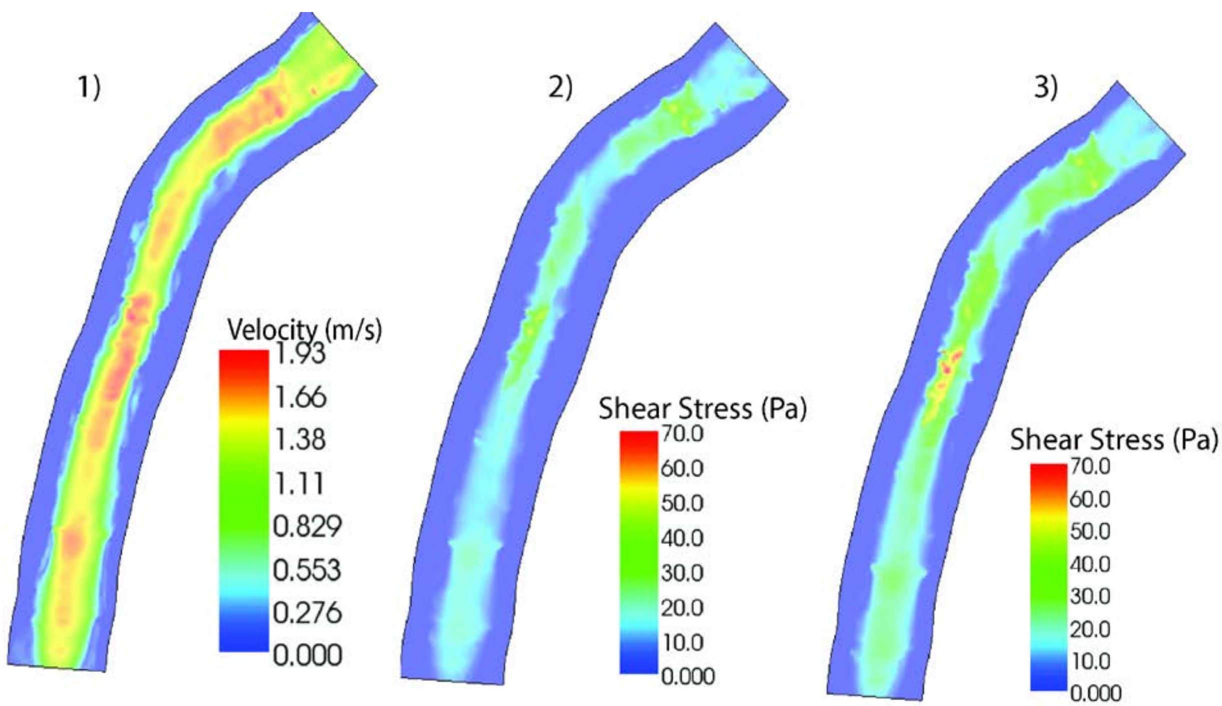

Figure 5: Example of modeled distributions of velocity and shear stress at Site 1. 1) Modeled velocity distribution at bankfull flow (Q_{bf}); 2) shear stress distribution at $0.45Q_{bf}$; and 3) shear stress distributions at Q_{bf}.

The model distributions velocity and shear stress will be used to quantify sediment transport and hydraulic conditions before and after the addition of wood to the streams. In addition we will determine the changes in suitable habitat at different flow levels in terms of changes in velocity and channel bed grain size. Figure 6 presents modeled distribution of velocity in Site 1 during a 8.6 m^3/s flow event (~$0.9Q_{bf}$). The highlighted red section corresponds to the portion of the reach that has a velocity below the critical swim speed (0.34 m/s) for a 10cm coho salmon (Glova and McInerey 1977), which corresponds to18% of the reach. Future modeling will allow for comparison of this percentage before and after the addition of logjams.

