THESIS

THE FABRIC OF WOOD: PATTERNS AND PROCESSES OF RIVER AND FLOODPLAIN LARGE WOOD ON THE MERCED RIVER, YOSEMITE NATIONAL PARK, CALIFORNIA

Submitted by

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ABSTRACT

THE FABRIC OF WOOD: PATTERNS AND PROCESSES OF RIVER AND FLOODPLAIN LARGE WOOD ON THE MERCED RIVER, YOSEMITE NATIONAL PARK, CALIFORNIA

This research on the Merced River above Nevada Falls in Yosemite National Park quantifies large wood loads (m^3 wood/ha) and the spatial distribution of wood in the bankfull channel, the floodplain, and the adjacent valley bottom, and tests hypotheses that give physical evidence of the dynamics that recruit, transport, and deposit large wood in the river corridor. The upstream portion of the study area includes a recently burned section of the Merced River corridor and the downstream portion of the study area includes a section of floodplain with undisturbed forest. Field work was conducted in June and July of 2019. The results indicate that different processes drive the dynamics of LW on the floodplain versus in the river. Large wood transport capacity is greater in the channel than on the floodplain, as reflected in larger diameter wood in channel jams than in floodplain jams (assuming trees next to the river are not significantly larger than those on the floodplain) and distribution of burned wood throughout the whole study area in the river but only in burned portions of the floodplain. Jams can occur across the entire width of the floodplain but tend to be concentrated near the channel and a greater proportion of large wood may be within jams in burned portions of the floodplain. Mean floodplain wood loads on the Merced floodplain are 250 m^3/ha overall, with non-significant differences between burned (median = 230 m^3/ha) and unburned (median = 300 m^3/ha) portions of the floodplain. Mean valley bottom wood load is 150 m^3/ha (area beyond the active floodplain that was not inundated in 2019 (mean water year discharge recurrence interval of 8 years) and is of similar elevation to the active floodplain (e.g. not terraces or hillslopes)). A multivariate analysis of potential predictors of wood load on the floodplain indicates that the proportion of large wood in logjams is significant for the floodplain overall, and for both burned and unburned areas. This research is important because it expands the data on LW to include a medium-sized, undisturbed, and partially-burned river in California. Increased knowledge of LW in river corridors aids in the protection and restoration of our nation’s rivers.

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1. INTRODUCTION

My research on the Merced River in Yosemite National Park (Yosemite) focuses on the dynamics that recruit, transport, and rearrange large wood (LW, downed pieces with an in-stream diameter ≥ 10 cm and length ≥ 1 m) in the river corridor. This includes non-human driven movement of wood between the valley bottom (areas beyond the active floodplain that were not inundated in 2019 and are a similar elevation as the floodplain), the active floodplain (floodplain), and the bankfull channel (or river), and how wildfire can affect the patterns of LW. I characterize the amount and spatial distribution of LW in a recently burned and undammed section of the Merced River corridor above Nevada Falls. The following sections summarize what we currently know about LW and fire in river corridors.

1.1 Large Wood in River Corridors

River corridors include the bankfull channel, active floodplain, and the valley bottom (Figure 1). In this study, the riparian area is defined as the area that includes the bankfull channel, underlying hyporheic zone, and floodplain. In recent decades, LW has been shown to provide many physical and ecological benefits to river corridors and riparian ecosystems.

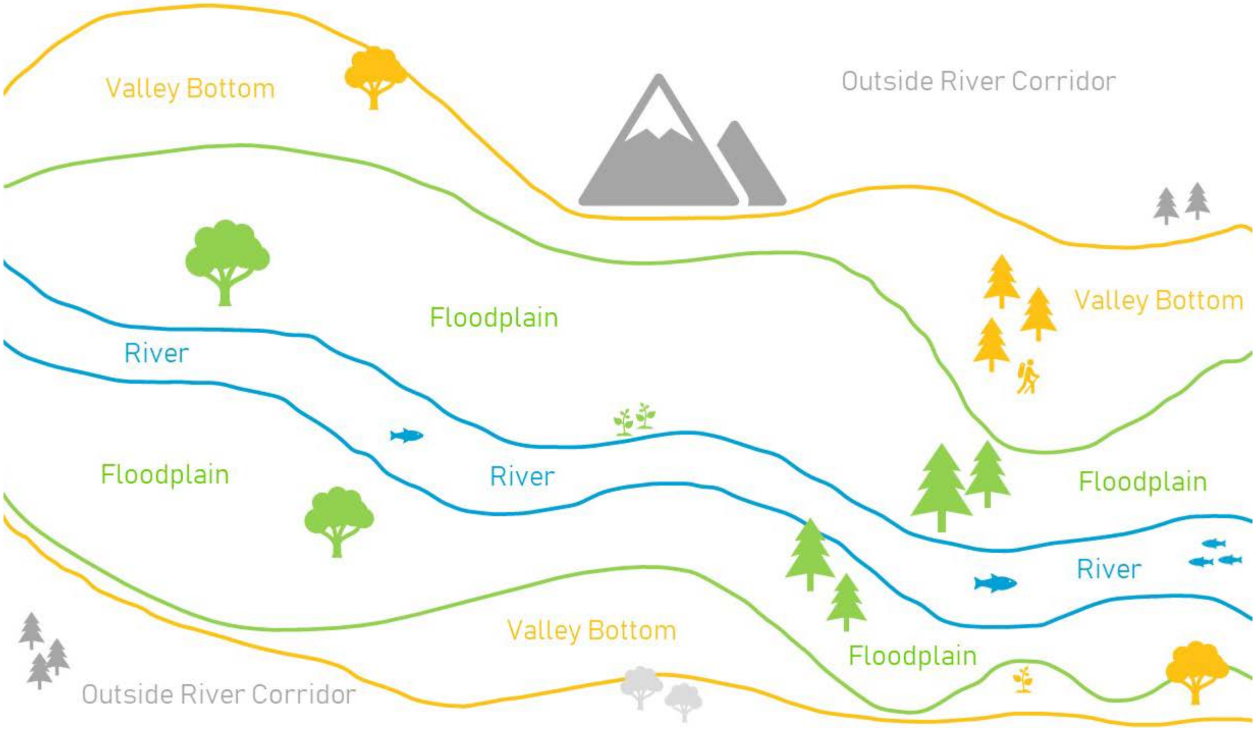


Figure 1. Illustration of a river corridor

The presence of LW in rivers increases river heterogeneity and complexity, hyporheic exchange, substrate diversity and related habitat diversity, habitat availability, and resistance and resilience to change (Keller & Swanson, 1979; Lautz et al., 2006; Fanelli & Lautz, 2008; Bocchiola, 2011; Collins et al., 2012; Beckman & Wohl, 2014a; Livers & Wohl, 2016; Wohl, 2016). Dispersed wood and logjams increase retention of fine sediment and particulate organic matter in the channel, via flow separation around LW obstacles, leading to increased biological activity and nutrient uptake (Battin et al., 2008; Fanelli & Lautz, 2008; Beckman & Wohl, 2014a). LW, logjams, and the backwater and plunge pools they create decrease flow velocity, increase depth of flow, and provide overhead cover and habitat for fish and macroinvertebrates (Richmond and Fausch, 1995; Riley and Fausch, 1995). LW can also provide habitat for trees re-establishing on islands in rivers and for plants colonizing the floodplain (Fetherston et al., 1995). In addition, research shows that organisms preferentially choose habitat based on the scale of natural environmental heterogeneity, such as LW. Fish, for example, have been shown to preferentially build reproduction sites in reaches that have a certain sinuosity (Fukushima, 2001) and choose sites for overhead cover based on the diameter of the wood that provides the cover (Berg et al., 1998).

Wohl (2020) summarizes how LW has been shown to affect the geomorphic and ecological landscape of floodplains in a similar ways as with channels (Table 1).

Table 1. Summary of the Effects of Large Wood on Floodplains

Floodplain Effect	References
Can create stable patches of varying topography and protect patches from erosion, increasing floodplain heterogeneity	Collins et al., 2012
Decreases flow velocity and increases ponding on the floodplain	Jeffries et al., 2003
LW in the river and on floodplains enhances interactions between the channel and floodplain, creating more heterogeneous floodplains	Jeffries et al., 2003; Sear et al., 2010
Acts as aquatic and terrestrial habitat for reestablishing saplings	Pettit & Naiman, 2006
Increases habitat diversity for diverse forms of animals when the floodplain is dry/exposed and when it is wet/inundated, such as fish and macroinvertebrates	Benke, 2001; Braccia & Batzer, 2001; Dolloff & Warren Jr., 2003; Zalewski et al., 2003

Compared to channels and floodplains, wood on the valley bottom has different properties and results in different effects on the landscape because it is not fluvially recruited, transported, or inundated (except during exceptionally high flows). Moreover, from a geomorphic perspective, LW on valley bottoms has not been a subject of in-depth study. LW, however, is often referred to as coarse woody debris (CWD) by the forestry community, and there are many studies describing the benefits of CWD for ecosystems (standing dead trees are called snags). Note that CWD may have different size definitions between disciplines – here

CWD refers to any downed wood outside of the riparian zone (river and floodplain). Trees can become CWD via physical damage (wind, fire, snow, and lightning); insect kill; disease (rot or mistletoe); and suppression and competition with other trees (Harmon et al., 1986; Maser et al., 1988). Forest vertebrates use CWD for habitat, resting sites, and natal dens (Bull & Heater, 2000; Butts & McComb, 2000; Ucitel, 2002; Payer & Harrison, 2003). CWD is a source of habitat and soil diversity, as it and the substrate around it changes as the wood decays on the forest floor (Maser et al., 1988). CWD is also a source of biomass and carbon on the forest floor (although it may or may not be a substantial source of nutrients) and increases microbial biomass during wood decay (Busse, 1994; Laiho and Prescott, 2004). Beyond these benefits to the ecosystem, if the CWD becomes LW by being transported to the floodplain and/or river (e.g. via mass movements on hillslopes), it has the additional benefits previously described for river corridors. While the presence of LW and CWD in river corridors creates dynamic feedback loops, the added disturbance of wildfire increases the feedbacks and creates new paths for LW dynamics.

1.2 Wildfire

Fire is a substantial disturbance in Sierra Nevada ecosystems, both historically and currently (Skinner and Chang, 1996). While wildfire consumes wood, it also has other effects on the dynamics of wood in river corridors. Kleindl et al. (2015) showed that fire "had the strongest total effect […] on the variability of floodplain habitat patch composition" in areas of the Rocky Mountains of Canada and Montana that experienced multiple historical fires. Fires may burn riparian areas differently because they may have different fuel loads, fuel moisture contents, fuel continuity, relative topography, and microclimates (Dwire and Kauffman, 2003). These factors could affect the vulnerability of a landscape to fire; a fire's area and rate of spread; and a fire's frequency, severity, and intensity (Dwire and Kauffman, 2003). Because of this, it would not be surprising if there are different LW dynamics in the river and on the floodplain in burned areas versus unburned areas. Comparing LW before and one year after a fire in a small river in the Eastern Sierra, Berg et al. (2002) found a shift from longer wood to shorter wood and a decrease in aggradation frequency post-fire. Additionally, variation in tree species that make up the forest can affect when and how many snags fall and become LW in the riparian area post-fire (Bendix and Cowell, 2010). Although fire can be a major disturbance in riparian areas, we cannot isolate the impacts of fire from the hydrologic response to fire that may also affect LW dynamics such as changes in sediment transport and bank erosion (Dwire & Kauffman, 2003; Bendix & Cowell, 2010; Kleindl et al., 2015). These are important feedbacks that work together to shape the geomorphic landscape of a river (Dwire & Kauffman, 2003; Bendix & Cowell, 2010; Wohl, 2013).

Fire can have contradictory effects on CWD on valley bottoms depending on the characteristics of a fire. Research by Innes et al. (2006) north of Kings Canyon National Park shows that fire decreases the overall mass of wood but increases the number of snags, a source of CWD/LW, when compared to pre-fire conditions. Tinker and Knight's work in Wyoming (2000) shows that fire leaves behind standing snags, stumps, and charcoal that a one-time clear cut forest did not have. Timing of the fire within the California fire season (late summer to early fall) can affect tree susceptibility to bark beetle attack (Schwilk et al., 2006) and the amount of wood consumed by the fire due to the moisture content of the fuel (Knapp et al., 2005). Decay class of the CWD can also affect the patterns of fire consumption in a forest (Stephens and Moghaddas, 2005). Although measured on the floodplain, Lininger et al. (2017) showed that fire can increase LW volumes in places with slower LW decay rates.

Synthesizing across these studies, fire can either decrease or increase CWD and LW. The net effects of fire on downed wood depend on the intensity of the fire, the size distribution of the pre-fire CWD and LW, and the rate at which snags fall to the forest floor or floodplain and become CWD and LW. Moreover, while studies investigate how LW and CWD behave in the river, on the floodplain, and on the valley bottom separately, little attention has been given to the connection of these three parts of the river corridor and how wood moves between them, both in the presence and absence of wildfire.

1.3 Knowledge Gaps

Although research has expanded our knowledge of the benefits of LW and CWD that remain in river corridors, current datasets do not span the full global range of geographic, spatial, or ecological diversity. This is especially true for large rivers (Wohl, 2017). Large rivers are defined as rivers that "are wider than the length of all of the wood pieces delivered to them" (Gurnell et al., 2002). I consider the Merced River a medium-large river, as I observed a few pieces of LW that could span the channel. Although there is some research regarding LW in California rivers, even fewer studies are focused on LW in one of California's most prominent water sources: the Sierra Nevada Mountains (Berg et al., 1998, 2002; Thompson et al., 2012; Thompson, n.d.). Expanding LW research beyond the Pacific Northwest and the Rocky Mountains provides an opportunity to explore different types of river systems, provide California natural resource managers with locale-specific data, and potentially contribute to the use of LW in river restoration applications based on California studies.

Other gaps in LW research include the need for studies focusing on floodplain wood transport (lateral and longitudinal), variations in LW loads, and effective addition and maintenance of LW in river corridors (Wohl, 2017). My research aims to fill a small part of the gap, as floodplain LW is the missing link between the fluvial geomorphology realm of LW in rivers and the forest ecology realm of CWD on the valley bottom. The effects of fire on LW dynamics are also poorly understood (Dwire & Kauffman, 2003; Bendix & Cowell, 2010). This study will dive into the dynamics of LW in Yosemite National Park and provide information on lateral feedbacks between the river, floodplain, and valley bottom, and longitudinal feedbacks between burned and unburned areas of the Merced River corridor.

2. RESEARCH FRAMEWORK

2.1 Research Questions

In this study, my objective is to answer the following research questions:

1. How much wood is in the Merced River corridor in Little Yosemite Valley (LYV), and how is it spatially distributed (in jams or dispersed, distance from the river)?
2. Do characteristics of LW on the floodplain (wood load, diameter) differ for burned and unburned areas?

The study reach on the Merced River was chosen specifically because of the (1) limited access, except by foot, which has helped to preserve the relatively natural conditions during the period of pre-park resource exploitation and subsequent development of infrastructure for motorized travel in the park, (2) the existence of natural boundaries (waterfalls) at both ends of the study reach and relatively consistent valley-bottom geometry within the reach, and (3) the presence of distinctly different floodplain forest stand characteristics as a result of the 2014 Meadow Fire. These qualities make the field site a natural laboratory in which to study floodplain LW and the effects of fire on river corridor forests.

2.2 Conceptual Model

In order to begin to understand the dynamics and interactions of LW in the valley bottom, the floodplain, and the bankfull channel, I prepared a conceptual model based on my field observations (Figure 2). The model begins with tree death either by fire or other causes. In the model, when a tree dies, it can either fall into the channel, the floodplain, or the valley bottom. When it falls, if it meets the size criteria, it is then referred to as LW or CWD. Field and Google Earth observations showed a lack of mass movements from the surrounding hillslopes, indicating that there was little to no movement of CWD from the valley bottom to the floodplain. Subsequently, this means that CWD will not become LW in this model, and that floodplain wood and valley bottom wood loads are separate populations of wood in this study. LW that falls directly in the river can either be transported downstream beyond the study area, caught in an in-stream logjam (jam, defined as a fluvially transported/arranged group of three or more pieces of LW), transported onto the floodplain during times of lateral connectivity, or become part of the river bed or banks (sunk, buried, immobilized, etc.). Alternatively, LW that falls onto the floodplain can be transported to the river during times of lateral connectivity, caught in a floodplain jam, or stay on the floodplain as dispersed pieces of LW. From these proposed LW dynamics, I also connected my observations of LW in the field with the processes I think are taking place. For example, I observed that the Merced River had much more transport capacity throughout the field season (faster, deeper flow) than the floodplain, and therefore I expect that LW transported in the river can be larger than LW transported on the floodplain. Thus, I developed hypotheses based on physical evidence I would expect to see if my conceptual model accurately describes LW dynamics in the river corridor.

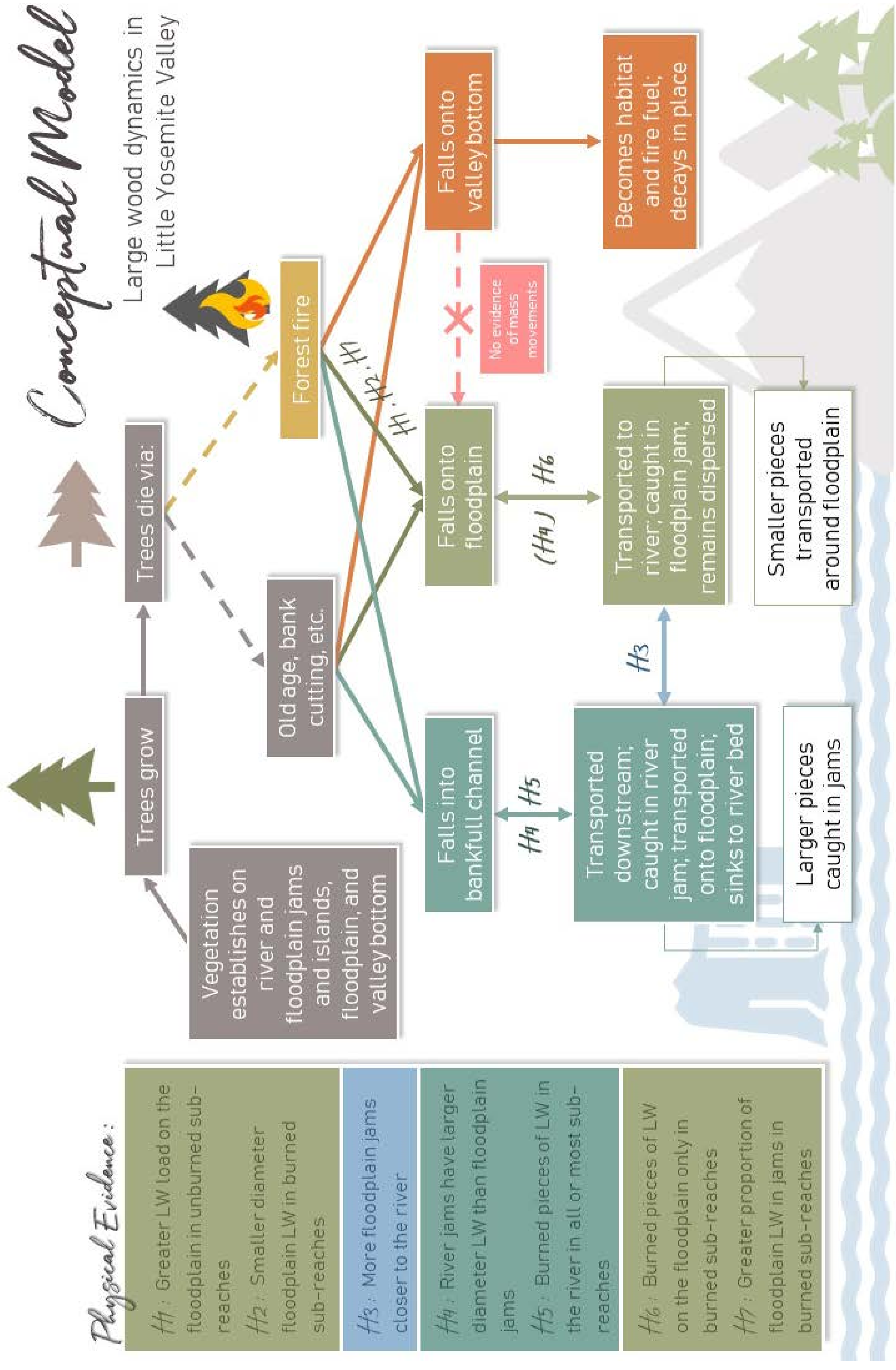


Figure 2. Conceptual model and associated hypotheses. Numbers correspond to hypothesized physical evidence.

2.3 Hypotheses

The conceptual model (Figure 2) leads directly to questions of what physical evidence would be needed to confirm the inferred LW dynamics. The following hypotheses address some of the evidence that can be tested with my field data.

Hypothesis 1 (H1)**:** There is a greater LW load on the floodplain in unburned sub-reaches compared to burned sub-reaches.

H1 follows from the idea that the wildfire would both kill trees and consume existing LW, leaving less volume of LW behind in burned sub-reaches. Alternatively, fire could increase the LW load on the floodplain in burned sub-reaches due to the increase of tree mortality (and therefore snags, a LW source) and incomplete combustion of downed wood.

Hypothesis 2 (H2)**:** There is smaller diameter LW on the floodplain in burned sub-reaches compared to unburned sub-reaches.

H2 follows from the idea that fire burns wood on the floodplain evenly and may only partially burn/consume larger pieces of wood, making them smaller. Alternatively, the net average diameter of LW on the floodplain could be larger in burned reaches due to fire consuming smaller pieces at a greater rate.

Hypothesis 3 (H3)**:** There are more floodplain logjams closer to the river.

H3 follows from the knowledge that when the floodplain is inundated, it experiences flow first next to the bankfull channel and then spreads laterally across the floodplain (when natural complexity such as side channels, abandoned meanders, etc. are not present). I expect the transport capacity of flow on the floodplain to be highest near the channel and therefore more able to create jams.

***Hypothesis 4 (H4)*:** River jams have larger diameter LW than floodplain jams.

H4 follows from the discussion of H3 – the greater transport capacity of the river compared to the floodplain would allow for larger pieces of LW to be rearranged into river jams compared to floodplain jams, assuming that jams are allochthonous (Abbe and Montgomery, 2003). Alternatively, if jams are autochthonous or combination (Abbe and Montgomery, 2003), then I would expect river and floodplain jams to have similarly sized wood.

***Hypothesis 5 (H5)*:** There are burned pieces of LW in the river in most/all sub-reaches.

H5 would be true if LW that dies due to fire falls either directly in the river or falls on the floodplain and is transported to the river. Since I expect that the most competent movement of LW is in the river, and the burned zone is in the upstream portion of the study area, there should be burned LW throughout the channel sub-reaches, regardless of the burn status of the sub-reach.

***Hypothesis 6 (H6)*:** There are burned pieces of LW on the floodplain only in burned sub-reaches.

H6 follows directly from H5. If movement of LW occurs laterally more readily than longitudinally across the floodplain, then burned LW would only be seen on the floodplain in burned sub-reaches and not on the floodplain of unburned sub-reaches.

***Hypothesis 7 (H7)*:** There is a greater proportion of floodplain LW in jams in burned sub-reaches compared to unburned sub-reaches.

H7 comes directly from H5 and H6 – if more organic material (LW and living vegetation) is consumed during fire, then floodplain hydraulic roughness and flow obstructions would decrease, LW mobility would increase, and jam formation would be more likely. Unburned sub-reaches would have more obstructions inhibiting jam formation.

As previously discussed, the field site has to be relatively undisturbed by humans, partially burnt, and have natural heterogeneity in order to test H1-H7. LYV in Yosemite was chosen for these reasons.

3. STUDY AREA

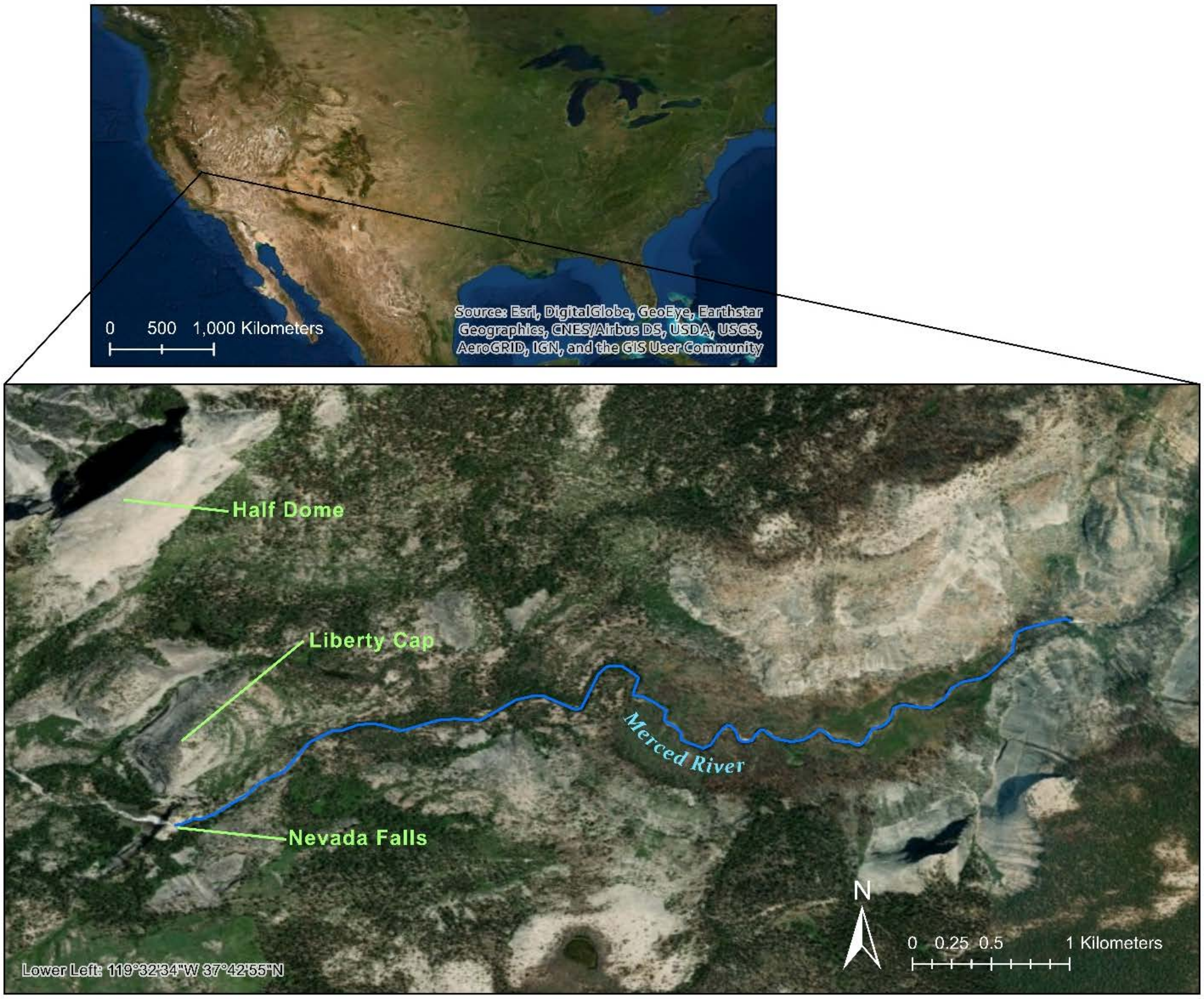
Yosemite, in northern California, spans from the western to the eastern Sierra Nevada mountains south of Lake Tahoe and north of Mammoth Lakes. Established as the third national park in 1890, Yosemite is home to some of the nation's most treasured natural features and resources, such as Half Dome, Yosemite Falls, and two Wild and Scenic Rivers (the Merced and the Tuolumne) (Bureau of Land Management et al., n.d.; Friends Of The Little Bighorn Battlefield, 2015). In addition to natural treasures, the park hosts many visitors. Over 4 million people visited Yosemite in 2018, making it the 6th most visited park in the country for that year (National Park Service, 2019a). This grand backdrop sets the stage for novel research on the Merced River to help inform the National Park Service (NPS) how to best use existing resources to restore ecosystem functions while balancing the many uses of the park.

This study took place on the Merced River in LYV, upstream of the famous Yosemite Valley (Figure 3). The Yosemite Valley portion of the Merced River is heavily visited and has been extensively altered (unpublished report and National Park Service 2019). This research conducted on the less-altered reach of the Merced in LYV provides the NPS with valuable information regarding the pre-altered geomorphology of its river corridors.

Figure 3. View of the Merced River flowing over Nevada Falls (right), Liberty Cap (center), and Half Dome (far left) from the John Muir Trail. Little Yosemite Valley is located upstream of Nevada Falls.

3.1 Physical Setting

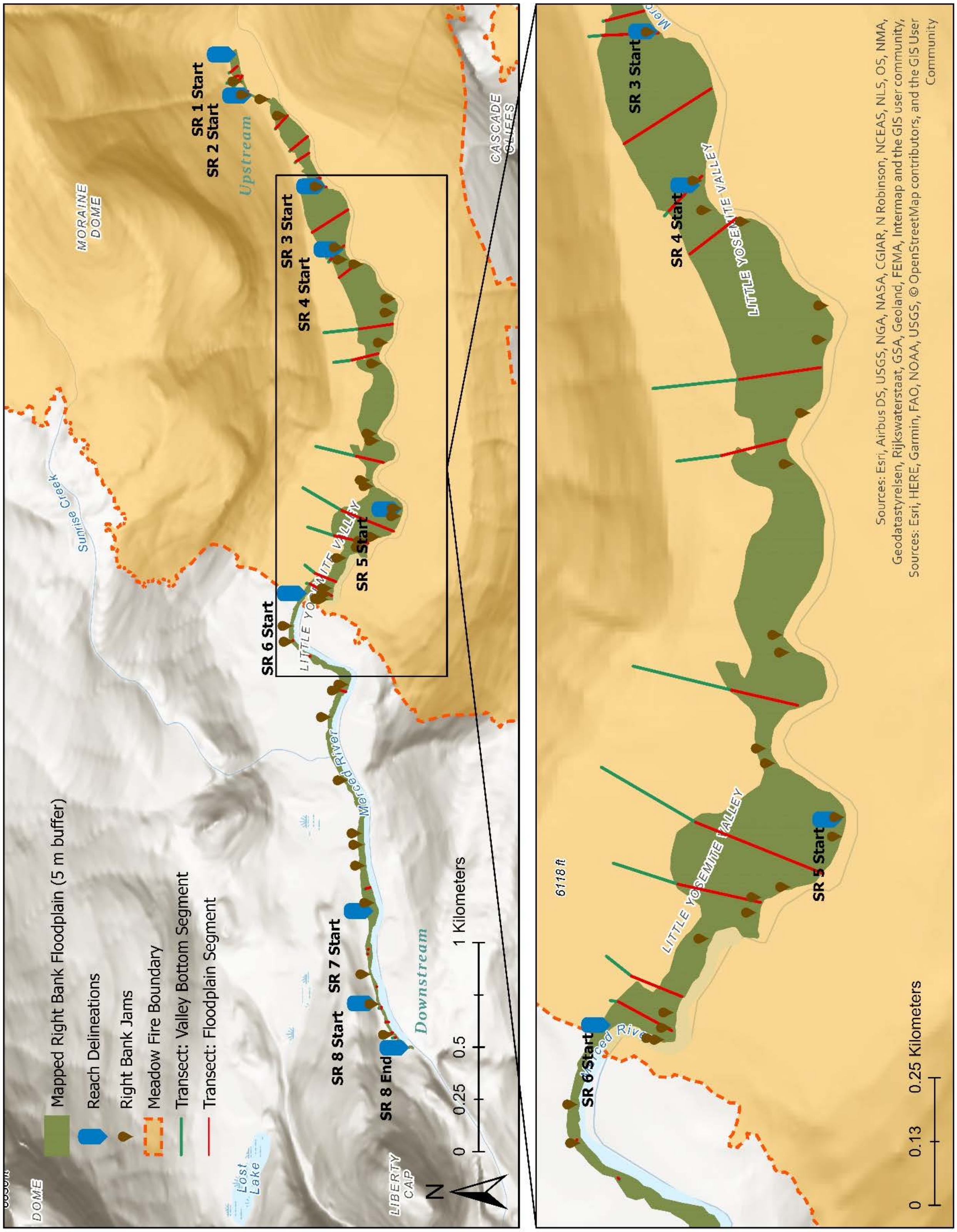
The study area extends along approximately 5 km of the Merced River upstream of Nevada Falls in LYV (Figure 4). The study area was partitioned into 8 sub-reaches based on Google Earth aerial photos and observations of geomorphic changes/discontinuities in the field (Figure 5). The study area includes a trail that connects the LYV backpacker's camp to Tuolumne Meadows via Merced Lake. This trail made the right side of the river very accessible, while a lack of trail and locally steep terrain on the left side of the river made it inaccessible for this study.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 4. Study area with prominent landmarks in green and the Merced River in blue

The study area is underlain primarily by Holocene alluvium, with Holocene talus including moraines and rock glaciers and Half Dome Granodiorite in the Late Cretaceous Tuolumne Intrusive Suite underlying parts of the reach (Peck, 2002, 1964). The granodiorite outcrops at the downstream end of LYV near Nevada Falls.



Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Figure 5. Study area map including the right bank floodplain, sub-reach boundaries (SR 1, etc.), instream logjam locations, 2014 Meadow Fire Boundary, and floodplain/valley bottom transects

3.2 Hydrologic Setting

The study area is located in the Upper Merced Watershed (HUC 18040008) (National Wetlands Inventory, 2019). Because the LYV watershed is so much larger than the 5-km study reach, the LYV basin characteristics differ from the study reach characteristics, most noticeably in relief (Table 2 and Table 3).

Table 2. Little Yosemite Valley Drainage Basin Characteristics

Parameter[1]	**Value**
Drainage area	300 km^2
Mean basin elevation	2896 m
Maximum basin elevation	3980 m
Minimum basin elevation	1780 m
Relief	2200 m
Mean basin slope computed from 30 m digital elevation model	36.7%
Basin relief/basin perimeter	18.9 m/km
Mean annual precipitation	120.4 cm
Percentage of area covered by forest	14.5%

[1] Data from StreamStats (U.S. Geologic Survey, 2019)

Table 3. Study Reach Characteristics

Parameter	Value
Study reach length[1]	5.1 km
Maximum elevation[2]	1884 m (6180 ft)
Minimum elevation[2]	1870 m (6140 ft)
Relief	14 m
Approximate reach-scale channel gradient[3]	0.021 m/m
Average river corridor width vs. average channel width (right bank only)[4]	4.4 m/m
Average floodplain width vs. average channel width (right bank only)	1.7 m/m
Forest type	Consistent, besides burn history
Dams	None
Upstream water source	Merced Lake
Two-year peak flood[5]	42.5 m^3/s (1500 ft^3/s) Prediction interval: (14.3 m^3/s, 125.4 m^3/s)

[1] Approximated in Google Earth
[2] Estimated from topographic map (U.S. Geologic Survey and Topozone, n.d.)
[3] Calculated from topographic map (U.S. Geologic Survey, 1988)
[4] Average river corridor width = average channel width + average floodplain width + average valley bottom width
[5] Data from StreamStats (U.S. Geologic Survey, 2019)

The closest downstream USGS stream gage to LYV is the Happy Isles gage (No. 11264500) in Yosemite Valley that drains approximately 470 km^2, including tributaries that enter the Merced River downstream of Nevada Falls such as Illilouette Creek. Using USGS data from 1915-202 at this gage, I calculated the mean water year discharge recurrence interval for 2019 to be 8 years with a mean water year discharge of 550 cfs (15.4 cms) (U.S. Geologic Survey, 2020). The peak discharge measured at the Happy Isles gage in May and June (Figure 6) indicates that the river's flow regime is snowmelt-dominated. California has a Mediterranean climate with hot, dry summers and cool, wet winters. In the Sierra, afternoon thundershowers can bring summer precipitation to the mountains. Figure 6, however, shows only one average peak discharge in May, indicating that summer storms are not a large contributor to Merced River flows.

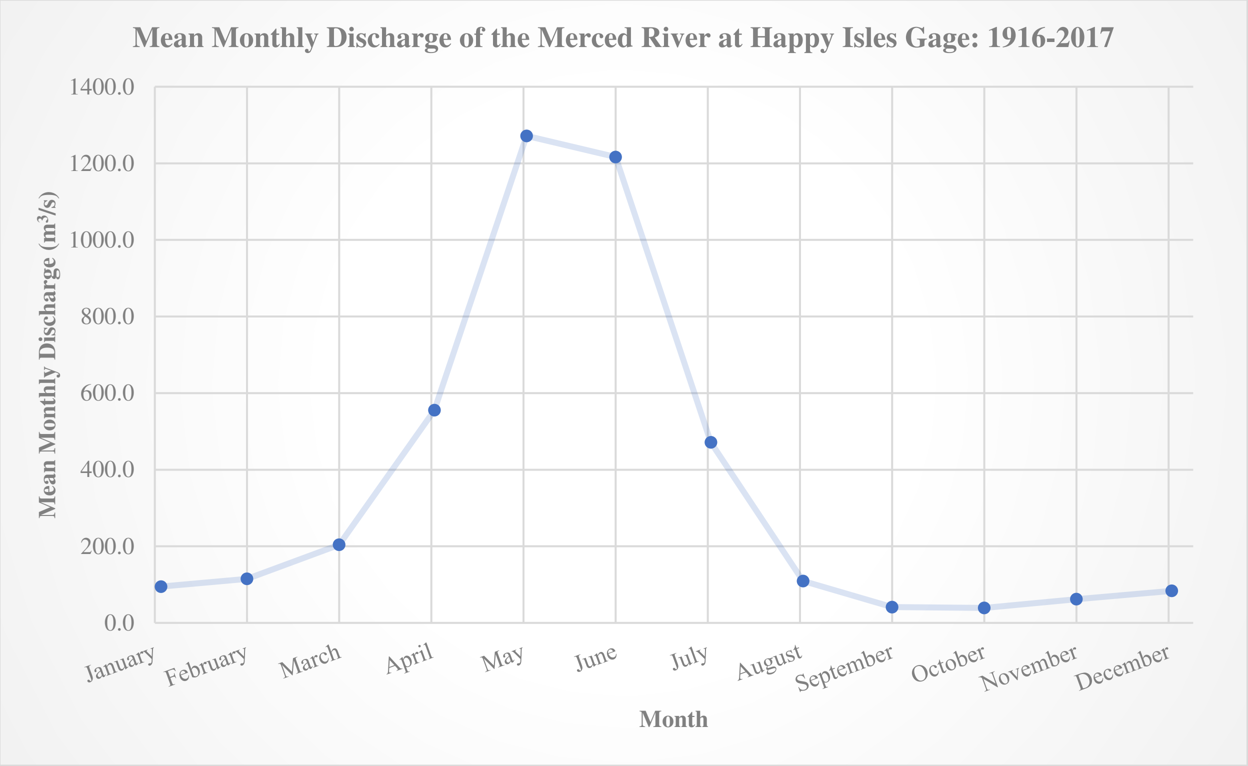


Figure 6. Mean monthly discharge of the Merced River at Happy Isles Stream Gage, data from WaterWatch (U.S. Geologic Survey, 2020)

Mean annual discharge at the Happy Isles gage is highly variable year-to-year (Figure 7), ranging from 2.5 m^3/s in 1977 to 23.8 m^3/s in 2018. This variability is likely to impact the geomorphology of LYV in terms of bank cutting, transport of sediment and LW, width and duration of floodplain inundation, and filling of side channels and abandoned meanders. The overall trend of annual flows is increasing, indicated by the linear trendline, with inter-annual variability in average flow increasing noticeably starting in the 1970s.

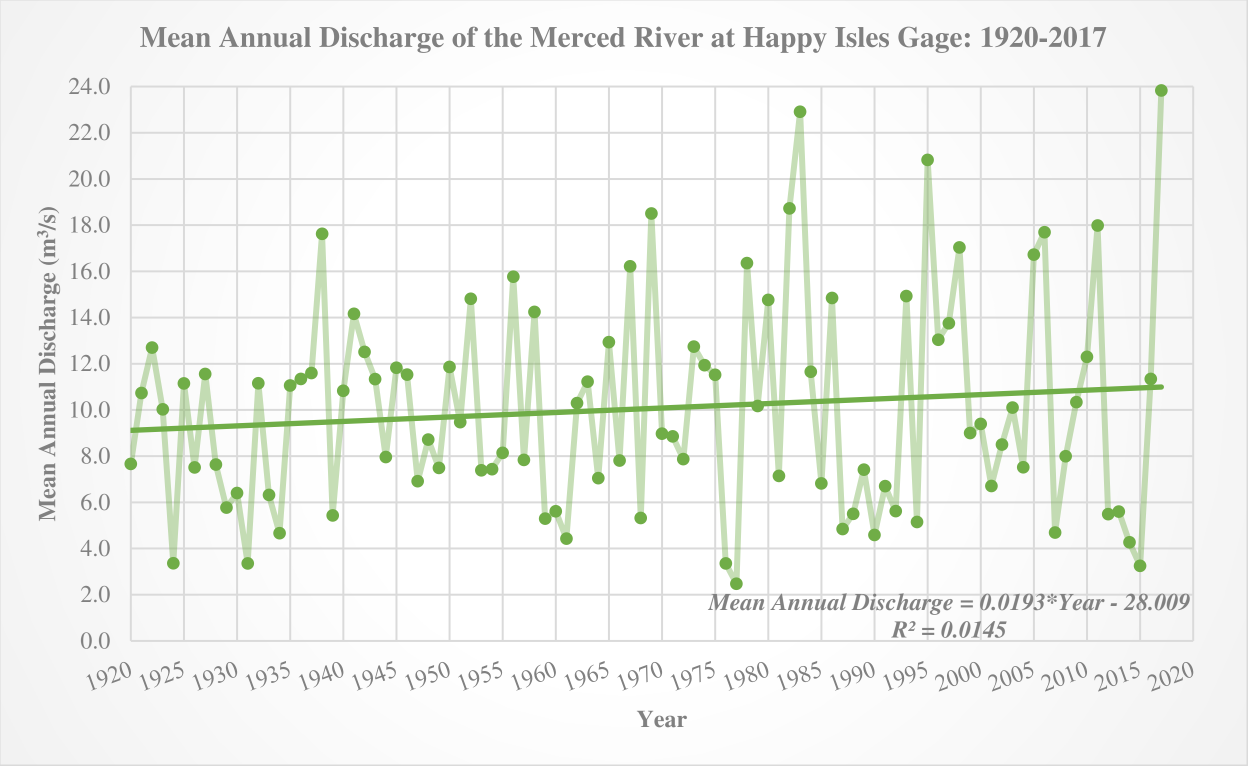


Figure 7. Mean annual discharge of the Merced River at Happy Isles Stream Gage, data from WaterWatch (U.S. Geologic Survey, 2020)

3.3 Ecological Setting

Forests in Yosemite span from the foothill-woodland zone to the alpine zone. The LYV watershed includes areas in the upper montane (approx. > 1,800 m), subalpine (approx. > 2,450 m), and alpine zones (approx. > 2,900 m) (National Park Service, 2015). Given these delineations, the study area is within the upper montane zone. Field observations showed there are deciduous trees and shrubs including such species as black cottonwood (*Populus trichocarpa*), quaking aspen (*Populus tremuloides*), and western azalea (*Rhododendron occidentale*) next to the river, on the floodplain and in wetland areas (Hall, 1921). There are also conifers including such species as Jeffrey pine (*Pinus jeffreyi*), incense cedar (*Libocedrus decurrens*), and Douglas-fir (*Pseudotsuga menziesii*) in all parts of the river corridor (Hall, 1921). The burned areas had generally less dense foliage than the unburned areas of the floodplain and valley bottom. NPS GIS data mapped in 1997 and verified in 2006 show that parts of the study area can be grouped by similar vegetation, such as (1) sub-reaches 1 and 2, (2) sub-reaches 3-5, (3) sub-reach 6, (4) and sub-reaches 7 and 8 (Figure 8). Accumulations of LW have been present in LYV for a long time, as shown by this example from Vol. 2 of the *Merced Wild and Scenic River, Comprehensive Management Plan and Final Environmental Impact Statement*: “Examples of hydrologic-process Outstanding Remarkable Values of wilderness segments of the main stem and South Fork of the Merced River include […] a logjam in Little Yosemite Valley that is hundreds of years old, […]” (National Park Service, 2000). Snowmelt floods and wildfire are primary components of the disturbance regime relevant to LW dynamics in LYV. The impressive Yosemite fire record extends back to 1930 (National Park Service, 2019b). For fires since 1980 where perimeter data were collected and computerized, the only large and/or long-duration fire in the study area since 1980 was the Meadow Fire in 2014 (National Park Service, n.d.).