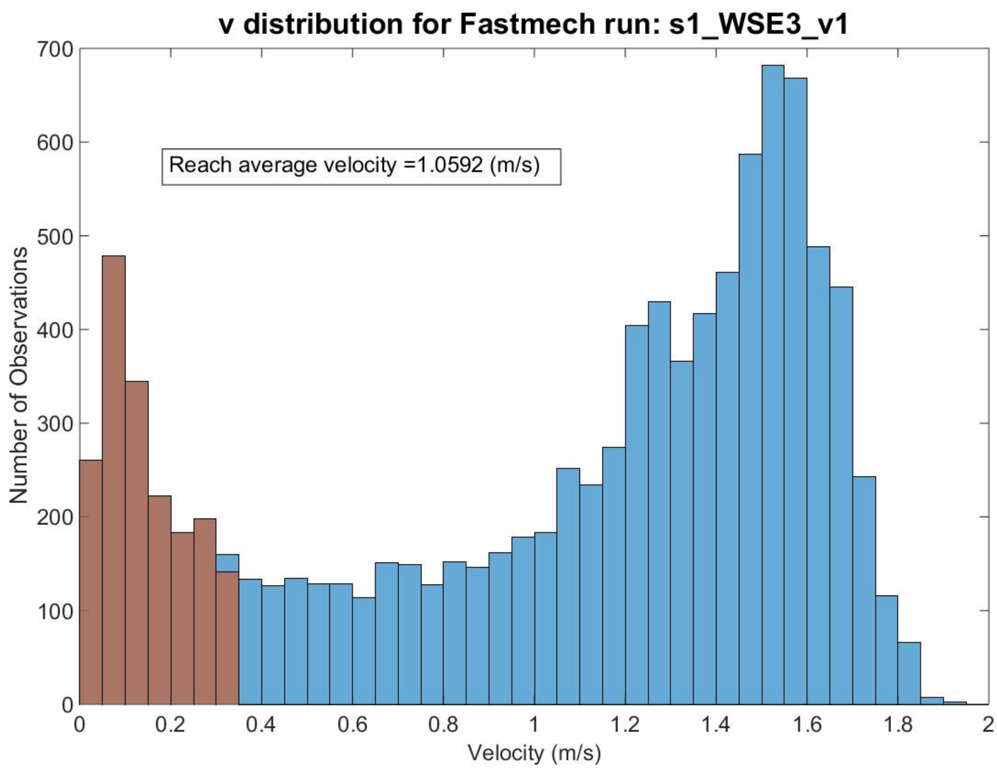

Figure 6: Modeled distribution of velocity for site 1 during a flow event of 8.6 m^3/s (90% of Q_{bf})

We will couple the modeled distributions of shear stress with the GSD to computed sediment flux for individual sediment size fractions in the channel surface of every site. This information will track the possible changes in overall channel surface grain size after wood addition and its potential relation to salmon spawning and rearing available habitat.

Wood addition: In August of 2015, 40 pieces of large wood (1-3 meters in diameter) were added to the three sites. The wood was arranged into two log jams per site. The wood additions were surveyed with a total station into the existing stream topography for future flow modeling activities.

Basin wide characterization: In order to characterize geomorphic channel types in the Mill Creek watershed, a geospatial analyst tool (NetMap) was used with remotely sensed topographic data. The characterization is based on channel types defined by Montgomery and Buffington (1997). This classification was ground truth in Cerine Creek. Figure 7 presents the whole basin classification as well as the comparison with ground checked points along Cerine Creek . Results indicate that the in general the 2 classification schems agree in plain bed sections.