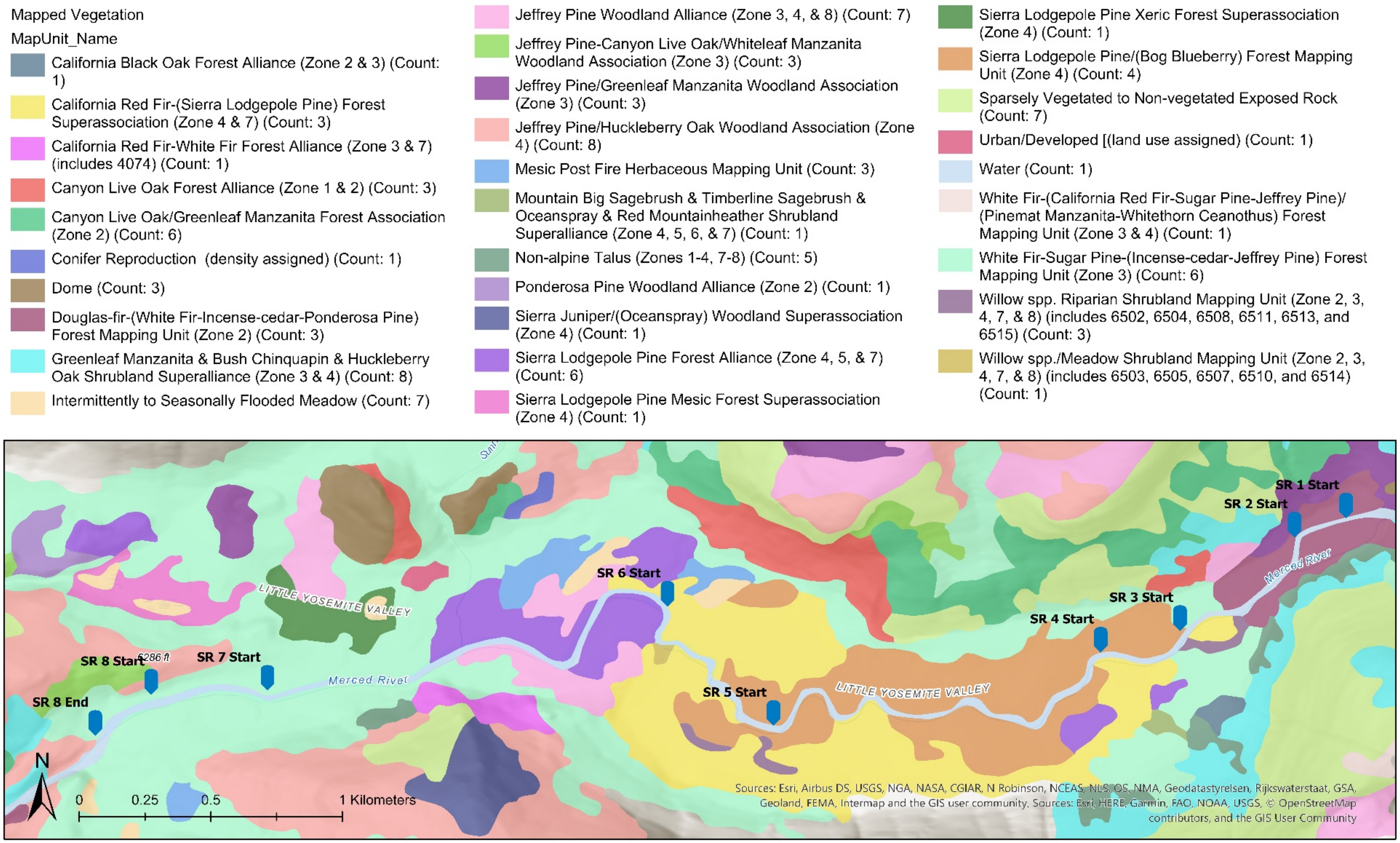


Figure 8. Mapped vegetation in Yosemite (National Park Service, 2006)

4. METHODS

4.1 Field Methods

Field work in Yosemite was conducted from June 18 to July 19, 2019. Methods used in the field ranged from in-stream measurements to corridor-wide measurements (Table 4). Summary tables of the data collected are given in the Appendices, including variables calculated from the original data (Table 22 through Table 30).

Table 4. River Corridor Metrics Measured and Used in Statistical Analyses

Category	Metric	Variable *Unit*	Description	Method
Locations	GPS	Lat, Long *WGS 84*	Locations of river corridor boundaries, river jams, reach delineations, etc.; bankfull, floodplain, and valley bottom boundaries noted at less regular spatial intervals than 50 m along the trail	Garmin eTrex 10, varying accuracy from very poor (approximately 100 m under dense vegetation) to good (3 m, best possible for the device); a few GPS points removed upon visual inspection
Large Wood	Diameter	D *Meters*	Approximate breast height diameter of LW	Laser Technology TruPulse 360º laser rangefinder (accuracy of 0.03 m), 100- and 300-m hand tapes, and visual estimation
	Length	L *Meters*	Length of LW that had a D ≥ 10 cm	
	Distance from Bankfull Edge of the River	DR *Meters*		
	Burn Class	BC *0-2*	(0) No visible burn, (1) Some visible burn, (2) Burned to the core	Visual/physical estimate, adapted from Wohl et al. (2010)
	Decay Class[1]	DC *1-5*	(1) Needles/leaves, branches, bark present; (2) Finer branches, no needles present; (3) No branches or bark, hard texture; (4) Some decay, not soft; (5) Soft texture, can pull apart with hands	Visual/physical estimate
	In Jam?	J? *Y/N*		Visual assessment

Category	Metric	Variable *Unit*	Description	Method
Large Wood cont.	Jam Size: Jam Length (parallel to river) Jam Width (perpendicular to river) Jam Height	JL, JW, JH *Meters*		Laser rangefinder, hand tapes, and visual estimation
	Jam Porosity	p *%*		Visual estimation
	Wood Load	WL m^3/m^2 *(except where noted)*	Calculated for each individual transect across the floodplain and valley bottom, and for each sub-reach of the bankfull channel	Van Wager's line intersect method (1968), and piece-based calculations
River Corridor	Sinuosity	S *m/m*		Calculated in Google Earth
	Bankfull Width	BFW *Meters*	Measured perpendicular to the flow of the Merced River approximately every 50 m along the trail	Laser rangefinder, hand tapes, visual estimation, and Google Earth estimation
	Floodplain Width	FPW *Meters*		
	Valley Bottom Width	VBW *Meters*		
	Sub-Reach	SR *1-8*		Designated on Google Earth based on visible longitudinal changes, paying particular attention to changes in floodplain forest cover, short reaches with islands or bars that create split flow, and noticeably large logjams. Designations were confirmed or re-established based on actual geomorphology of the field site.
	Transect	T *1-4*		Designated in the field, four randomly spaced transects nested within each of the eight sub-reaches
	Burned?	B? *Y/N*		Visual assessment
	Basal Area	BA *Count*		Panama Angle Gage

I conducted a thorough LW survey of the right bank for the entire reach to estimate LW load. Due to high flows that limited access to the channel and the lack of trail on the left side of the river, only right-bank marginal and channel-spanning in-stream log jams were measured. Log jam measurements included noting the length, diameter, burn class, and decay class of each piece of LW in each jam. Thirty-eight in-stream jams were measured, including 7 jams at least partially spanning the channel and 31 on the right bank. I estimated the volume of a large channel-spanning log raft in sub-reach 6 using only the shape-based method due to its size and complexity (more information below). I visually estimated the number of dispersed pieces in the channel and the number of left bank jams by counting from the right bank of the river because of the inability to physically access and directly measure instream pieces and left bank jams. These visual estimates of dispersed pieces and left bank jams are not included in the statistical analyses.

The large size of the study area precluded directly measuring every piece of wood in the floodplain and valley bottom. In order to obtain representative samples of LW load in these locations, I assigned four randomly spaced transects within each sub-reach (total 32 transects for the study area) and measured the diameter of every piece of LW and every logjam (same measurements as river jams) that intersected the transect line (Van Wagner, 1968). Each transect extended from the right bankfull edge of the river to the back boundary of the valley bottom and I noted GPS points for the bankfull edge, floodplain, and valley boundaries. I determined the inner edge of the valley bottom as the end of the 2019 inundated floodplain (last visible high water marks and floodplain fabric features) and the outer edge as the point where the elevation started to change significantly from that of the floodplain (e.g. at a shallow hillslope, alluvial terrace, or the exposed bedrock of the river corridor walls). A total of 28 jams were measured along the transects on the floodplain. Additionally, the distance from bankfull edge, dimensions, and sometimes grain size were recorded for any water features encountered along the transect (side/secondary channels, groundwater seeps, abandoned meanders, etc.) (Table 27 in Appendices).

Calculation of volume for every jam shows that the shape-based jam volume (Equation 1) is higher on average than the piece-based in-stream jam volume (Equation 2) (119% for river jams and 94% for floodplain jams) (Table 5). Interestingly, although the average percent difference (Equation 3) for the floodplain estimates is lower than the average percent difference for the river estimates, the range of difference for floodplain jams (291%) is almost 100% greater than the range of difference for river jams (range of 204%) (Table 5). Consequently, I used the piece-based volume for all analyses because the measurements were more precise.

$$\text{Volume}_1 = JL * JW * JH * (1\text{-}p)\ [\text{m}^3] \tag{1}$$

$$\text{Volume}_2 = \sum \pi * \frac{D^2}{2} * L\ \ [\text{m}^3] \text{ for each piece of LW in the jam} \tag{2}$$

$$\text{Percent Difference} = \frac{\text{Volume}_1 - \text{Volume}_2}{(\text{Volume}_1 + \text{Volume}_2)/2} \tag{3}$$

Table 5. Jam Volume Calculation Error

Jam Location	Avg. % Difference	Min. % Difference	Max. % Difference
River	119%	-7%	197%
Floodplain	94%	-116%	175%

In order to translate the river jam volumes into the volume per area metric (m^3/m^2) in which the floodplain LW load was calculated, I summed the volumes of the jams I calculated using Equation 2 for each sub-reach and divided the sum by the approximate surface area of the river for that sub-reach. The wood load on the floodplain and valley bottom was calculated with Van Wagner's method (1968) for each of the 32 transects. The jams were incorporated into this calculation by treating all the pieces of LW in each jam as dispersed pieces of LW at the same location. The average wood loads for each location in the river corridor were converted into m^3/ha for ease of comparison to published data.

I measured riparian forest basal area in 32 places (13 in the floodplain, 8 in the floodplain/valley bottom, and 11 on the valley bottom) along the reach with a Panama Angle Gage, a standard tool used by foresters to measure the basal area of a forest stand. Aerial image observations also supplemented the field data collected. River corridor characteristics, such as sub-reach sinuosity and some bankfull widths, were measured in Google Earth (32 out of 115 total bankfull widths were measured in Google Earth (28%), with a +/- maximum error of 6 m; where there were two GPS bounding points for the transect, some of the floodplain widths were also estimated in Google Earth).

I mapped the 2019 floodplain boundary using GPS points delineated in the field (Figure 5). A 5-m buffer was added during data processing to the outside edge of the mapped floodplain to account for the accuracy of the GPS (the 5-m buffer was added as opposed to subtracted to create a conservative estimate of the floodplain boundary for 2019, refer to Figure 5 to compare transect boundary locations and mapped floodplain with buffer). The boundary that separates the floodplain and valley bottom was determined visually as the point where high water marks and floodplain fabric (pine needles, other duff) ceased and a more random, less compacted forest floor began. Although the mapped floodplain is approximate due to the limitations of GPS accuracy, visual comparison of the mapped floodplain to the digital elevation model (downloaded from OpenTopography) shows agreement of floodplain boundaries. It also shows that most of the spatial heterogeneity of the right bank of the river was captured within the mapped floodplains (Figure 9) (data acknowledgement in the Appendices).

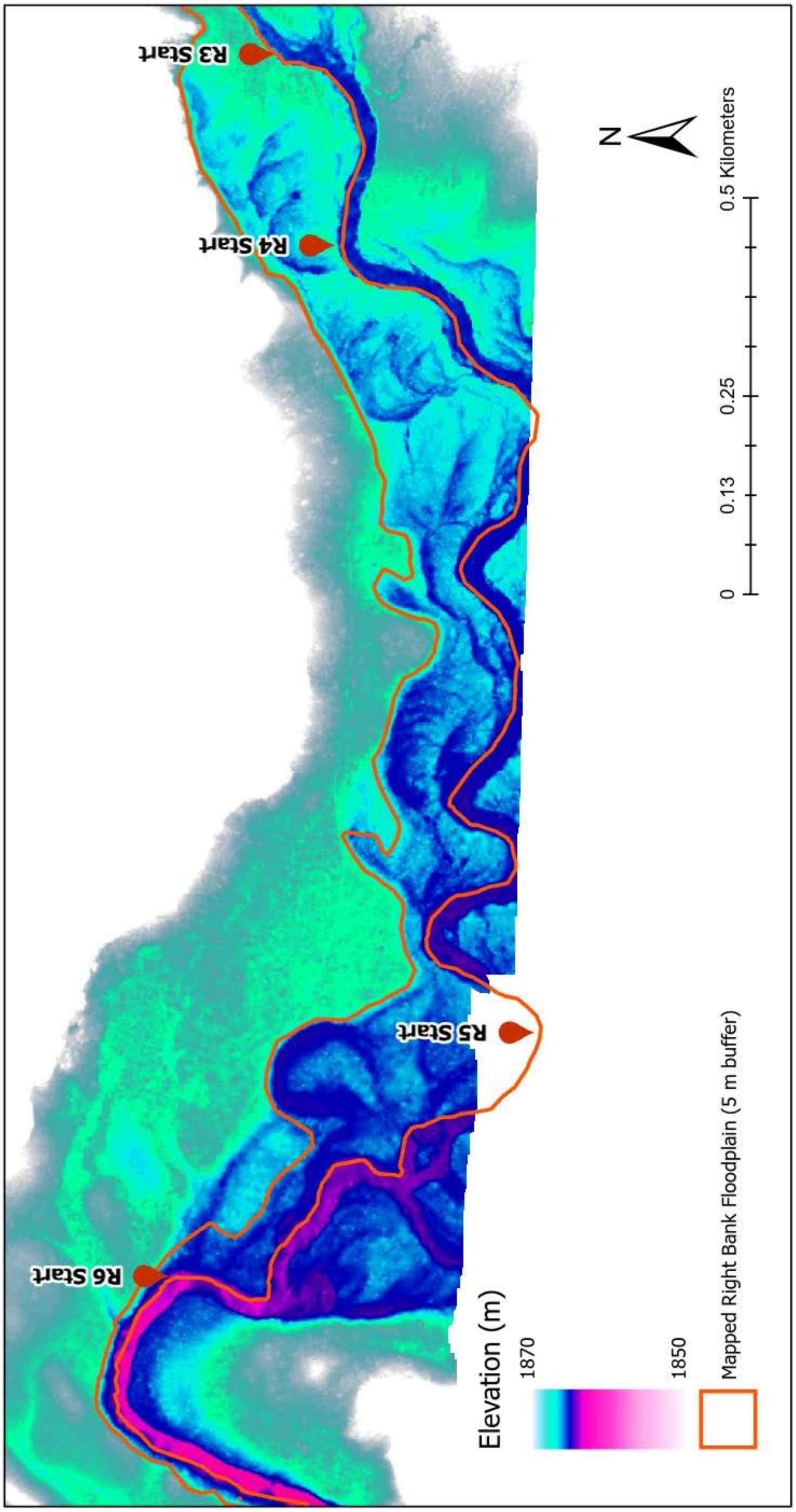


Figure 9. Comparison of mapped right bank floodplain (outline in orange) and digital elevation model (Stock, 2012)

4.2 Statistical Methods

All statistics were run in either RStudio (R Core Team, 2019) or Microsoft Excel (simple averages, maximums, minimums). The data used in the statistical analyses are given in the Appendices. NAs were removed for all summary statistics prepared and tests run in R (Table 6). Although the transects were nested within the sub-reaches, this was not considered for the statistical analyses. An $\alpha = 0.05$ was used for all tests of significance.

Table 6. Summary of Statistical Tests (H5 and H6 do not require statistical tests)

Statistical Test	Description	Use
Kruskal-Wallace Rank Sum Test	Non-parametric approximate test of equality of three or more medians, useful for non-normal data[1]	Exploratory Analysis
Dunn's Test with no adjustment for multiple testing [2]	Non-parametric pairwise comparison of three or more medians[1]	Exploratory Analysis
Wilcoxon Rank Sum Test (without ties) [3]	Non-parametric approximate test of equality of two medians, useful for non-normal data[1]	Exploratory Analysis, H1, H4
Exact Wilcoxon-Mann-Whitney Test (with ties) [3,4]		Exploratory Analysis, H1, H2
Brown-Forsythe Test [5]	Test for equality of variances using the median as the measure of center, useful for non-normal data[1]	Exploratory Analysis, H1, H2, H4
D'Agostino Test of Skewness [6]	Test for skewness, null hypothesis is that the data is normally distributed with a skew = 0	H3
Pearson's Chi Square Test for Contingency Tables	Test of association between variables, also gives expected values[1]	H7
Odds Ratio with Wald Method [7]	Describes the strength of association between variables[1]	H7
All Subsets Model Selection [8]	Ranks multivariate linear models by Akaike Information Criterion (AIC) value, where the lowest value is the best model	Multivariate Analysis

[1] Adapted from Hess (2019)
[2] From the *dunn.test* package (Dinno, 2017)
[3] Will be referred to generally as Wilcoxon test going forward because these two tests test the same null/alternative hypotheses
[4] From the *coin* package (Hothorn et al., 2006)
[5] From the *car* package (Fox and Weisberg, 2019)
[6] From the *moments* package (Komsta and Novomestky, 2015)
[7] From the *epitools* package (Aragon, 2017)
[8] From the *MuMIn* package (Barton, 2019)

5. RESULTS & DISCUSSION

These results are organized into those that explore and characterize the dataset first, followed by those directly related to the specific hypotheses from the conceptual model. Following the results is an integrative discussion that brings it all together and synthesizes across the analyses.

5.1 Summary Statistics

The summarized data (Table 13 through Table 21 in the Appendices) give an overview of the raw data (also in the Appendices) with respect to wood piece size, logjam size, wood load, water features, and valley-bottom geometry. Both means and medians are tabulated as the data are non-normal (right skew) (Hess, 2019). In total, I measured 1,345 pieces of LW in LYV across the river, floodplain, and valley bottom. The summarized data shows the salient features of the study area (Table 7).

Table 7. Summary of All Large Wood

SR	**Location**	***LW Characteristics***				***Study Area Characteristics***			
		n	**Median D (m)**	**Median BC**	**# of Jams**	**n**	**Median W (m)**	**n**	**Median WL (m^3/m^2)**
1	BF	10	0.27	1	2	8	23.3	1	0.0003
1	FP	10	0.10	NA	0	5	28.5	4	0.0056
1	VB	14	0.23	NA	0	4	18.9	4	0.0160
2	BF	50	0.30	1	3	12	36.5	1	0.0015
2	FP	46	0.20	NA	0	5	71.1	4	0.0155
2	VB	9	0.25	NA	0	4	6.8	4	0.0192
3	BF	3	0.20	2	1	11	31.0	1	0.0001
3	FP	179	0.20	2	6	5	108.0	4	0.0222
3	VB	7	0.25	NA	0	5	6.4	4	0.0117
4	BF	175	0.25	1	11	19	31.2	1	0.0020
4	FP	201	0.20	2	5	19	116.1	4	0.0262
4	VB	63	0.15	NA	0	20	139.0	4	0.0087
5	BF	85	0.25	1	9	12	31.8	1	0.0016

SR	Location	*LW Characteristics*				*Study Area Characteristics*			
		n	Median D (m)	Median BC	# of Jams	n	Median W (m)	n	Median WL (m^3/m^2)
5	FP	261	0.20	1	11	12	115.7	4	0.0383
5	VB	72	0.20	NA	0	12	178.2	4	0.0086
6	BF	42	0.20	0	9	32	30.0	1	0.0589
6	FP	38	0.20	0	3	32	12.0	4	0.0240
6	VB	2	0.13	NA	0	30	3.6	4	0.0000
7	BF	5	0.20	0	1	11	31.0	1	0.0005
7	FP	25	0.20	0	1	11	4.3	4	0.0129
7	VB	6	0.30	NA	0	8	0.7	4	0.0000
8	BF	18	0.20	0	2	10	33.9	1	0.0009
8	FP	19	0.20	0	2	10	3.6	4	0.0351
8	VB	5	0.30	NA	0	8	1.6	4	0.0117

Abbreviations: Sub-reach (SR), bankfull channel (BF), floodplain (FP), valley bottom (VB), sample size (n), diameter (D), burn class (BC), width (W), wood load (WL)

5.2 Exploratory Statistics

The exploratory data analysis compares channel, floodplain, and valley bottom width, floodplain water features, LW diameter, and LW load in all sub-reaches and locations of the study area. As in the summary statistics, the locations are the bankfull channel/river, floodplain, and valley bottom. The comparison of location widths shows that both the median bankfull channel and median floodplain are significantly wider than the median valley bottom via Kruskal-Wallace (p-value = 0.00036) and Dunn's tests (p-value $_{(BF-FP)}$ = 0.076, p-value $_{(BF-VB)}$ = 0, p-value $_{(FP-VB)}$ = 0.0067) (Figure 10). Additionally, the Brown-Forsythe Test shows that the variances of the three data sets are not equal (p-value < 1.2×10^{-11}), which can clearly be seen by the side-by-side boxplots (Figure 10). These results make sense as, although the river is wide, the spread of the floodplain and valley bottom widths are much greater and include much higher values than the river.

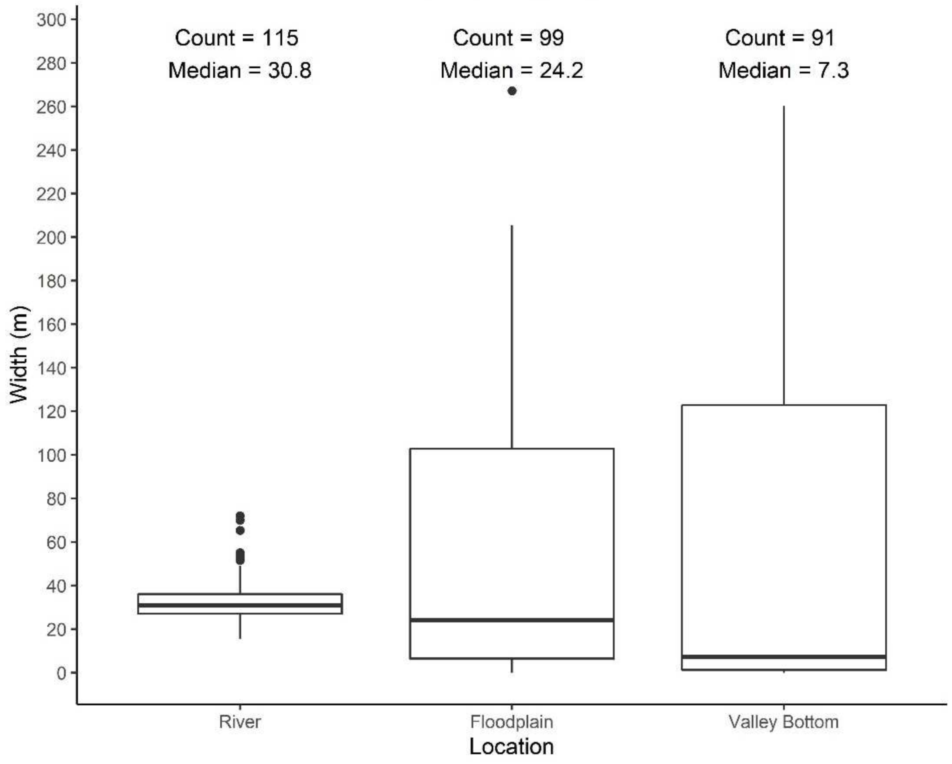


Figure 10. Comparison of geomorphic unit widths perpendicular to river corridor orientation

Some of the heterogeneity in location widths can be attributed to burned versus unburned areas (Figure 11). The first panel in Figure 11 shows evidence of a marked change in valley geometry between the burned and unburned sub-reaches (between sub-reaches 5 and 6), although geologic maps of the study area do not indicate any lithological or structural changes that might explain the change in valley geometry. While this change in valley geometry lines up well with the Meadow Fire boundary, I cannot conclude whether the change is related to the fire, vice versa, or something else. Wilcoxon and Brown-Forsythe tests show that the median widths of the river in burned and unburned areas are not significantly different (p-value = 0.85), but the variances are different (p-value = 0.00078); the median widths of the floodplain in burned and unburned areas are significantly different (p-value $< 6 \times 10^{-15}$) and the variances are different (p-value $< 5.5 \times 10^{-10}$); and the median widths of the valley bottom in burned and unburned areas are also significantly different (p-value $< 2 \times 10^{-10}$) and the variances are different (p-value $< 2.2 \times 10^{-16}$). Although the river is not significantly different in (un)burned areas, the significantly wider floodplain in the burned area indicates that there could be some hydraulic backwatering from the river onto the floodplain at the Meadow Fire boundary (between sub-reaches 5 and 6). In order to determine whether this is occurring e, a 2D hydraulic model with channel and floodplain cross sections would have to be built and tested.

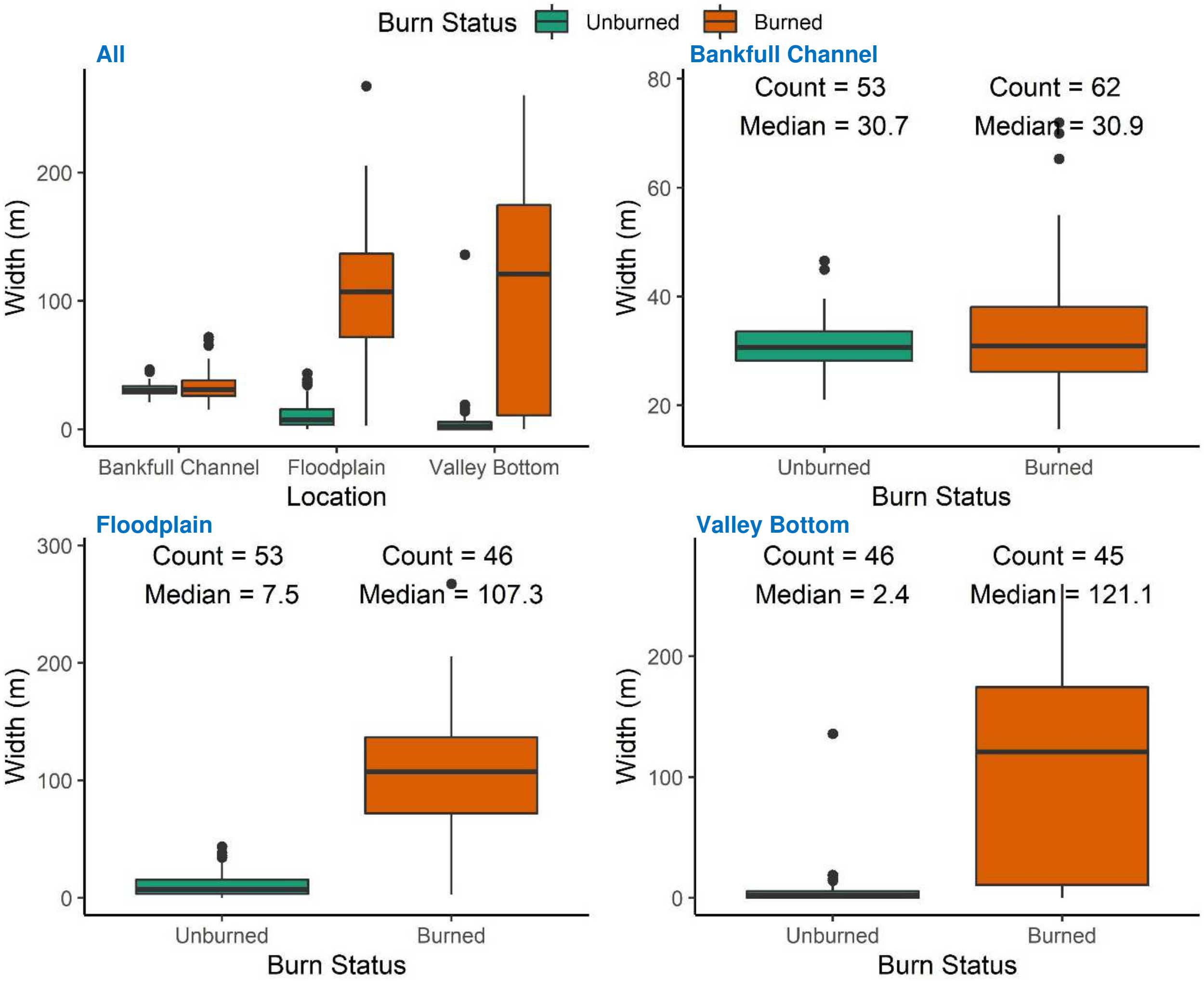


Figure 11. Comparison of geomorphic unit widths perpendicular to river corridor orientation by burn status

Floodplain water features, areas with a lower relative elevation and greater flow depth during overbank flow, could be expected to either (1) receive more LW during overbank transport from the channel, or (2) have more mobile floodplain LW. To look at the frequency of floodplain water features (side channels, abandoned meanders, groundwater seeps, flooded floodplain, ponds, and bank overflow) and their possible correlation with logjams, I plotted the location of floodplain logjams and the location of floodplain water features on the same jitter plot for the sub-reaches with the longest floodplains (Figure 12). The resulting plot shows that there are some jams that seem to coincide with water features, but there are also many that do not. Additionally, it seems like there is some longitudinal pattern among the four sub-reaches where a water feature may have extended along the length of the floodplain. I do not think these results are particularly illuminating because of the way I collected the water feature data. While I attempted to note each water feature that crossed the transect, I know that I may have missed some due to the change in the water levels on the floodplain throughout the field work. In order to collect data like these that are useful in the future, I would have to measure all the spatial extent of all ephemeral water features within a few days (and not weeks) of the highest flow on the floodplain.

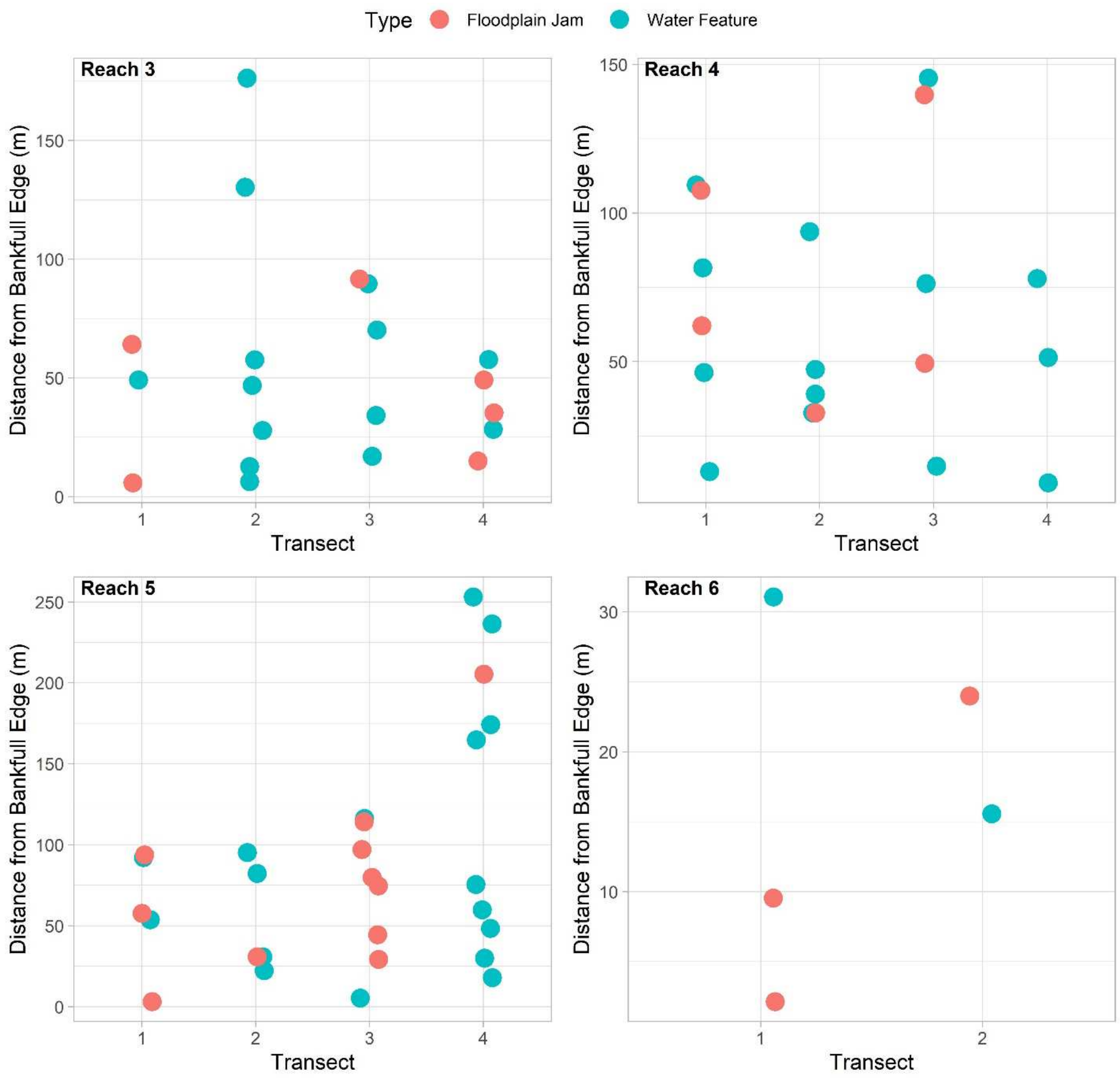


Figure 12. Location of floodplain jams and water features

The piece size distributions of LW diameters in each location are slightly different, with the approximate inclusive graphic standard deviations (IGsd, Folk & Ward, 1957) calculated from the empirical cumulative distribution function of LW diameter differing for each ($IGsd_{BF} = 0.12$, $IGsd_{FP} = 0.095$, $IGsd_{VB} = 0.12$) (Figure 13). Moreover, the statistical comparison of diameter shows that the median diameter of LW in the river is significantly larger than that of both the floodplain and valley bottom via Kruskal-Wallace (p-value < 7.5×10^{-11}) and Dunn's tests (p-value $_{\text{(BF-FP)}}$ = 0, p-value $_{\text{(BF-VB)}}$ = 0, p-value $_{\text{(FP-VB)}}$ = 0.33) (Figure 14). Additionally, the Brown-Forsythe Test shows that the variances of the three data sets are not equal (p-value = 1.0 x 10^{-5}), which can also be seen from the boxplots.

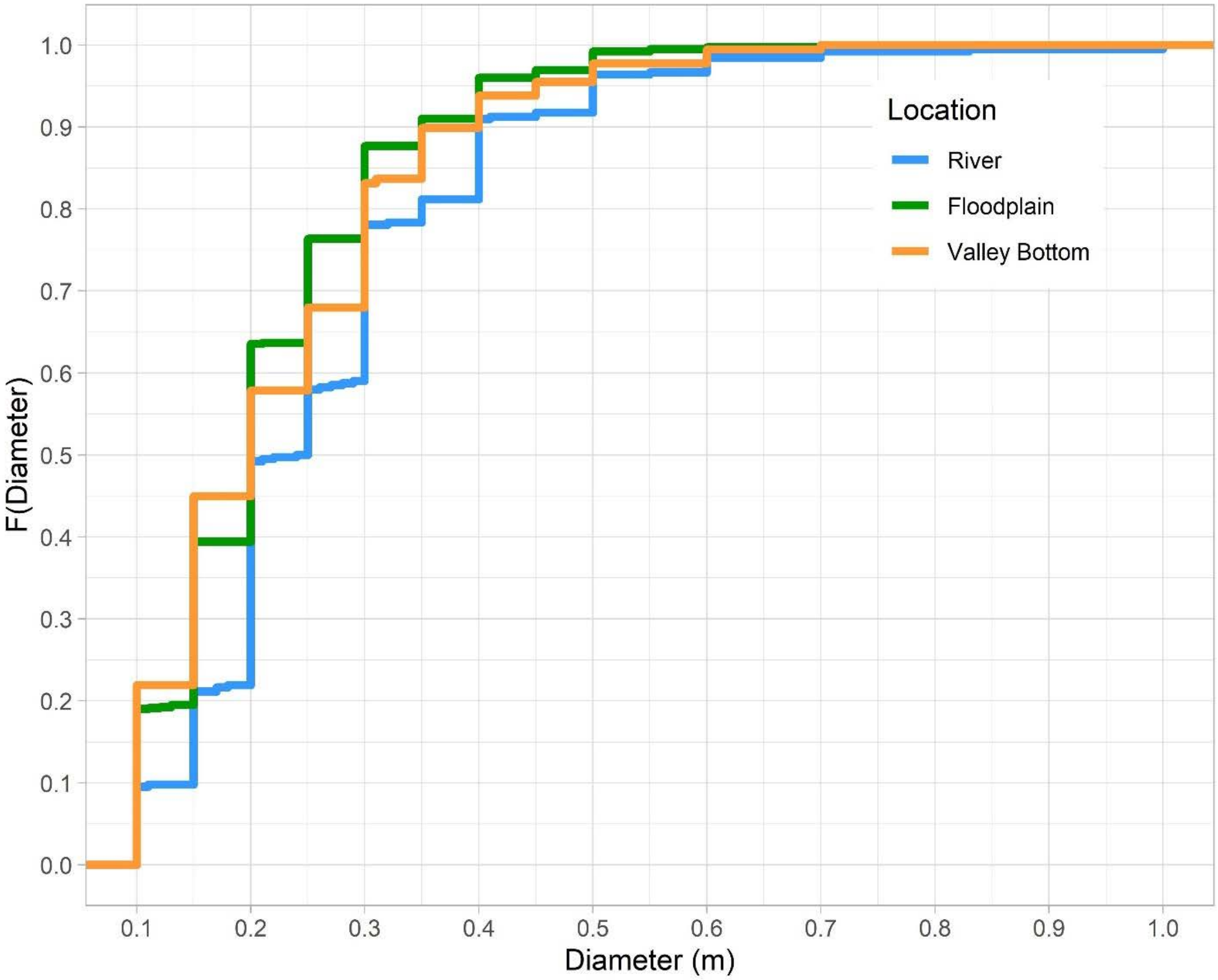


Figure 13. Empirical cumulative distribution functions of LW in the river corridor

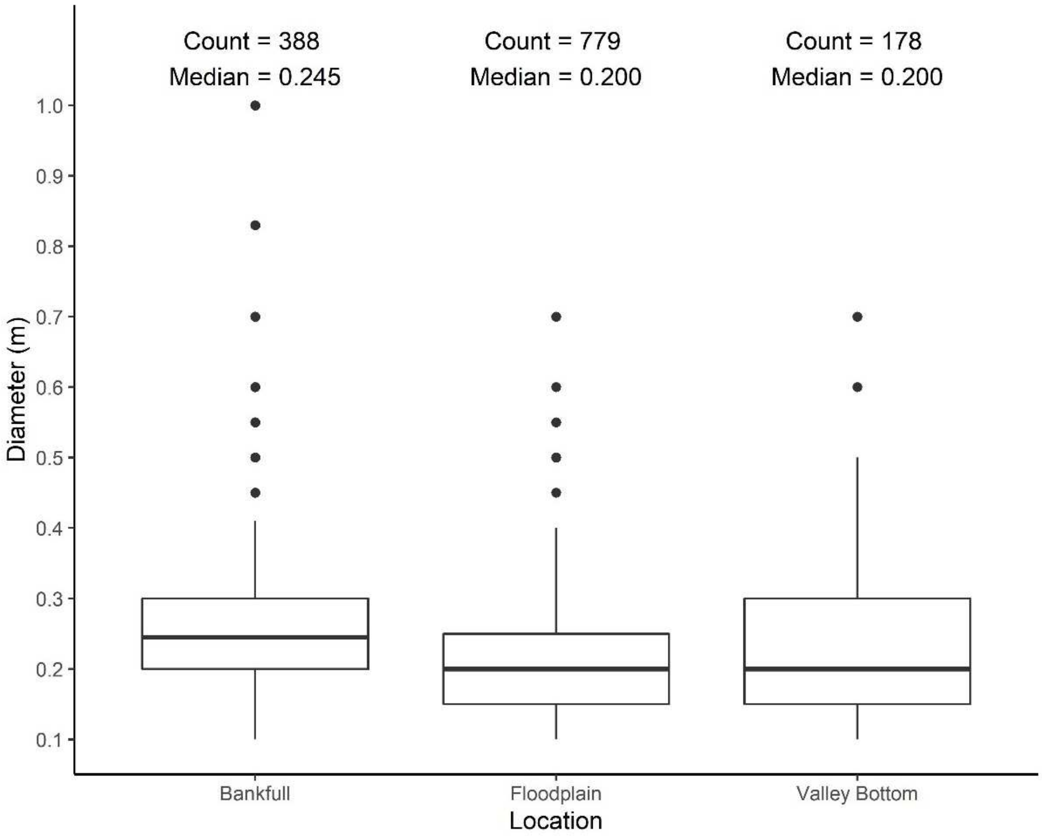


Figure 14. Comparison of large wood diameter by location

The average LW load in each location was calculated as the mean value for all of the eight sub-reaches in the river (for the bankfull channel estimate) and for all of the 32 transects (for both the floodplain and valley bottom estimates) (Table 8).

Table 8. Estimated Mean Large Wood Loads in Little Yosemite Valley

Location	Included Data	No. of Sub-Reaches/Transects	Mean Wood Load (m^3/m^2)	Mean Wood Load (m^3/ha)
River/Bankfull Channel	All sub-reaches	8	0.0082	82
Floodplain	All transects	32	0.025	250
	Burned transects	20	0.023	230
	Unburned transects	12	0.030	300
Valley Bottom	All transects	32	0.015	150

The distribution of LW load for each location varies by sub-reach/transect (Figure 15). This shows that while some of the areas have very minimal wood load, some areas have a very high wood load (possibly attributed to one or two very large jams in that area, like the wood raft in sub-reach 6 of the river). This also demonstrates that wood load can be very localized and may not be represented best by mean/median values.

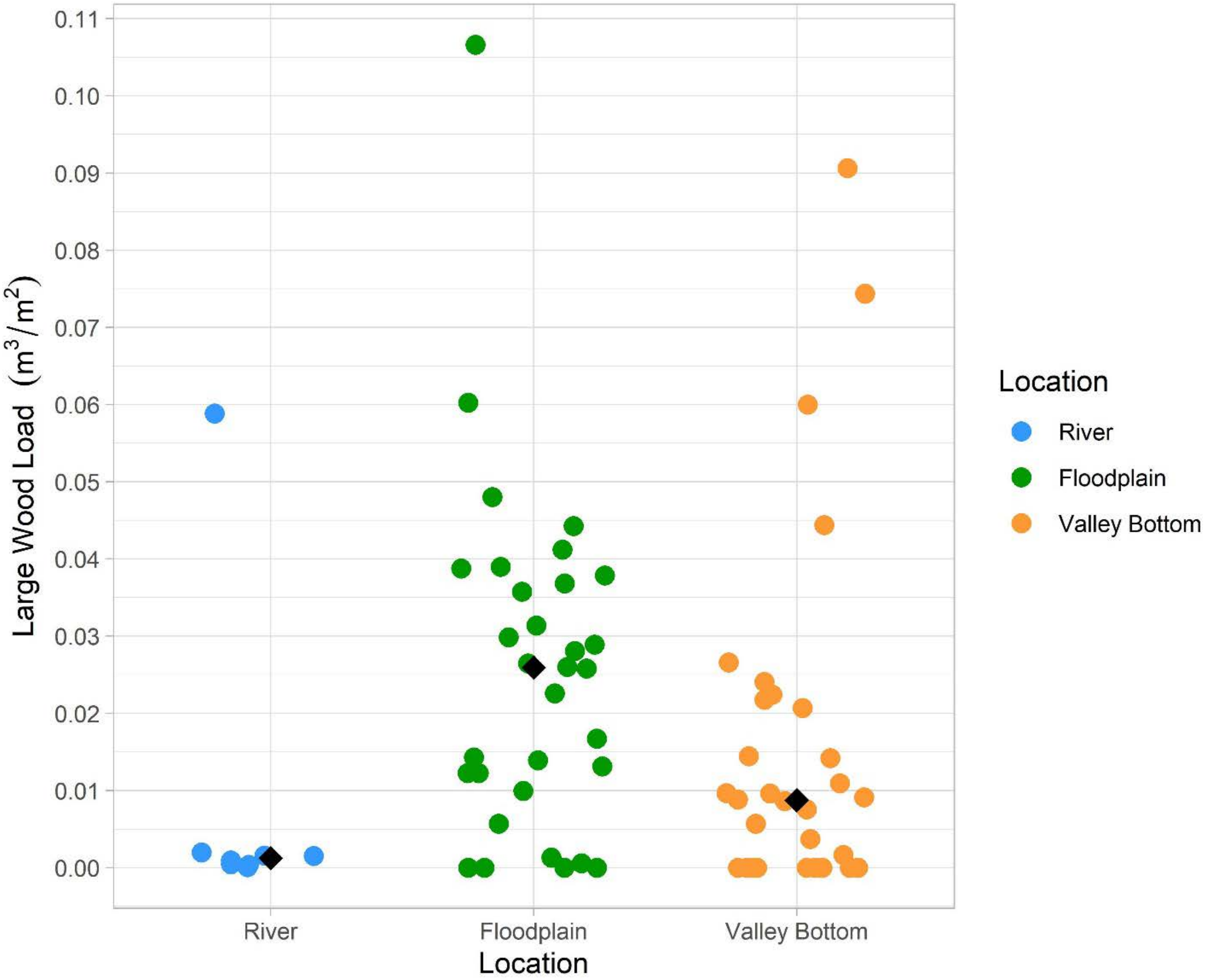


Figure 15. Range of large wood load in the study area. The black diamonds indicate the median values.

To narrow in on some of the patterns of wood load on the LYV floodplain, I plotted the distribution of LW by sub-reach and transect (Figure 16). This jitter plot shows distance from the bankfull edge for every piece of LW on the floodplain. The single dots are dispersed pieces and the dots that form a horizontal line indicate the location of a floodplain logjam (all pieces of LW in the jam were marked as being in the same location). This distribution shows that sub-reaches 3 through 5 had LW farther away from the channel and had the widest floodplains compared to the other shorter sub-reaches (1, 2, and 6 through 8). It also shows that many of the floodplain jams line up horizontally between adjacent sub-reaches, indicating that there are areas of the floodplain with more competent flow and/or channels on the floodplain. This aligns with my field observations of the subtle complexities in topography and channeling on the floodplain, especially on the wider floodplains of the burned area.