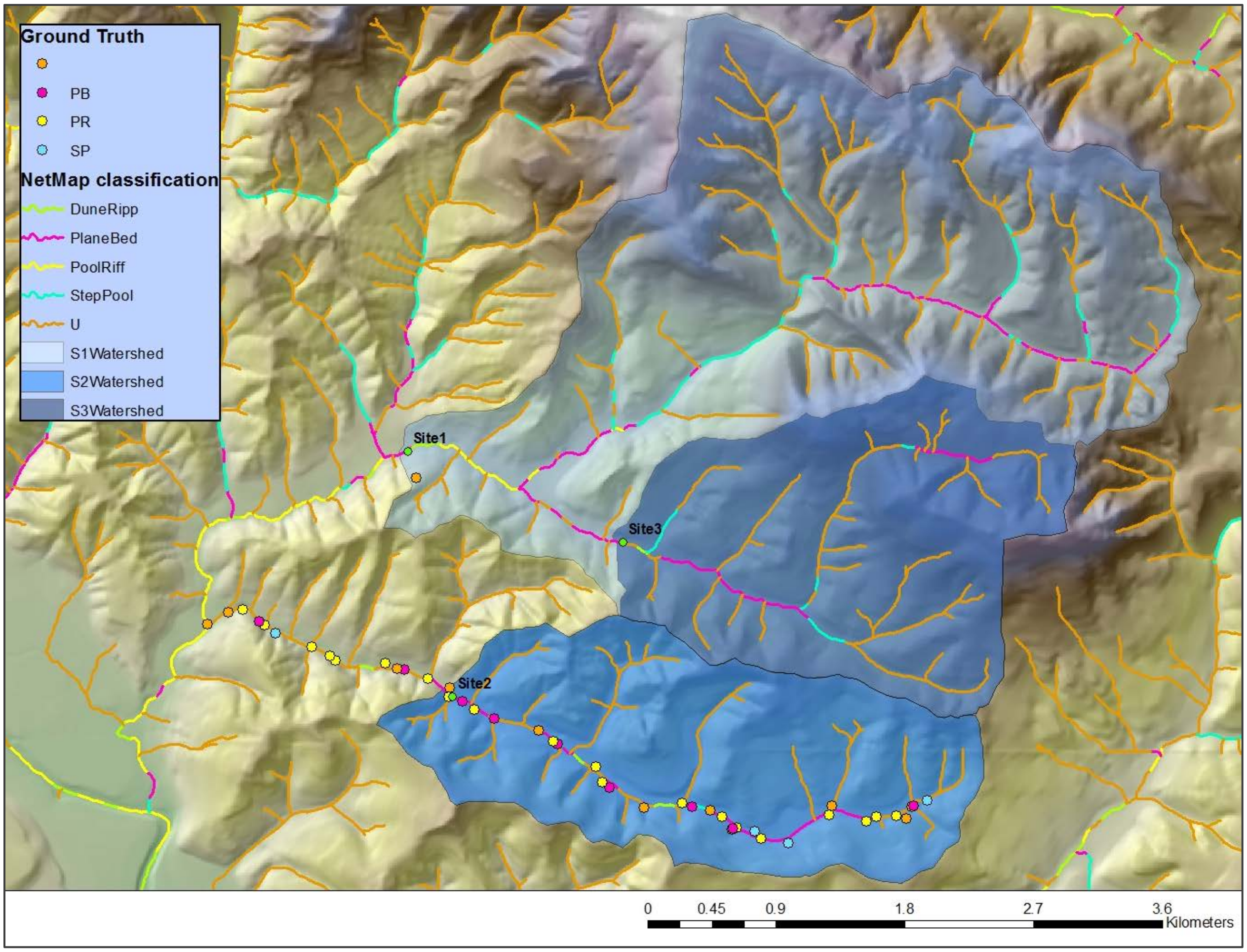

Figure 7 Channel type based on slope, and field observations

Problems, barriers, proposed changes to objectives:

We have in general not experience major barriers in our study. However we made the following adjustment:

Use of scour chains to measure scour and deposition. We installed ~12 chains per site last winter but had significant difficulties relocating them after flow events. We decided instead to further our modeling efforts by increasing our topographic resolution and to assess topographic changes between 2014 and 2015 as a measure for scour and deposition by comparing the surveys

Planned work:
We are on track according to the planned activities (Table 4):

Table 4: Time line of activities (blue=before and green= after the LW addition)

Activity	F 14	W 14	Sp15	Su15	F 15	W 15	Sp16	Su16
Channel classification of alluvial network								
Geomorphic observations in selected reaches								
Sediment entrainment study								
WSE and Q measurements								
Data analysis								
Dissemination of results								

Specific activities to be competed between now and the end op the project include:

- Fall-winter 2015/2016—We will monitor log jams during high flow events for geomorphic changes
- Fall-winter 2015/2016—Continued discharge measurements and water surface elevation measurements for model calibration
- Fall-winter 2015/2016—Models including the log jams will be created to predict the influence on flow parameters

Winter-Spring 2015/2016— Synthesize data, present results at conferences (i.e. America Geophysical Union and River Restoration Northwest), and prepare manuscripts.

List of names and brief overview of graduate and/or undergraduate engagement in project:

Russell Bair, Master Student in Water Resources Engineering (thesis); Jon Sanfilippo (field support summer 2014); Michael Griffith- undergraduate student from the COAS (field support summer 2015), Joey Tinker (undergraduate student in Natural Resources). Part of the funds to support these undergraduate students has been provided by the College as a BOV Student Success and SEEDS Student Success Award.

List of presentations, posters, etc

Hydropohiles Water Research Symposium- Poster (April 2015)
Western Forestry Graduate Research Symposium- Poster (April 2015)
American Geophysical Union Fall Meeting- Poster (December 2015)
River Restoration Northwest- Presentation (February 2016)

List of publications, thesis citations:

None to report