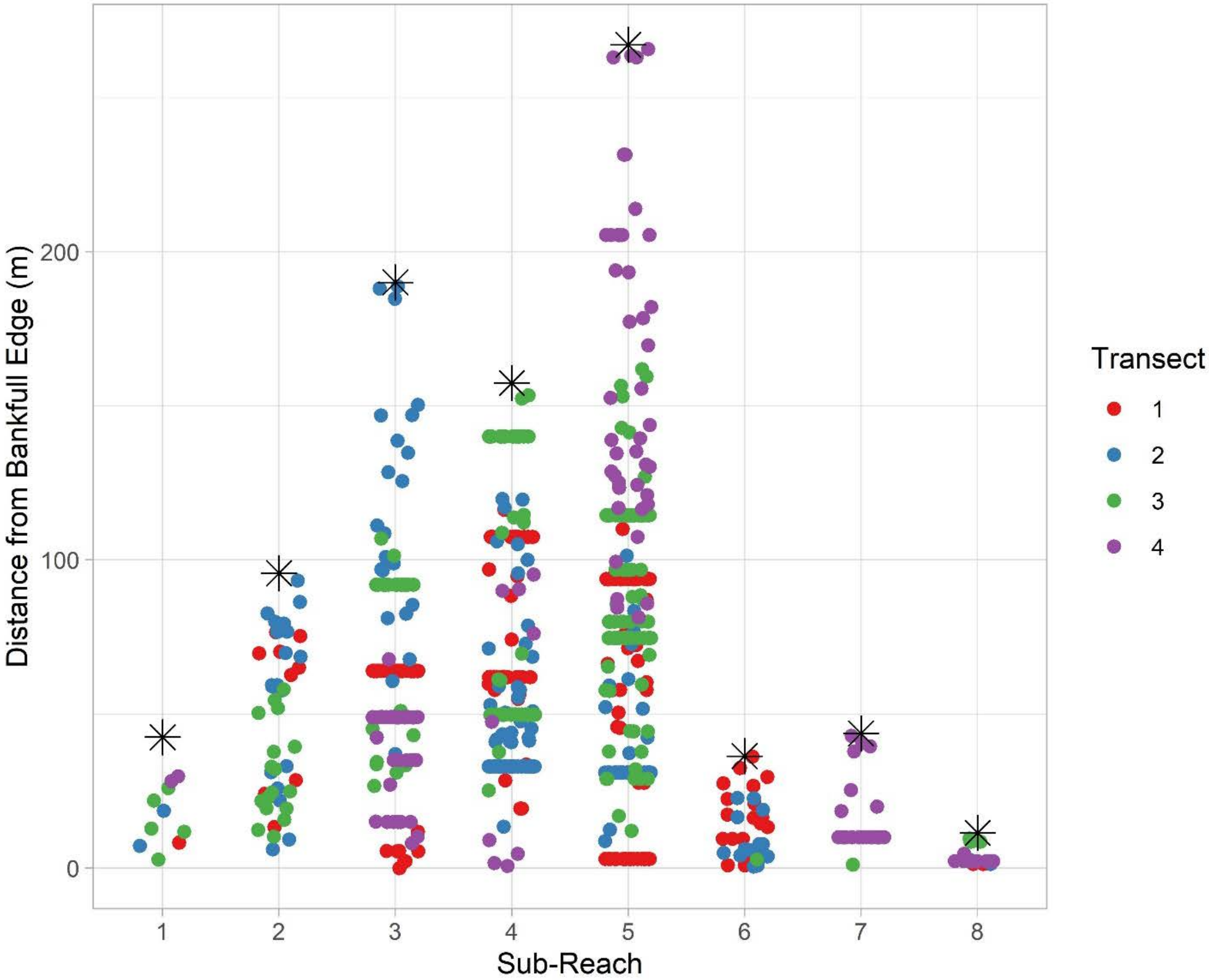


Figure 16. Location of large wood on the floodplain. The black stars indicate the maximum floodplain width of the four transects for each sub-reach. Reaches 1-5 are in the burned zone.

To summarize, there are statistical differences in the widths of the river, floodplain, and valley bottom compared to each other and compared to themselves between burned and unburned areas. Some floodplain jams lined up with floodplain water features, but others did not. The distribution of LW diameters differs in each of the three locations as well, both in median diameter comparisons and in the distributions of LW diameters. Lastly, the estimated wood loads for LYV are reasonable and on the high end when compared to published data. Wood loads can differ greatly depending on the specific location, indicating that there may be a better metric to summarize wood load than the mean/median value. The distribution of LW across the floodplain of the study reach shows distinct patterns between reaches of jam locations and demonstrates the difference in floodplain widths between the sub-reaches (and even the transects). Moreover, most of the exploratory analysis also shows that there is some type of discontinuity between the burned and unburned areas that makes it difficult to discern what characteristics of large wood load and distribution are due to the Meadow Fire. These results illuminate and enrich the analysis of the hypotheses from the conceptual model.

5.3 Conceptual Model Results

Moving beyond the exploratory data analysis, specific hypotheses from the conceptual modal (Figure 2) can be tested to dig deeper into the dynamics of LW in the river and on the floodplain in LYV. In order to test H1 (greater floodplain wood load in unburned reaches), the LW load on the burned and unburned areas of the floodplain were compared by sub-reach (Figure 17) and by transect (Figure 18). Sub-reaches 1 through 5 were in the burned area, while sub-reaches 6 through 8 were not (each sub-reach has 4 transects).

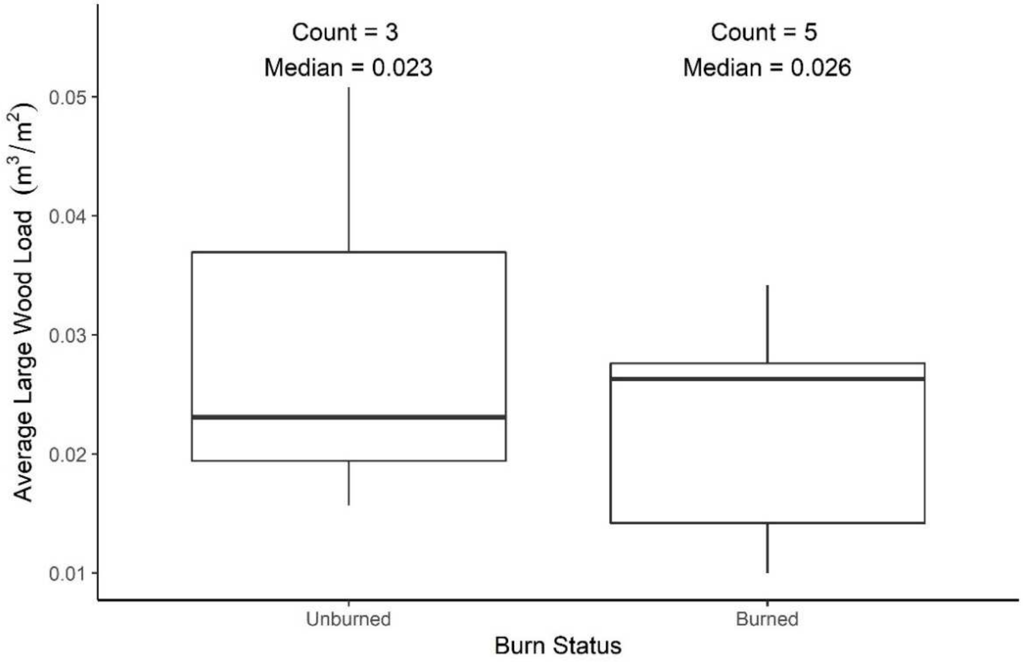


Figure 17. Comparison of sub-reach average large wood load on the floodplain by burn status (H1)

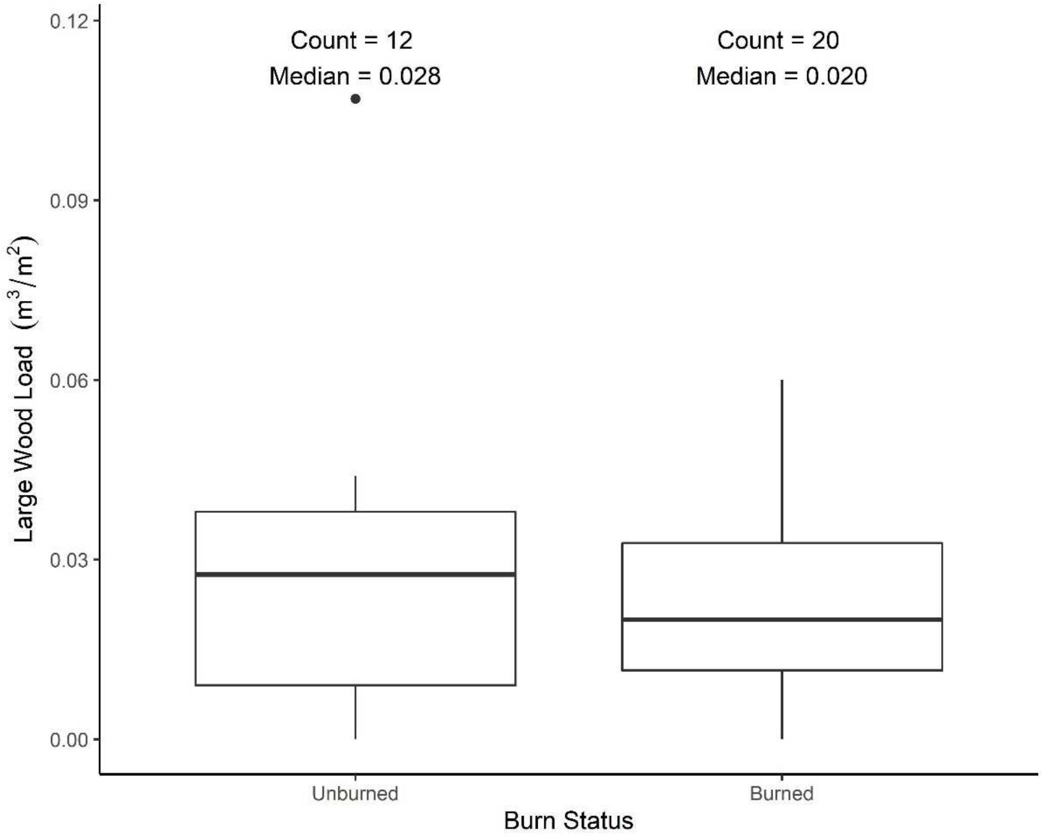


Figure 18. Comparison of transect large wood load on the floodplain by burn status (H1)

The results of the Wilcoxon tests show that that there is no significant difference between either the median average sub-reach LW loads in burned/unburned areas (p-value = 0.786) or the median total transect LW loads in burned/unburned areas (p-value = 0.737). I think this mainly is due to the way that the data were split, resulting in a low number of observations ($n_{\text{sub-reach}}$ = 8, n_{transect} = 32) and therefore making it difficult to discern a statistical difference. The boxplots indicate that with more data points this difference in LW loads on the floodplain may prove significant (although it is difficult to tell which area would have the higher wood load). Alternatively, the fire could have both decreased LW load (via consumption) and increased LW load (via tree mortality and fall, and incomplete combustion) resulting in no difference. More data would have to be collected to clarify. **Consequently, the results do not support H1.**

A comparison of LW loads by sub-reach on the floodplain (Figure 19) and valley bottom (Figure 20) shows that there is some longitudinal trend in the data from sub-reach 1 to 8 (n = 4 for each sub-reach). These graphs mirror the unexplained discontinuity between sub-reaches 5 and 6 that was described in the exploratory data analysis.

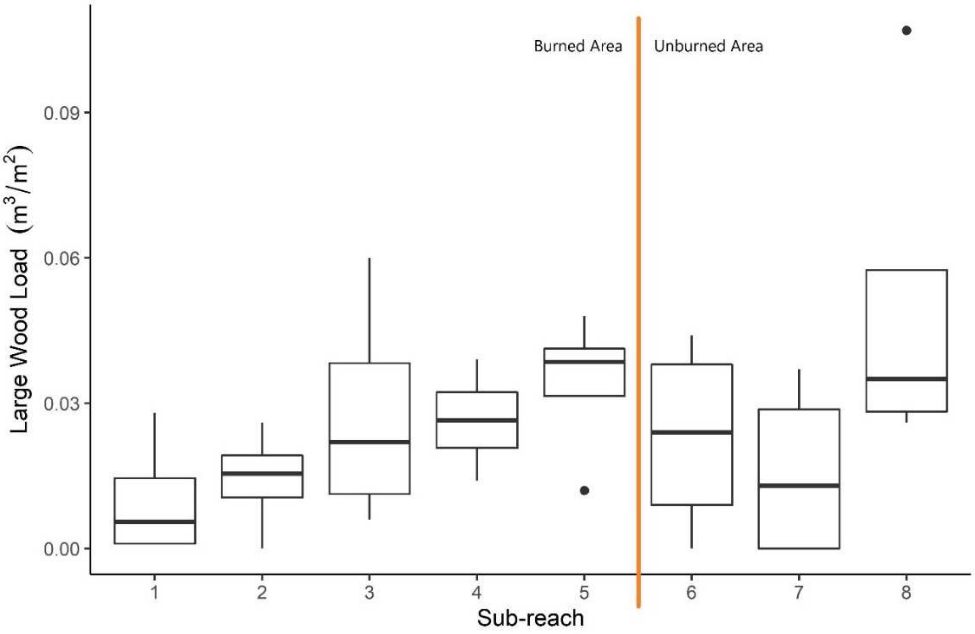


Figure 19. Comparison of large wood load on the floodplain by sub-reach (H1)

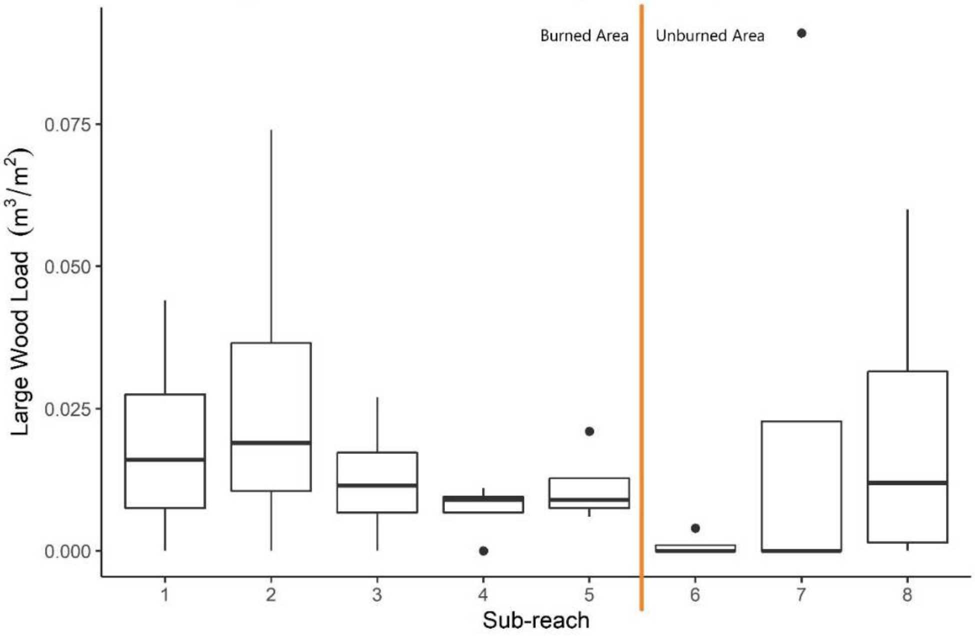


Figure 20. Comparison of large wood load on the valley bottom by sub-reach (H1)

For H2 (smaller diameter LW on the floodplain in burned sub-reaches), the floodplain LW data were split into burned and unburned areas (Figure 21). The result of the Wilcoxon test shows that there is not a significant difference between the median diameters of floodplain LW in burned/unburned areas (p-value = 0.835). The result of the Brown-Forsythe test shows that the variances are also homogeneous for the two data sets (p-value = 0.893). **Thus, the results do not support H2.**

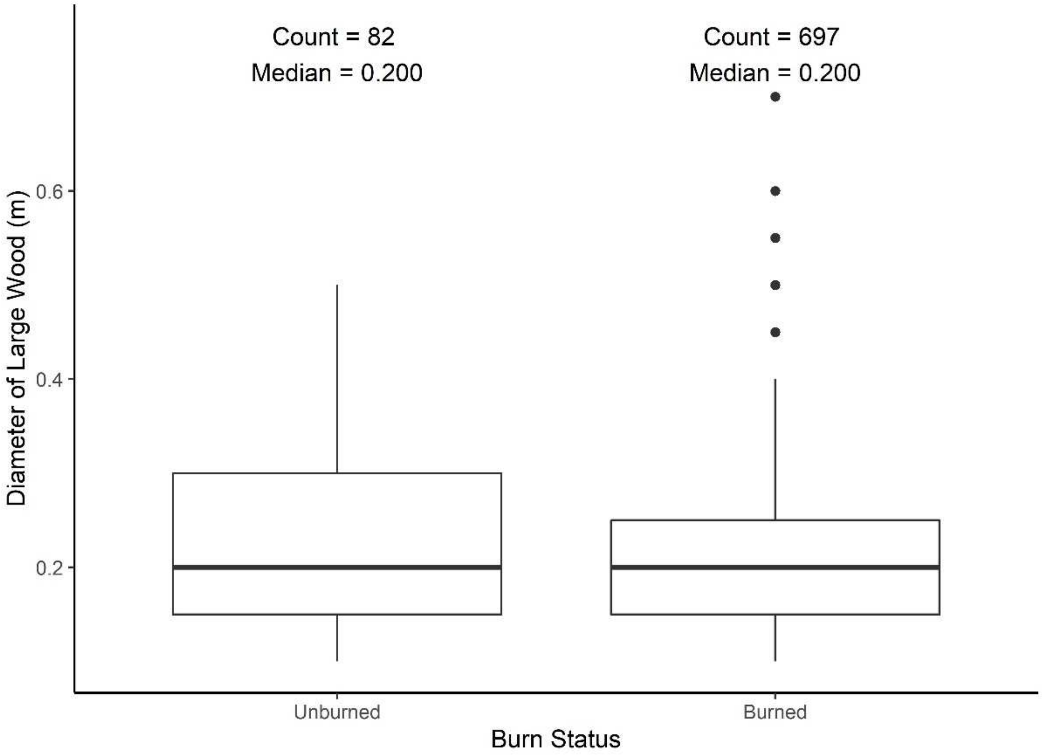


Figure 21. Comparison of diameter of all large wood on the floodplain by sub-reach burn status (H2)

I observed a much larger number of LW pieces on the floodplain in burned areas (n = 697) compared to unburned areas (n = 82). This could be due to the fact that the floodplain was much wider in the burned versus unburned areas (aligned with the discontinuity, Figure 11), resulting in more pieces of LW to measure. While the median diameters are not significantly different in the two areas, that does not necessarily mean that wildfire does not have an effect on floodplain LW. I think other data would need to be collected in order to determine the effect of fire on the floodplain, including potential covariates.

For H3 (more floodplain logjams closer to the river), the floodplain jam data were plotted against distance from the bankfull edge of the channel (Figure 22). The boxplot shows a positively skewed distribution and the one-sided D'Agostino test confirms it (skew = 1.156, p-value = 0.00479). This means that there are more floodplain jams positioned to the right of the mean than in a normal distribution ($skew_{normal} = 0$). This result indicates that there is a tendency for floodplain jams to be closer to the river rather than farther away. One caveat is that the width of the floodplain differs for each jam, so this could influence how far a jam can form or move from the edge of the river (as seen in Figure 16). **In summary, the results do support H3.**

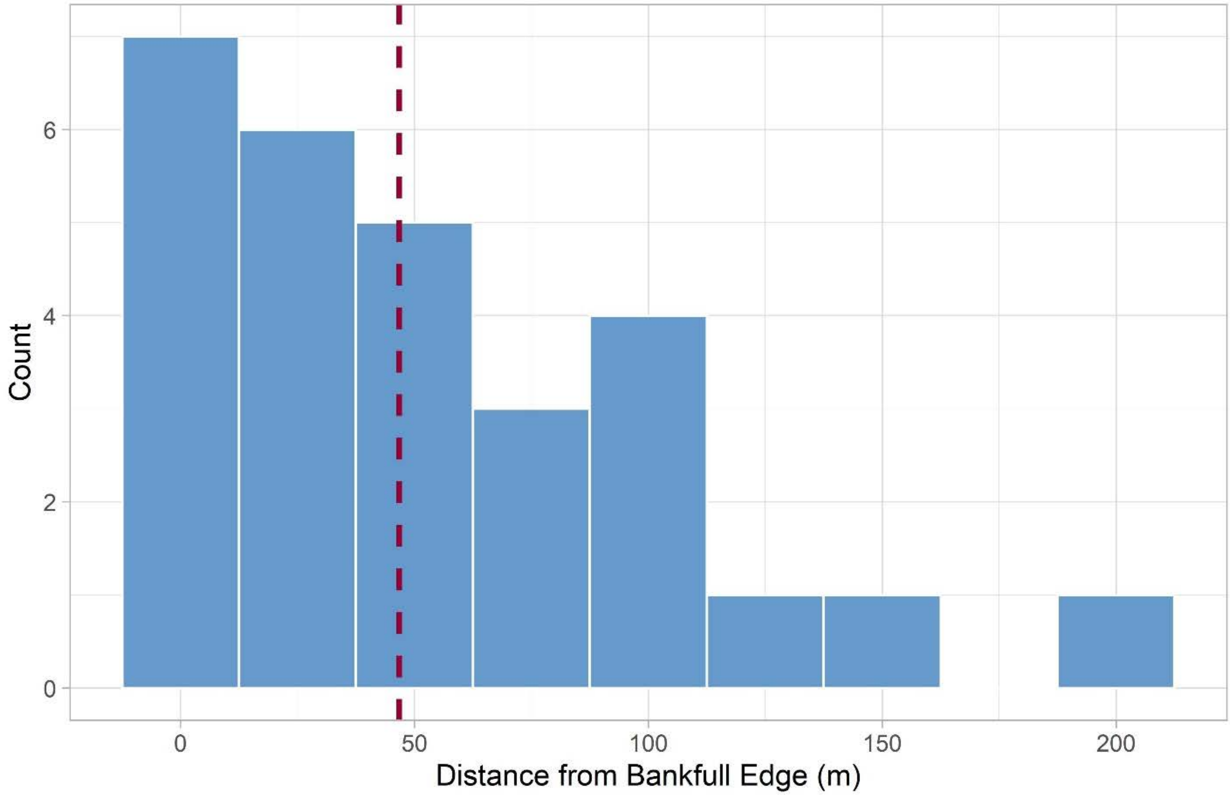


Figure 22. Distance from the bankfull edge of floodplain jams (H3). Median distance from the river showed by the dashed red line (46.7 m).

For H4 (river jams have larger diameter LW than floodplain jams), I compared the river versus floodplain diameters of in-jam LW pieces. The distributions of the diameter of large wood for both locations appear positively skewed (Figure 23), indicating that more LW has a smaller-than-average diameter than in a normal distribution.

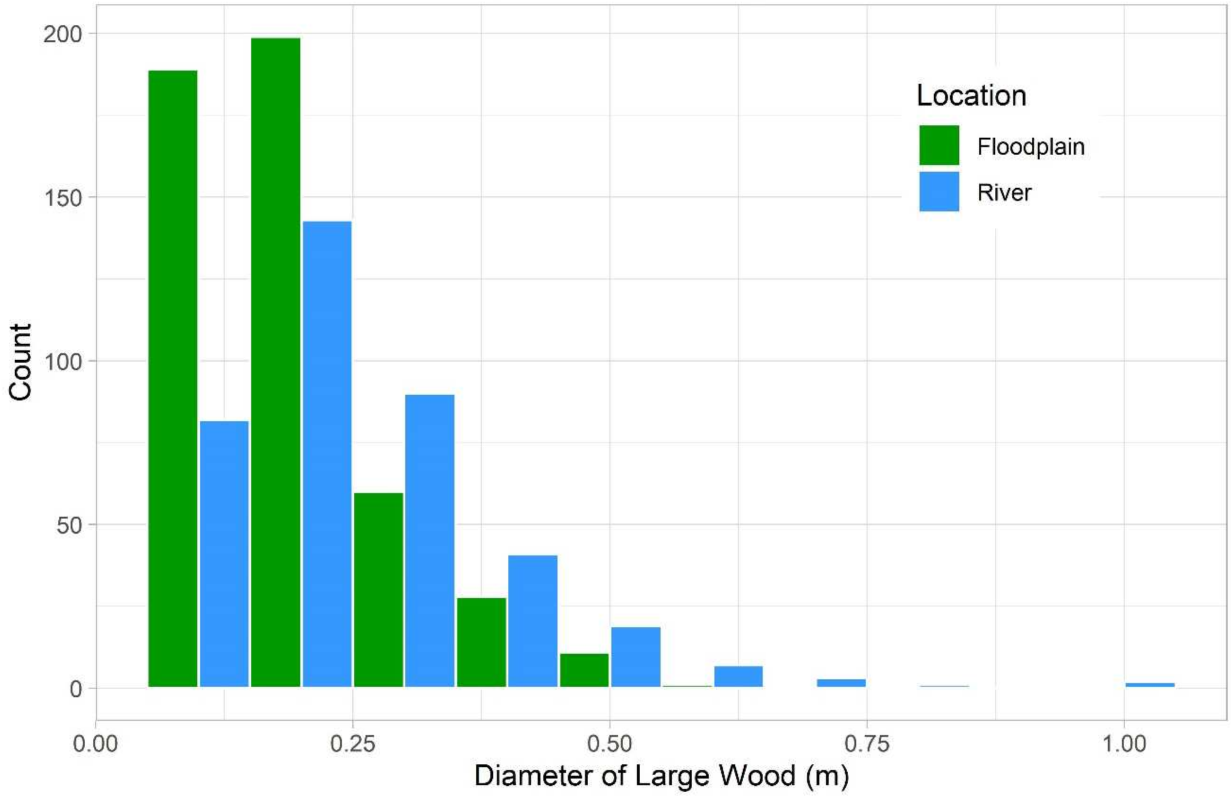


Figure 23. Diameter of large wood in floodplain and river jams (H4)

The Wilcoxon test shows that the median diameter of LW in floodplain jams is significantly smaller than the median diameter of LW in river jams ($\Delta D = 0.045$ m, $p < 1.5 \times 10^{-11}$) (Figure 24). Additionally, the Brown-Forsythe test shows that the variances between the two samples are significantly different ($p < 5.0 \times 10^{-8}$). **The tests thus support H4.** I observed qualitatively from aerial imagery that river jams marginal to the right bank appear to be more common near pool-riffle transitions of channel bed morphology. This could indicate that there is a change in transport capacity of the flow at these transitions, resulting in lower flow velocities and deposition of LW in the form of jams. Overall, these results therefore support the inference that there could be different mechanisms driving the movement of LW on the floodplain versus the river. It also supports the assumption that the jams in the study area are allochthonous, or at least combination jams. It should be noted, however, that there could have been a difference in diameter of trees growing next to the river (and eventually becoming part of river jams) and trees growing farther from the river in the floodplain. To account for this in future studies, the diameter data should be normalized by some average factor of tree diameter in different areas (in the river, marginal to the river, on the floodplain, etc.). Additionally, wood decay rates could be part of the normalization to account for potential differences in decay rates in the river and on the forest floor. For example, white fir (*Abies concolor*) decays 50% in 14 years and 95% in 61 years in Sequoia National Park, south of Yosemite (Harmon et al., 1987). Harmon et al. (1987) thought that this decay rate is faster than for other conifers.

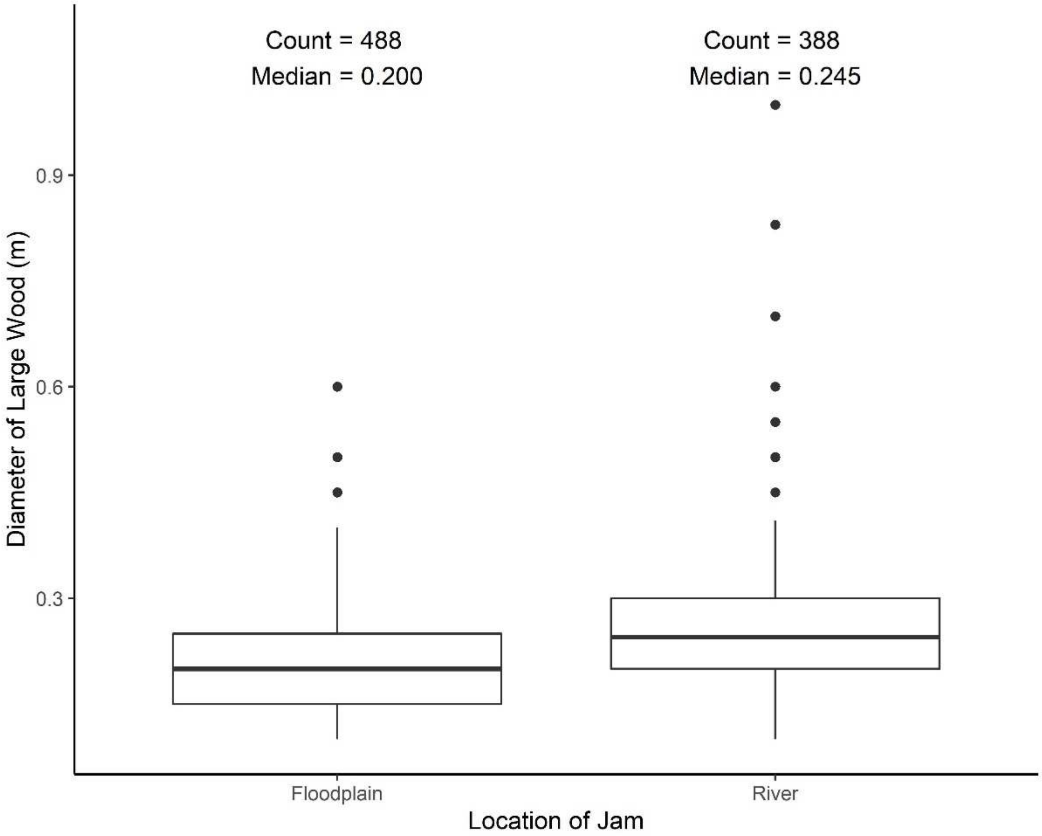


Figure 24. Comparison of diameter of large wood in floodplain and river jams (H4)

For H5 (burned pieces of LW in the river in most/all sub-reaches), I compiled the number of LW pieces in river jams by burn status of the sub-reaches (Figure 25), and by sub-reach and burn class of the LW itself (Figure 26). The burn class histogram (Figure 25) shows that there are all three burn classes of LW in both areas of the river, albeit there is more burned LW in the burned area by count. This indicates that burned wood from the burned area is being transported downstream to the unburned sub-reaches. The point plot (Figure 26) shows that there is indeed LW of burn class > 0 with each sub-reach of the river. **Thus, the results support H5** and the inference that LW in the river is transported both laterally from the floodplain to the river and longitudinally downstream. I also saw burned pieces of wood in the Merced River downstream of the study area, indicating that longitudinal connectivity stretches beyond Little Yosemite Valley.

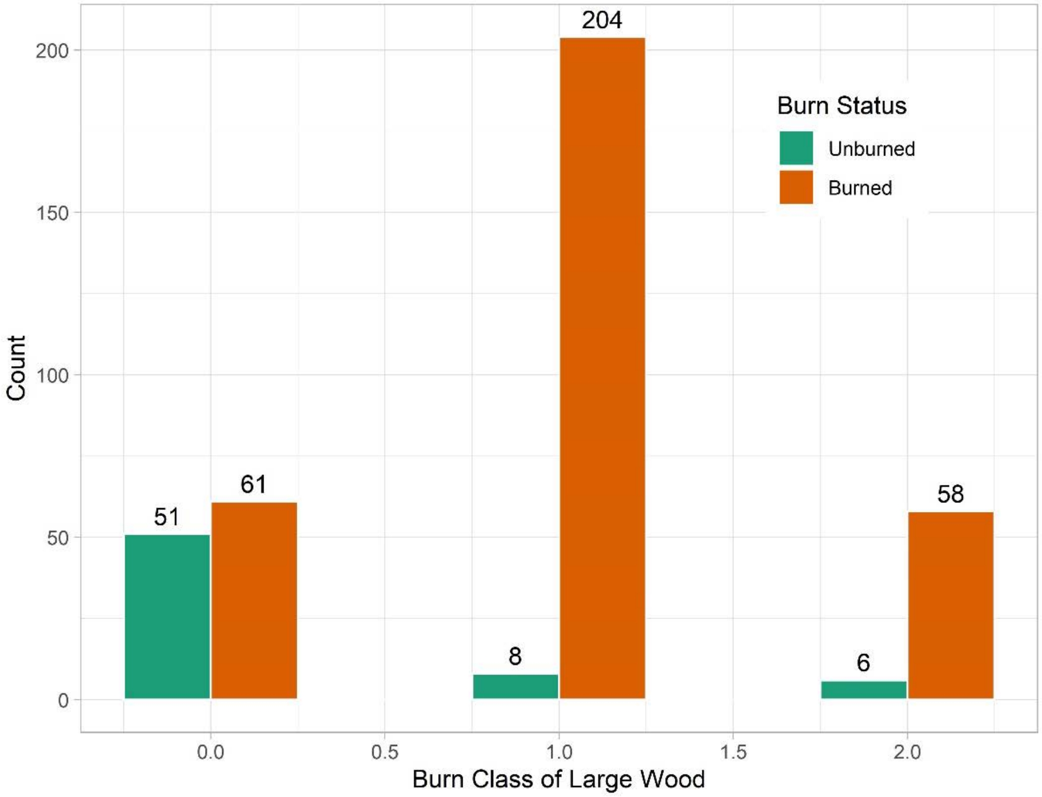


Figure 25. Burn class of large wood in river jams by sub-reach burn status (H5)

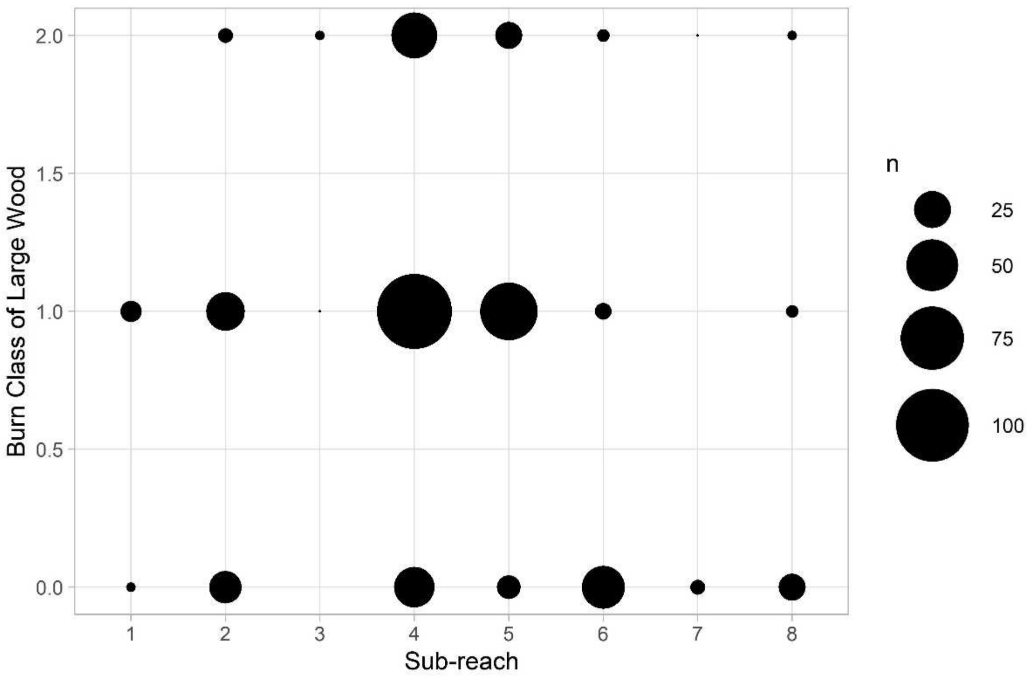


Figure 26. Burn class of large wood in river jams by sub-reach (H5)

For H6 (burned pieces of LW on the floodplain only in burned sub-reaches), I compiled the number of LW pieces in floodplain jams by burn status of the sub-reaches (Figure 27) and by sub-reach and burn class of the LW itself (Figure 28) (I only collected burn class data for in-jam LW). The histogram (Figure 27) shows that there is only one piece of burned LW in a jam in the unburned area of the floodplain. The point plot (Figure 28) shows that all in-jam LW has a burn class of 0 in the unburned sub-reaches (sub-reaches 6 through 8; except for one piece in a jam in sub-reach 7). **These results support H6** and the inference that the majority of movement of LW on the floodplain is lateral towards the river, and not longitudinal down the floodplain.

When Figure 26 is compared to Figure 28, it looks like a pattern of a lower number of river jams in sub-reaches 6 through 8 aligns with the lower number of floodplain jams in these sub-reaches. This could be due to the change in valley geometry previously described. Sub-reaches 7 and 8 also appeared to be transport reaches with a steeper gradient, which may account for the smaller number of river jams in these sections. Lastly, these figures show that there are no floodplain jams in sub-reaches 1 and 2. I believe this is because sub-reaches 1 and 2 were also transport reaches with a steeper gradient and narrower floodplain, leading to no floodplain jams. I hypothesize that if there were jams on the floodplain in these reaches, they would contain LW with burn classes > 0.

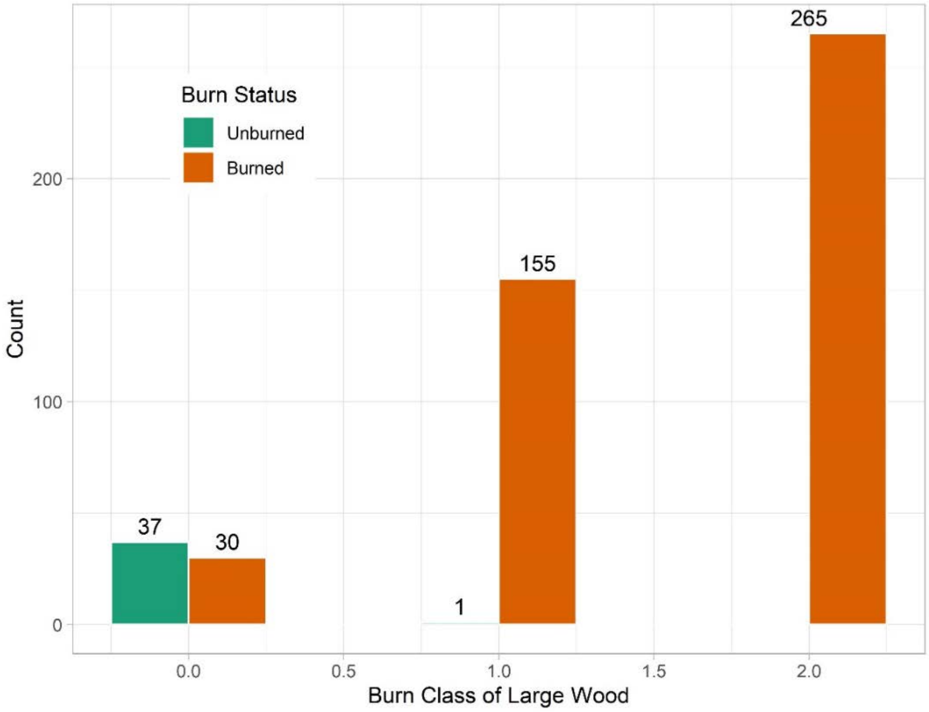


Figure 27. Burn class of large wood on the floodplain by sub-reach burn status (H6)

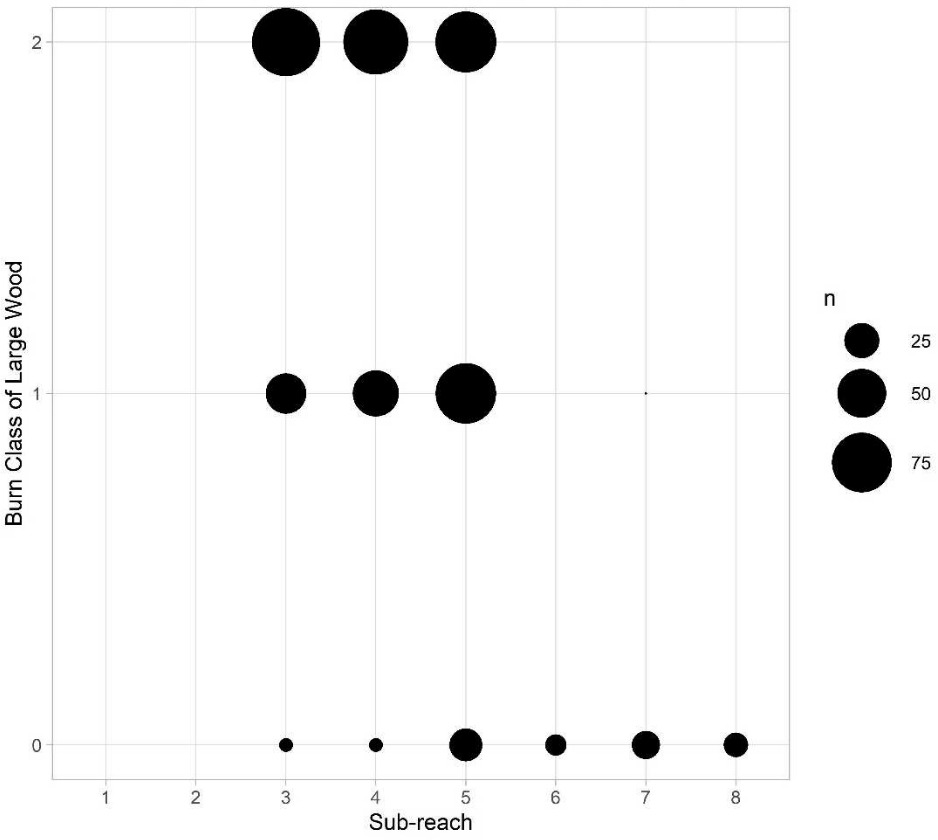


Figure 28. Burn class of large wood on the floodplain by sub-reach (H6)

For H7 (greater proportion of floodplain LW in jams in burned sub-reaches), I conducted three tests:

1. Comparison of the proportions of floodplain LW that were/were not in jams and in burned/unburned areas for the entire floodplain (Figure 29)
2. Comparison of the proportions of floodplain LW that were/were not in jams and in burned/unburned areas for just the first 50 m of the floodplain (Figure 30)
3. Comparison of the proportions of floodplain LW that were/were not in jams and in burned/unburned areas for just jams that formed within the first 50% of the floodplain width (Figure 31)

The results show that there is an association between being in a jam and in the burned area for Comparisons 1 and Comparison 2, but not for Comparison 3 (Table 22). The Chi Square p-values < 0.05 indicate that there is an association, and the odds ratio confidence intervals that do not include 1 show that the odds ratio is statistically significant. The odds ratio, λ, is the odds of a piece of LW being in a jam in the burned area is "λ" times as likely as the odds of a piece of LW being in a jam in the unburned area. For Comparison 1 (entire floodplain) and Comparison 2 (first 50 m of the floodplain), the odds of a piece of LW being in the burned area is more than two times as likely as in an unburned area. For Comparison 3 (first 50% of the floodplain), I fail to reject the null hypothesis that the odds of a piece of LW being in a jam is any different as in the unburned area. These results provide partial, mixed support for H7**.**

Table 9. Results of the Hypothesis Testing for H7

Comparison	**χ^2 p-value**	**Odds Ratio, λ**	**95% Confidence Interval**	**Significant?**
Full floodplain length	0.0013	2.11	(1.33, 3.34)	Yes
First 50 m of the floodplain	0.00013	2.63	(1.59, 4.34)	Yes
First 50% of the floodplain	0.42	1.26	(0.72, 2.20)	No

This is an interesting result because it is hard to tell whether H7 appropriately describes the field area. I think that the even greater odds of 2.63 for the first 50 m of the floodplain compared to 2.11 for the entire floodplain makes the case that the data support H7 stronger because this analysis does not include the jams on the widest part of the floodplain (widest floodplain width is 267.2 m for transect 4 in sub-reach 5). The results from Comparison 3 may or may not be useful because including jams that have traveled ≤ 50% of the floodplain width (calculated individually for each of the 32 transects) excludes only three jams from the Not Burned/In Jam group, but excludes 19 jams from the Not Burned/Not In Jam group. Because of this and the fact that some of the floodplain transects were very narrow, I am inclined to trust the results from Comparison 1 and Comparison 2. **Overall, these results support H7.**

Figure 29. Proportions of floodplain large wood in jams in (un)burned areas (H7)

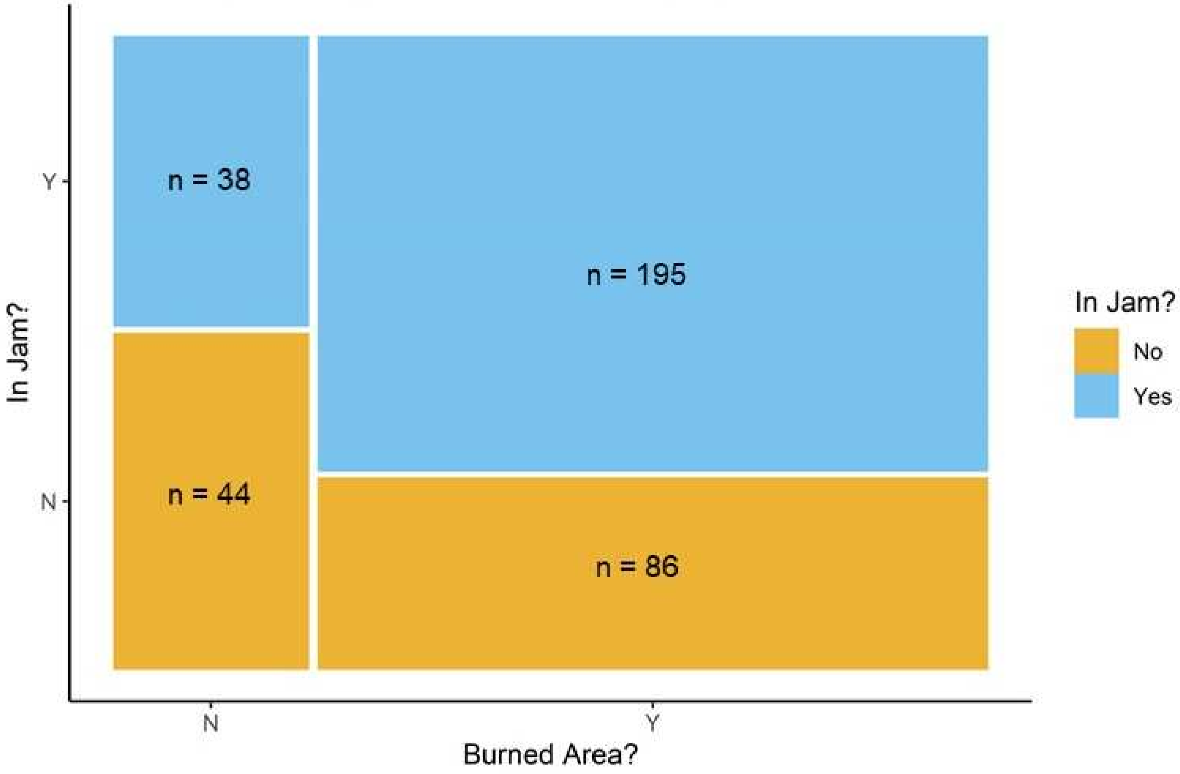


Figure 30. Proportions of floodplain large wood in jams in (un)burned areas - first 50 m (H7)

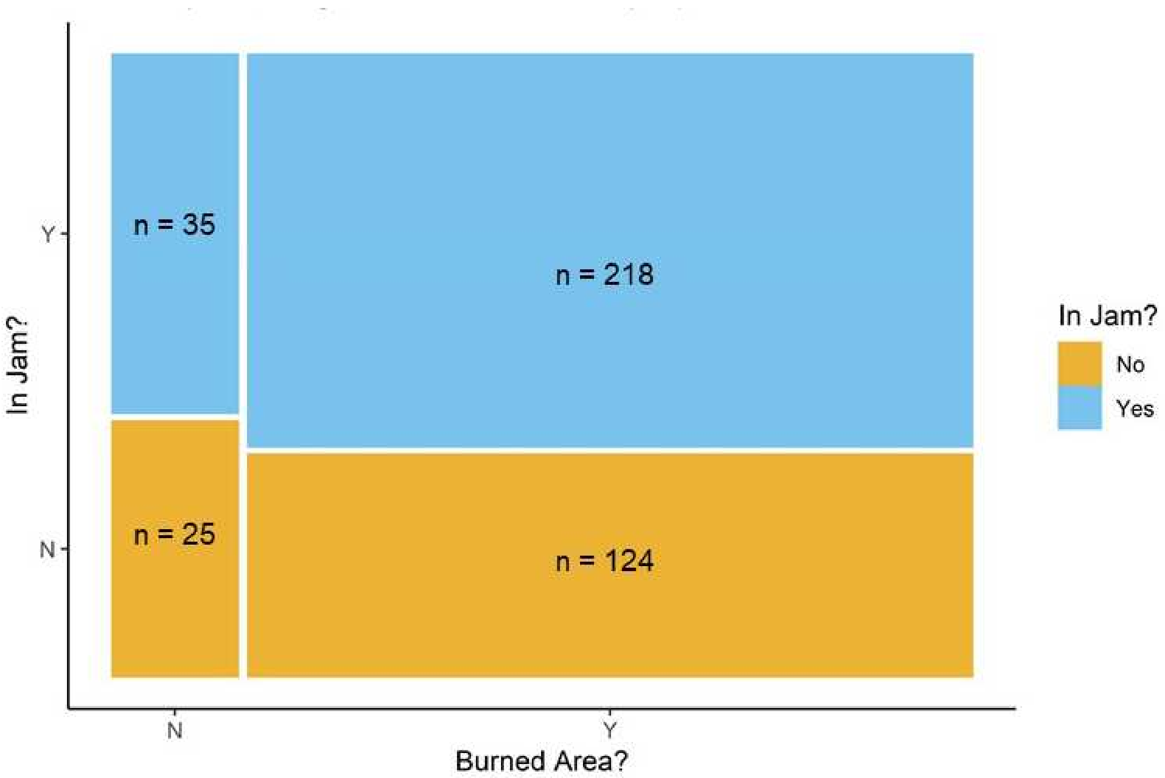


Figure 31. Proportions of floodplain large wood in jams in (un)burned areas - first 50% (H7)

In summary, the results do not support H1 and H2 as floodplain wood load and median LW piece diameter do not differ significantly between burned and unburned areas of the study reach. Additionally, the results do support H3 through H6 as more floodplain jams are located close to the channel; LW piece diameters are larger in river jams than in floodplain jams; and burned wood pieces are present in the channel throughout the study area, but they are only present in burned portions of the floodplain. The results partly support H7, indicating that a greater proportion of floodplain large wood may be in jams in the burned reaches. As previously discussed in the Exploratory Analysis, if trees do in fact have a significantly larger diameter at breast height closer to the river (e.g., due to access to more water year-round), then these results may not fully capture the complexity of this system and I may not be able to conclude that different mechanisms drive wood transport in the river and on the floodplain. Future studies may need to account for different standing tree diameters in the different parts of the river corridor.

5.4 Multivariate Analysis

I performed multivariate model selection on the transect data (Table 31 in the Appendices) to determine what, if any, variables are included in the model to predict floodplain LW load. I performed model selection using all subsets and AIC as the criterion three times: (1) all transect data, (2) only data from burned transects, and (3) only data from unburned transects Table 10). I natural log transformed all of the predictor variables (basal area, floodplain width, valley bottom width, valley bottom LW load, number of water features, and percent of LW pieces in jams) and square root transformed the response variable (floodplain LW load) in order to more closely meet the required model assumption of normality. While the assumptions required for the model are not completely met (Hess, 2019) and the basal area values sometimes represent the closest basal area measurement to the transect rather than being on the transect, the results provide some insight into what might be driving factors when it comes to floodplain wood load. There are different best-fitting models for all the data combined and for the burned/unburned data when separated (Table 10). The portion of LW in floodplain jams appears and is a significant variable in all of the best-fitting models. Basal area and number of water features are in the two models describing burned and unburned transects separately, though it is only significant for the burned transect model. Portion of LW pieces in floodplain jams represents the amount of aggregation of the LW along the transects. The significance of this variable may reflect the greater likelihood of forming jams when more downed wood is present on the floodplain, either from overbank transport of instream wood or from wood recruited from the floodplain forest (Beckman and Wohl, 2014b). Basal area represents local wood recruitment potential of standing trees (snags and living trees). Number of water features reflects the potential for concentrated transport of large wood during overbank flows. Water features may be particularly important as sites of concentrated overbank flow and wood deposition in the densely vegetated unburned portion of the floodplain. Consequently, although the models summarized in Table 10 explain around half of the variability in floodplain wood load, there is still much uncertainty when predicting floodplain wood load.

Table 10. Multivariate Analysis Results

Data Used	**Response Variable and Adjusted Multiple R^2**	**Predictor Variables in Model with Lowest AIC**	**Partial Regression Coefficients**	**p-values in Selected Model[1]**	**Importance in the Full Model**
Transformed transect data with burned and unburned transects	$\sqrt{\text{Floodplain LW load } (m^3/m^2)}$ $R^2 = 0.41$	Intercept	0.21	**2.2×10^{-12}**	NA
		ln[Portion of LW in Floodplain Jams]	0.0033	**0.0061**	0.96
		ln[Valley Bottom LW Load (m^3/m^2)]	0.0026	0.068	0.62
Transformed transect data with only burned transects	$\sqrt{\text{Floodplain LW load } (m^3/m^2)}$ $R^2 = 0.58$	Intercept	0.14	**0.00026**	NA
		ln[Basal Area (count)]	0.026	0.15	0.60
		ln[Number of Water Features (count)]	0.0035	**0.024**	0.68
		ln[Portion of LW in Floodplain Jams]	0.0034	**0.0020**	0.94
Transformed transect data with only unburned transects	$\sqrt{\text{Floodplain LW load } (m^3/m^2)}$ $R^2 = 0.60$	Intercept	-0.37	0.28	NA
		ln[Basal Area (count)]	0.072	0.18	0.48
		ln[Floodplain Width (m)]	0.11	0.22	0.48
		ln[Number of Water Features (count)]	-0.018	0.084	0.62
		ln[Portion of LW in Floodplain Jams]	0.011	**0.031**	0.80
		ln[Valley Bottom Width (m)]	0.014	0.16	0.71

[1] The bold p-values indicate statistical significance ($p\text{-value} < \alpha = 0.05$)

Diagnostic plots for each model are included as **Figure 36** through **Figure 38** in the Appendices.

5.5 Integrative Discussion

Overall, my results generally support my hypotheses and inferences regarding the movement and storage of LW in LYV (Figure 35). From my results, I can infer that there are indeed different processes driving the dynamics of LW on the floodplain versus in the river because I have shown that although floodplain jams can be present across the entire width of the floodplain, they tend to be concentrated near the channel (H3); river jams have larger diameter wood than floodplain jams (H4); burned wood was transported through all the sub-reaches by the river (H5) but not on the floodplain (H6); and there is some evidence that LW in burned areas is more likely to end up in a jam as opposed to LW in unburned areas (H7).

I observed a few patterns in the field that relate my results to the processes that drive LW dynamics in LYV. First, logjams marginal to the right bank of the Merced River seem to form in predicable places, specifically at the outside of meander bends in sinuous sections of the river where the slope is shallower, such as in sub-reaches 4 and 5. I also noticed significant bank cutting on the right side of the river near where these jams accumulate and key pieces in logjams are commonly connected to the bank by a root wad. This leads to the inference that there is increased tree mortality and fall into the river via bank cutting, causing wood accumulation in these locations (due to increased flow velocities on the outside of meander bends). This is reinforced by the results of H3 and H4 that show that floodplain logjams are closer to the riverbank and that river jams have larger pieces of wood. Knowing that logjams generally decrease flow velocities upstream, I expect that the bank cutting near the jam would decrease over the years after the jam has formed, decreasing direct input of LW into the river via tree fall. I believe that wood has been transported from the banks and nearby floodplain into the river and forms jams close to where it falls. I think that wood that is transported farther downstream from the location of fall often gets caught in these marginal jams or sinks to the bottom of the river, as I observed distinct jams along the margin and many individual pieces of LW in the middle of the river on the bed. Where the slope was steeper, such as in sub-reaches 7 and 8, I noticed smaller log jams and less bank cutting, potentially due to the higher flow velocities of the river transporting LW out of these sub-reaches and the exposure of erosionally resistant granitic bedrock.

Second, I observed many pieces of LW that were buried and had become part of the right bank of the river. I think that deposition of the LW in jams decreases flow velocities in the river and supports sediment deposition on the margins of the river and on the adjacent floodplain due to ponding/pooling of flow around the jam obstruction. I expect that interactions between river and floodplain flows of water and sediment eventually lead to the burial of jams and widening and stabilizing of the riverbank. This is supported by the results of H6 and H7 that use burned wood as an indicator for LW transport. Most likely, river jams become part of the riverbank as wood is transported downstream in the river and laterally across the floodplain, but not longitudinally down the floodplain. More data over a period of time would have to be collected to investigate this hypothesis. This discussion also leads to the hypothesis that there might be more buried wood near the river as opposed to farther away. Again, more data would have to be collected to investigate.

Third, many of the logjams on the floodplain were concentrated in or near side channels, secondary channels, and abandoned meanders. I think that, similar to the river, higher flow velocities on the floodplain in these distinct water features leads to competent transport of LW across the floodplain. Unlike in the river, I think there is more variable longitudinal and lateral flow on the floodplain due to the intermittency of its inundation and the interaction of the flow on the floodplain with flow in the river (laterally at the river margins and longitudinally at locations where return flow from the floodplain enters the river or). I think that these two-dimensional interactions lead to different patterns of deposition of LW on the floodplain. In some areas, I observed many jams that were longer than they were wide and were aligned perpendicular to the river corridor. These jams were often held in place by one or more standing trees/snags on the floodplain. I think that the overland flow could have caused long, narrow, jams that are nor very thick in the vertical direction via high velocities of flow interacting with high surface roughness of the floodplain. From the difference in shape of the logjams on the floodplain, I infer that flow on the floodplain decreases velocity faster than in the river. Although flow velocities may be higher in the river than on the floodplain, I think that the rate of change of the flow velocity (acceleration) is higher on the floodplain.

Along with inferring the processes contributing to LW recruitment, transport, and deposition based on field observations, it should be noted that the patterns of LW observed are time-dependent, particularly in the burned zone, in regard to the time since wildfire and time since last high flow that significantly inundated the floodplain. I have prepared a brief demonstrative model of LW loads on the floodplain and in the river incorporating time as the independent variable in relation to wildfire (Figure 32). This model is based on wood loads changing over an interval of 100 years (Wohl, 2011), a bimodal input of wood to the riparian forest with a second similarly-sized peak after 30 years when the snags fall (Bragg, 2000), a bimodal input of wood to the river with a small peak right after the fire and a large peak 30 years after (Bragg, 2000), and 255 years for a forest to reach steady state post de-snagging (Stout et al., 2018). Due to the lack of data for California forests and the fact that wood loads can differ greatly depending the region, species composition, and many other river corridor characteristics, no values or units are given on the y-axis. The effects of wildfire on a forest are dependent on not only the characteristics of the fire, as previously mentioned, but also on drought history, beetle kill history, previous history of fire suppression and/or maintenance fires, resistance of trees to fire, rate of tree regrowth, and the pre-fire spatial diversity of the forest (Turner, 2010; Kocher, 2015; National Park Service, 2020).

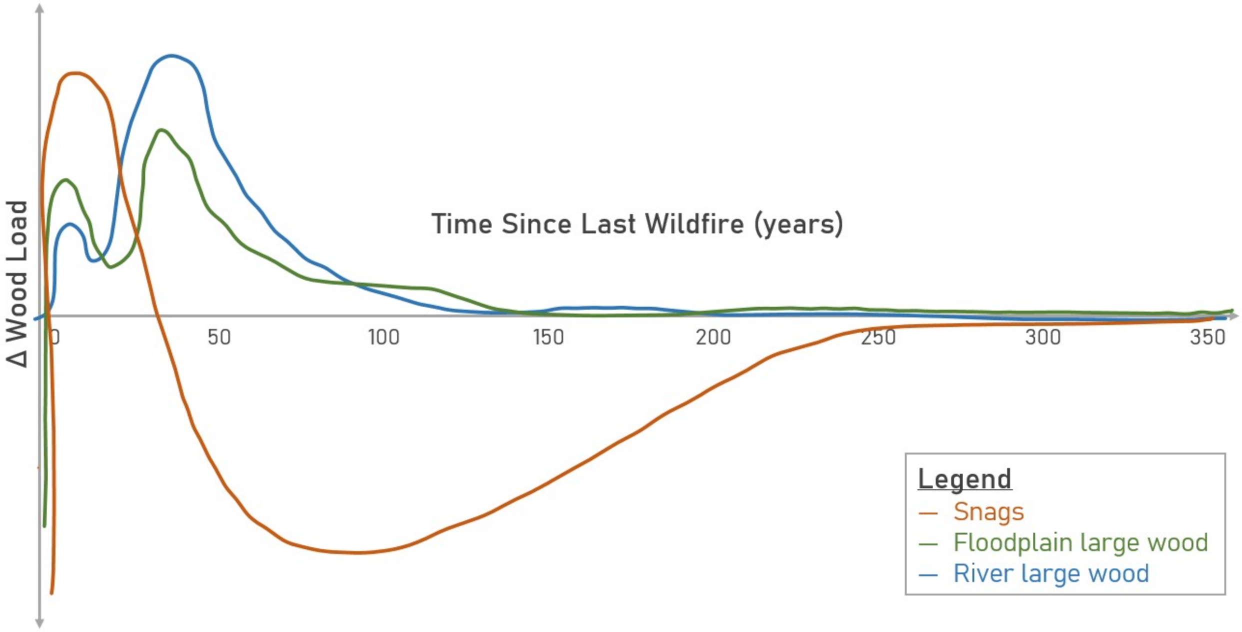


Figure 32. Demonstrative Model of Change in Wood Loads Post-Wildfire. Based on Bragg (2000), Wohl (2011), and Stout et al. (2018)

Comparing my wood load values to published values, my floodplain and valley bottom values are higher than many of the available published data of channel wood loads around the world (Table 11, Figure 33) (Wohl, 2020). It should be noted that because I only measured right-bank and channel-spanning logjams in the river, and only measured floodplain and valley LW along right-side transects, my results may be skewed. If there happens to be a greater wood load on the right side of the river corridor, then my values overestimate how much wood is in Little Yosemite Valley. Because my values are already higher than most of the published values, I expect that in this case the "true" loads are still higher than at other sites. If the right bank river wood loads are an underestimate for the river corridor as a whole, then the conclusion that my values are higher than published values is still valid. Applying the same volume-per-area wood loads to the left bank as calculated for the right bank floodplain (Area $_{\text{left bank}}$ = 0.53 km^2 = 53 ha;

roughly estimated in Google Earth) gives a wood volume of approximately 13,300 ± 11,700 m^3 (1 standard deviation). As the standard deviations of my results are high, I expect that the error in measuring wood load is also high. The greatest source of error is in how the floodplain was sampled. Although the transects were randomly spaced along each sub-reach in order to avoid any bias, the fact remains that one large logjam on a transect increases the measured wood load for that transect. In order to minimize this error in future studies, I suggest choosing a small area of the floodplain and measuring all of the wood in that area. While this is time and energy intensive, it would provide a more constrained estimate of actual floodplain wood loads.

The range of forest types, ecosystems, and locations around the world that my values are similar to is broad and indicates that LW load varies dramatically from forest to forest. I think we very much need more data on the wood load of river corridors around the world in order to begin to characterize patterns of wood load. Additionally, as previously discussed, wood load can be very localized and punctuated across a landscape (Figure 15). I think it is therefore important to recognize that mean/median values of wood load may not be the best statistic to present. I propose also presenting the standard deviation in order to capture some of the variability in each dataset (Table 11 and Table 12).

Table 11. Comparison of Mean Large Wood Loads from Around the World

Location	**$\overline{\text{Floodplain WL}}$ (m^3/ha)**	**$\overline{\text{Valley Bottom WL}}$ (m^3/ha)**
Little Yosemite Valley Study Area, *upper montane conifer forest*	250 Standard Deviation = 220	150 Standard Deviation = 220
Alaska, *boreal lowlands* [1]	42.3 ± 4.6	8[1]
Colorado, *semi-arid mountains* [1]	116.3 ± 16.1	12.4 -188.8
South Carolina, *subtropical lowlands* [1]	50.4 ± 5.0	11.7-15.8
Northern Sweden, *old-growth boreal conifer* [1]	67.8	18.5
Central Coast of Mexico, *tropical dry* [1]	28.4	17.7
Western Amazon of Peru, *tropical wet* [1]	42.8 ± 20.1	74.7-108.8
New Mexico, *semiarid montane conifer* [2]	68	-
California, *redwood* [2]	743	-
Montana, *montane conifer* [2]	430-490	-
Northern Colorado, *semiarid temperate montane conifer* [3]	66	15
Northern Colorado, *semiarid temperate subalpine conifer* [3]	70	70-130
Southern Colorado, *semiarid subalpine temperate conifer* [3]	128	12-189
Wyoming, *semiarid temperate subalpine conifer* [3]	190	160
Southwestern Colorado, *semiarid temperate montane conifer* [3]	198	15
Southeastern Australia, *semiarid temperate eucalyptus* [3]	250	-
Oregon, *humid temperate conifer* [3]	380	12-76
Washington, *humid temperate conifer* [3]	422	5-86
Washington, *humid temperate rainforest conifer* [3]	88-289	46

Note that the global values used for comparison have, in some cases drastic, differently sized channels (and associated floodplains), making this comparison not congruent.

[1] Data from Lininger et. al (2017) summary

[2] Data from Wohl et. al (2018) summary

[3] Data from Wohl (2020) summary

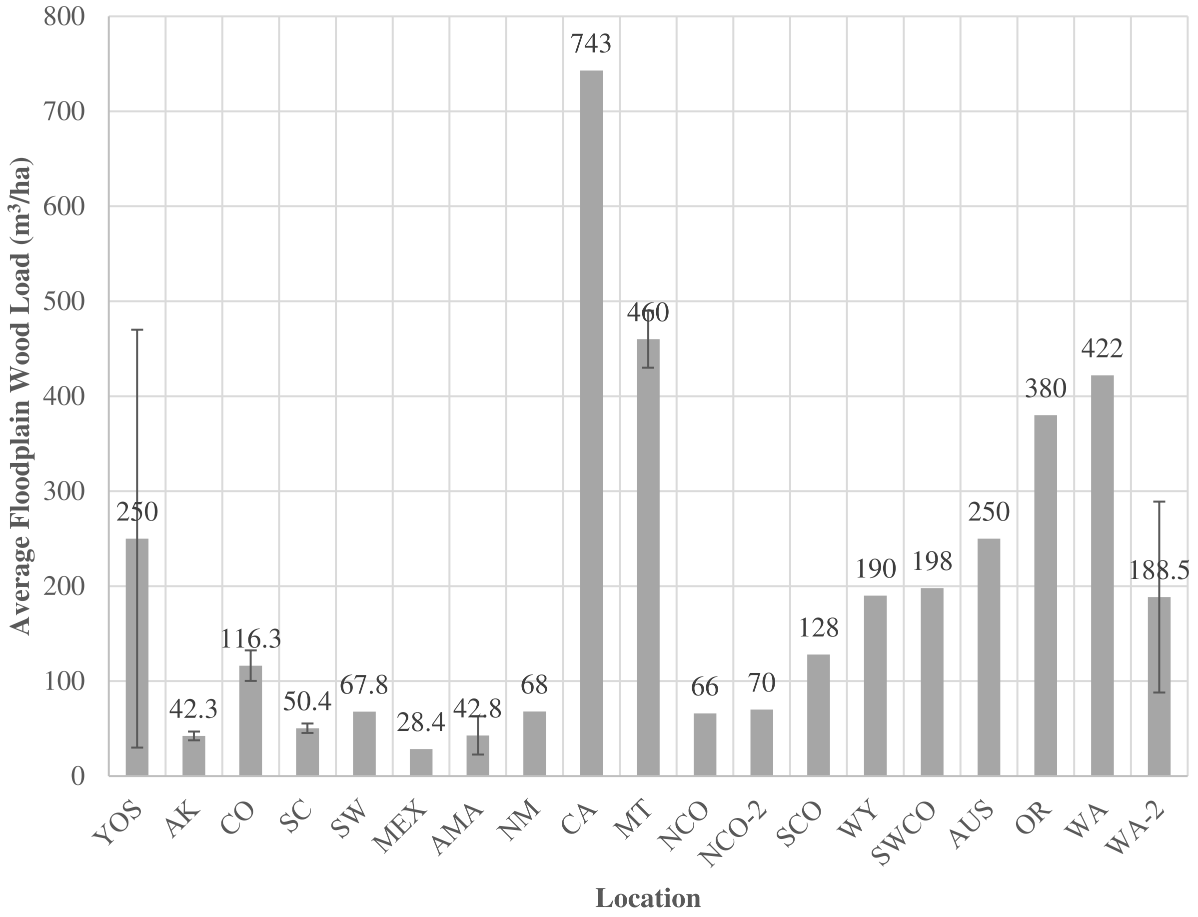


Figure 33. Graphical representation of Table 11. YOS = Yosemite Study Area, AK = Alaska, CO = Colorado, SC = South Carolina, SW = Northern Sweden, MEX = Central Coast of Mexico, AMA = Western Amazon of Peru, NM = New Mexico, CA = California, MT = Montana, NCO = Northern Colorado (montane), NCO-2 = Northern Colorado (subalpine), SCO = Southern Colorado, WY = Wyoming, SWCO = Southwestern Colorado, AUS = Southeastern Australia, OR = Oregon, WA = Washington (conifer), WA-2 = Washington (rainforest conifer) . Values shown by the grey bars are the average floodplain wood loads, the vertical bars represent the standard deviation (YOS), the range of the data (MT, WA-2), or the ± given with the published data (AK, CO, SC, AMA). The other locations did not have a range or standard deviation reported.

Lastly, comparing wood loads to one other site with fire history (the Yukon River in Alaska) shows that the wood loads on the Merced River floodplain are much higher, but have similarly large standard deviations (Table 12, Figure 34). The Alaskan wood loads are also higher in the burn zone, which is the opposite of the Yosemite data. The higher values in the burn zone along the Yukon River likely reflect two factors. First, fires in this region tend to be of very low intensity, leaving many standing dead trees that gradually topple and add to the floodplain wood load and creating incomplete combustion of existing downed wood at the time of the fire. Second, downed wood has an extremely slow rate of decomposition in the cold, dry conditions of the Yukon River site (Lininger et al., 2017). Again, more data are needed to determine the direct and indirect impacts of fire on floodplains.

Table 12. Comparison of Floodplain Large Wood Loads in Burned and Unburned Location

Location	**Burn Status**	**Sample Size, n**	**$\overline{\text{Floodplain WL}}$ (m^3/ha)**	**Median Floodplain WL (m^3/ha)**	**Standard Deviation (m^3/ha)**
Merced River, Little Yosemite Valley Study Area, *upper montane conifer forest*	Burned	20	230	200	170
	Unburned	12	300	280	290
Yukon River, Alaska, *white spruce forest* [1]	Burned	5	97	49	81
	Unburned	23	42	29	33

[1] Data from Lininger et al. (2017, and pers. comm. 2020)

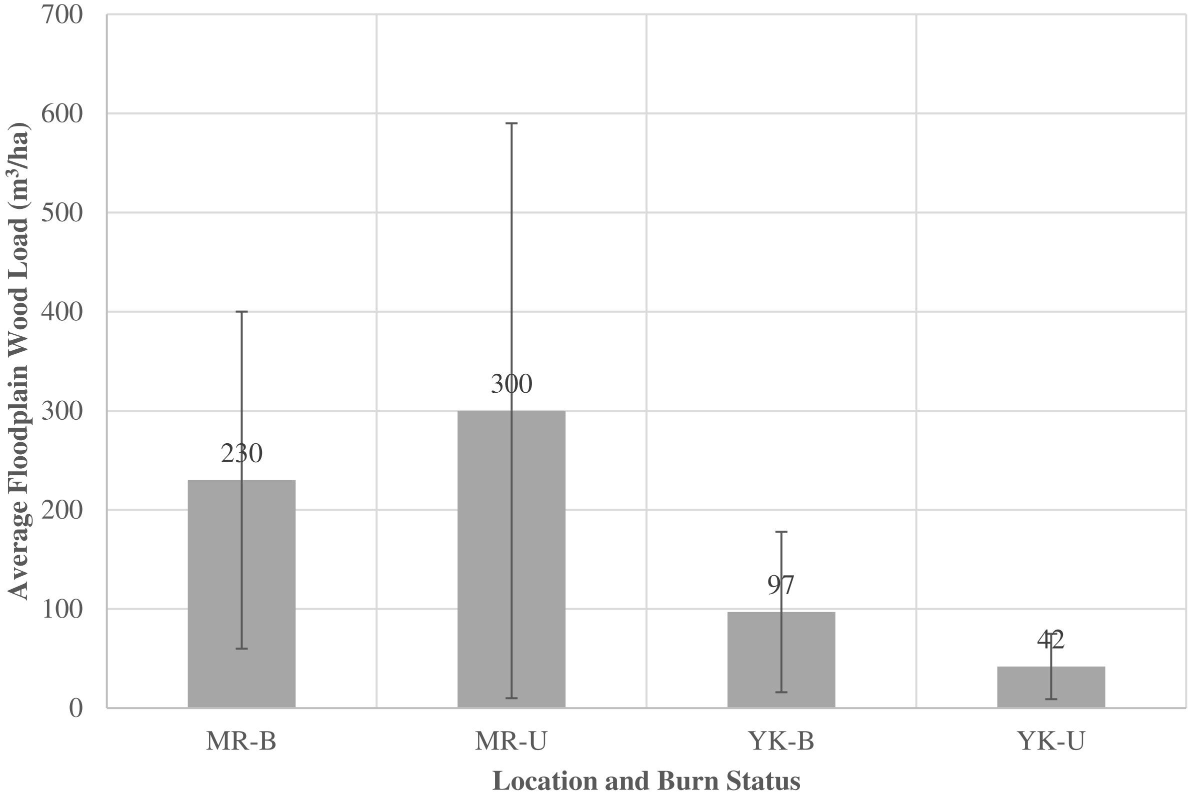


Figure 34. Graphical representation of Table 12. Values shown by the grey bars are the average floodplain wood loads, the vertical bars represent standard deviation. MR stands for Merced River, YR stands for Yukon River, B stands for Burned, and U stands for Unburned.

I have also shown that although the recent fire in the study area is associated with wider floodplains and valley bottoms, that there might be either no net effect or more complicated interactions occurring resulting in no difference in the diameter of LW and wood load in burned versus unburned areas. I think that in order to determine the impacts of wildfire on floodplains, multiple sites should be tested to evaluate whether the fire is causing significant differences or whether observed differences are related to something else (like the change in valley-bottom geometry at this field site). Additionally, having sites with different fire histories would shed light on how the frequency, severity, and duration of fires specifically affects floodplains, as previous research shows contradicting results.

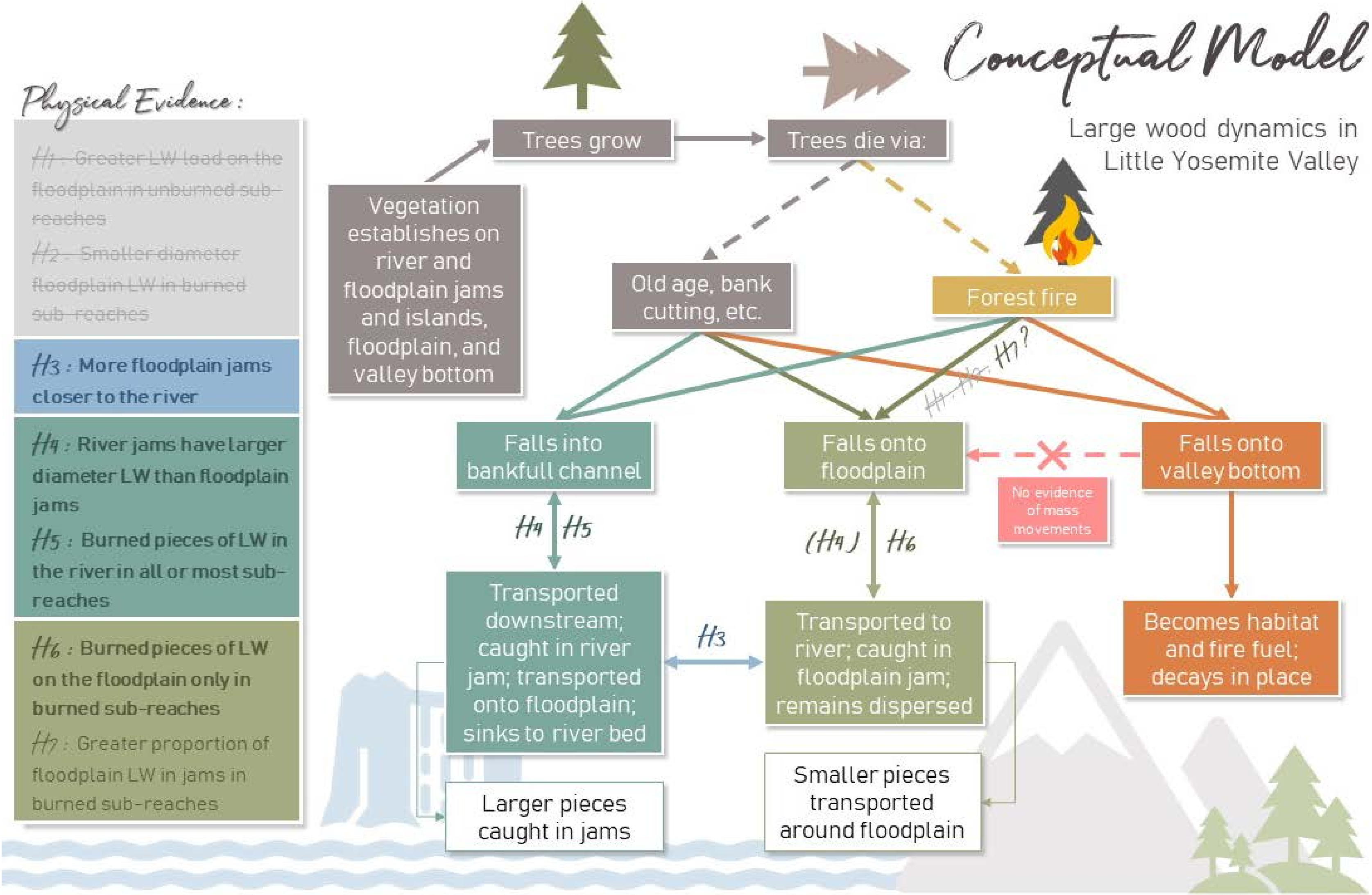


Figure 35. Revised conceptual model with supported hypotheses

Through the multivariate analysis, I have shown that the best fitting models differ for all of the data combined, just the burned transects, and just the unburned transects. This indicates that fire could influence the overall floodplain wood load. Additionally, the results show that there are a few potential predictor variables that would make good subjects of future research, such as basal area, floodplain water features, and valley bottom wood load (even though my study area did not have evidence of LW movement from the valley bottom to the floodplain).

Overall, I cannot conclude from my data analysis that fire is a significant influence on wood loads. There are, however, patterns that arise in LW on the floodplain that are distinctly different from those in the bankfull channel (spacing and location of jams, size of LW that is in jams, etc.). Additionally, I observed many distinct side channels and abandoned meanders on the floodplain that no doubt complicate overbank LW transport and resulting spatial patterns. With this in mind, I think that the geomorphic effects of LW on the floodplain are more complicated than those in the river because the floodplain is seasonally inundated and the LW comes in contact with the floodplain surface and associated local decreases in transport capacity more often than LW that is in a perennial river. Ecologically, I think that there could be additional benefits of LW on the floodplain that moves primarily in the lateral direction, whereas wood in the river moves primarily longitudinally. Lateral movement across the floodplain of LW and the flora and fauna that inhabit the floodplain could increase exchanges of biomass and carbon between the river and floodplain. This movement could also increase biodiversity, as populations may adapt to both floodplain and channel habitats. In summary, there is much left to be discovered about LW and floodplains and how naturally operating ecosystems function in the wild.

6. CONCLUSION

6.1 Return to the Research Questions

My objective was to address the following two research questions:

1. How much wood is in the Merced River corridor in Little Yosemite Valley (LYV), and how is it spatially distributed (in jams or dispersed, distance from the river)?
2. Do characteristics of LW on the floodplain (wood load, diameter) differ for burned and unburned areas?

I was able to quantify the wood load of LYV for the bankfull channel (82 m^3/ha, a minimum as I was only able to measure right-bank and channel-spanning logjams), floodplain (250 m^3/ha), and valley bottom (150 m^3/ha). I compared my estimates of wood load to published global data, recognizing that the rivers I used for comparison varied (sometimes drastically) in size to the upper Merced River. I was also able to describe the spatial distribution of that wood. I found that characteristics of LW do not differ for burned and unburned areas except for the proportion of LW in jams (65% in jams in burned areas and 46% in jams in unburned areas) (Figure 29). As discussed earlier, more data at more diverse sites with varying fire history would need to be collected to dig into this question further.

6.2 Future Research, Applications & the National Park Service

This study scratched the surface of the LW dynamics in river corridors and the effects of fire on those dynamics. There are many questions that my results lead to, including the following ideas for future research and application questions:

- Wood loads in other California rivers – do the results compare?

- Is there a better way to measure floodplain wood loads to minimize error and maximize time and energy efficiency?
- What is the residence time of LW in the river versus the floodplain versus the valley bottom? (for the Merced River and others)
- Can a two-dimensional flow model accurately depict the hydraulics of the channel-floodplain boundary and provide insight into the processes that control lateral transport of LW?
- Effects of LW placement on the floodplain and applications to river restoration (e.g. can smaller LW be an effective tool for floodplain restoration?)
- Does adding LW to the valley bottom aid in transport of LW to the floodplain and river? If so, at what spatiotemporal scales?
- Direct and indirect effects of fire on the floodplain?
- When does fire increase wood loads and when does it decrease them? When does fire increase floodplain heterogeneity and when does it decrease it?
- How long does it take river corridors to recover from fire? Is “full” recovery possible or necessary for the river corridor to perform the same geomorphic and ecosystem functions?
- Could fire be a river restoration tool? That is, could fire be used to restore LW regimes in river corridors? This follows from the idea that burned LW might be more physically resistant to decay and therefore persistent, but also potentially less biochemically available.
- What characterizes natural heterogeneity of floodplains? (This will constitute my PhD work.)

Additionally, this work brings to mind some educational opportunities around LW, floodplains, and fire both in Yosemite and in other National Parks. I think that some signs, in LYV but also other areas of Yosemite, pointing out features of dispersed LW and logjams and the benefits they have for river corridors would go a long way to changing the public's perspective on where wood should and should not be in a natural ecosystem. There are many beautiful natural floodplains in Yosemite National Park that could be the source of learning about lateral and longitudinal connectivity of a river corridor. Lastly, most Californians like myself, and in fact people from around the world, are cognizant of the impact of wildfire in the state. Yosemite's long and varied fire history presents an opportunity for park-goers to collect their own data about what they see comes back after a fire.

There are many opportunities for research and education around LW, floodplains, and fire in river corridors, and I hope my work is just the beginning of such research in California.

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APPENDICIES

Data Acknowledgement

Figure 9 Dataset Acknowledgement: Lidar data acquisition and processing completed by the National Center for Airborne Laser Mapping (NCALM - http://www.ncalm.org). NCALM funding provided by NSF's Division of Earth Sciences, Instrumentation and Facilities Program. EAR-1043051.

Summarized & Raw Field Data

In the summary tables (Table 13 through Table 21), “var” means variance and “sd” means standard deviation (for other abbreviations, refer to Table 4). The field data are given in Table 22 through Table 30.

Table 13. Summary of River Large Wood

SR	n	$\bar{D}$	Median D	var	sd	$\overline{BC}$	Median BC	var	sd
1	10	0.26	0.27	0.00	0.07	0.80	1	0.18	0.42
2	50	0.30	0.30	0.02	0.15	0.70	1	0.38	0.61
3	3	0.21	0.20	0.00	0.02	1.67	2	0.33	0.58
4	175	0.27	0.25	0.02	0.12	1.05	1	0.39	0.63
5	85	0.28	0.25	0.02	0.15	1.04	1	0.27	0.52
6	42	0.23	0.20	0.02	0.13	0.26	0	0.34	0.59
7	5	0.24	0.20	0.01	0.10	0.40	0	0.80	0.89
8	18	0.25	0.20	0.02	0.13	0.39	0	0.49	0.70

Abbreviations: Sub-reach (SR), sample size (n), diameter (D), burn class (BC)

Table 14. Summary of River Jams

SR	n	$\overline{\text{Piece Volume}}$	Median Piece Volume	var	sd
1	2	0.68	0.68	0.02	0.13
2	3	9.92	1.59	243.91	15.62
3	1	0.61	0.61	NA	NA
4	11	7.93	4.12	95.50	9.77
5	9	4.37	1.48	21.07	4.59
6	9	1.29	0.97	2.52	1.59
7	1	5.50	5.50	NA	NA
8	2	3.60	3.60	0.03	0.17

Table 15. Summary of Floodplain Large Wood

SR	n	$\bar{D}$	Median D	var	sd	$\overline{DR}$	Median DR	var	sd
1	10	0.21	0.10	0.04	0.20	16.71	15.70	90.56	9.52
2	46	0.26	0.20	0.02	0.13	45.97	44.90	641.23	25.32
3	179	0.19	0.20	0.01	0.09	64.07	64.00	1018.69	31.92
4	201	0.22	0.20	0.01	0.09	67.09	49.80	1483.75	38.52
5	261	0.22	0.20	0.01	0.11	81.94	76.80	3113.65	55.80
6	38	0.21	0.20	0.01	0.10	12.50	9.50	101.35	10.07
7	25	0.22	0.20	0.01	0.10	15.82	10.00	137.22	11.71
8	19	0.20	0.20	0.01	0.10	3.57	2.20	8.34	2.89

New abbreviations: Distance from river (DR)

Table 16. Summary of Floodplain Jams

SR	n	$\overline{\text{Piece Volume}}$	Median Piece Volume	var	sd	$\overline{DR}$	Median DR	var	sd
3	6	3.93	1.64	28.06	5.30	43.42	42.00	1026.24	32.04
4	5	3.86	3.53	2.89	1.70	78.48	62.00	1950.44	44.16
5	11	3.33	1.42	12.23	3.50	75.50	74.70	2990.97	54.69
6	3	0.48	0.44	0.06	0.25	11.03	9.50	120.57	10.98
7	1	1.54	1.54	NA	NA	10.00	10.00	NA	NA
8	2	0.51	0.51	0.06	0.24	1.75	1.75	0.41	0.64

Table 17. Summary of Valley Bottom Large Wood

SR	n	$\overline{D}$	Median D	var	sd	$\overline{DR}$	Median DR	var	sd
1	14	0.25	0.23	0.02	0.15	40.89	41.00	88.91	9.43
2	9	0.24	0.25	0.02	0.14	92.40	98.60	125.24	11.19
3	7	0.28	0.25	0.01	0.11	110.19	112.00	446.64	21.13
4	63	0.21	0.15	0.01	0.10	206.43	195.00	2619.88	51.18
5	72	0.22	0.20	0.01	0.11	283.03	276.95	8996.15	94.85
6	2	0.13	0.13	0.00	0.04	30.75	30.75	4.80	2.19
7	6	0.28	0.30	0.00	0.07	45.75	45.90	1.23	1.11
8	5	0.38	0.30	0.07	0.26	12.24	11.90	17.00	4.12

Table 18. Summary of Floodplain and Valley Bottom Water Features

SR	n	$\overline{D}$	Median D	var	sd	$\overline{DR}$	Median DR	var	sd
1	6	3.17	2.75	2.47	1.57	26.87	26.65	70.48	8.40
2	11	2.94	2.30	5.74	2.40	47.13	50.60	491.73	22.18
3	14	20.01	7.40	1075.24	32.79	57.49	48.00	2250.14	47.44
4	15	17.13	9.50	243.36	15.60	67.63	51.70	2329.91	48.27
5	21	9.97	3.50	406.90	20.17	139.15	92.30	15718.39	125.37
6	2	5.70	5.70	5.78	2.40	23.35	23.35	174.85	13.22
7	1	3.20	3.20	NA	NA	41.20	41.20	NA	NA

Table 19. Summary of River, Floodplain, and Valley Bottom Widths

Location	Burned?	n	$\overline{\text{Width}}$	Median Width	var	sd
R	No	53	31.21	30.70	28.59	5.35
R	Yes	62	33.52	30.90	147.79	12.16
FP	No	53	11.50	7.50	122.61	11.07
FP	Yes	46	105.19	107.30	3298.94	57.44
VB	No	46	7.00	2.40	403.68	20.09
VB	Yes	45	104.96	121.10	7144.75	84.53

New abbreviations: Bankfull channel/river (BF), floodplain (FP), valley bottom (VB)

Table 20. Summary of Large Wood Loads

SR	Location	n	$\overline{WL}$	Median WL	var	sd
1	BF	1	0.0003	0.0003	NA	NA
1	FP	4	0.0100	0.0056	0.0002	0.0128
1	VB	4	0.0191	0.0160	0.0004	0.0192
2	BF	1	0.0015	0.0015	NA	NA
2	FP	4	0.0142	0.0155	0.0001	0.0108
2	VB	4	0.0282	0.0192	0.0010	0.0323
3	BF	1	0.0001	0.0001	NA	NA
3	FP	4	0.0276	0.0222	0.0006	0.0243
3	VB	4	0.0125	0.0117	0.0001	0.0111
4	BF	1	0.0020	0.0020	NA	NA
4	FP	4	0.0263	0.0262	0.0001	0.0107
4	VB	4	0.0071	0.0087	0.0000	0.0048
5	BF	1	0.0016	0.0016	NA	NA
5	FP	4	0.0342	0.0383	0.0002	0.0153
5	VB	4	0.0109	0.0086	0.0000	0.0067
6	BF	1	0.0589	0.0589	NA	NA
6	FP	4	0.0231	0.0240	0.0004	0.0205
6	VB	4	0.0009	0.0000	0.0000	0.0019
7	BF	1	0.0005	0.0005	NA	NA
7	FP	4	0.0157	0.0129	0.0003	0.0186
7	VB	4	0.0227	0.0000	0.0021	0.0453
8	BF	1	0.0009	0.0009	NA	NA
8	FP	4	0.0508	0.0351	0.0014	0.0378
8	VB	4	0.0209	0.0117	0.0008	0.0279

New abbreviations: Wood load (WL)

Table 21.Summary of All Large Wood Measured

SR	Location	n	$\bar{D}$	Median D	var	sd
1	BF	10	0.26	0.27	0.00	0.07
1	FP	10	0.21	0.10	0.04	0.20
1	VB	14	0.25	0.23	0.02	0.15
2	BF	50	0.30	0.30	0.02	0.15
2	FP	46	0.26	0.20	0.02	0.13
2	VB	9	0.24	0.25	0.02	0.14
3	BF	3	0.21	0.20	0.00	0.02
3	FP	179	0.19	0.20	0.01	0.09
3	VB	7	0.28	0.25	0.01	0.11
4	BF	175	0.26	0.25	0.02	0.12
4	FP	201	0.22	0.20	0.01	0.09
4	VB	63	0.21	0.15	0.01	0.10
5	BF	85	0.27	0.25	0.02	0.15
5	FP	261	0.22	0.20	0.01	0.11
5	VB	72	0.22	0.20	0.01	0.11
6	BF	42	0.23	0.20	0.02	0.13
6	FP	38	0.21	0.20	0.01	0.10
6	VB	2	0.13	0.13	0.00	0.04
7	BF	5	0.24	0.20	0.01	0.10
7	FP	25	0.22	0.20	0.01	0.10
7	VB	6	0.28	0.30	0.00	0.07
8	BF	18	0.25	0.20	0.02	0.13
8	FP	19	0.20	0.20	0.01	0.10
8	VB	5	0.38	0.30	0.07	0.26
	Total:	**1345**				

Table 22. River Large Wood Data

SR	B?	DR	D	L	BC	J?
1	Y	0	0.41	3.1	1	Y
1	Y	0	0.27	1.3	1	Y
1	Y	0	0.28	1.7	1	Y
1	Y	0	0.32	1.3	1	Y
1	Y	0	0.2	1.1	0	Y
1	Y	0	0.2	1.5	0	Y
1	Y	0	0.2	3.4	1	Y
1	Y	0	0.29	3.4	1	Y
1	Y	0	0.26	1.58	1	Y
1	Y	0	0.2	5.1	1	Y

SR	B?	DR	D	L	BC	J?
2	Y	0	0.83	2.6	2	Y
2	Y	0	0.21	2.8	1	Y
2	Y	0	0.17	1.3	1	Y
2	Y	0	0.22	1	0	Y
2	Y	0	0.11	2	0	Y
2	Y	0	0.18	3.6	1	Y
2	Y	0	0.3	1.9	1	Y
2	Y	0	0.1	2	1	Y
2	Y	0	0.4	10	1	Y
2	Y	0	0.4	8	1	Y
2	Y	0	0.5	15	0	Y
2	Y	0	0.4	10	1	Y
2	Y	0	0.6	8	2	Y
2	Y	0	0.4	11	0	Y
2	Y	0	0.15	11	1	Y
2	Y	0	0.25	6	0	Y
2	Y	0	0.2	7	1	Y
2	Y	0	0.3	3	0	Y
2	Y	0	0.5	3	0	Y
2	Y	0	0.2	7	1	Y
2	Y	0	0.4	15	1	Y
2	Y	0	0.3	15	1	Y
2	Y	0	0.2	10	1	Y
2	Y	0	0.2	6	2	Y
2	Y	0	0.3	3	0	Y
2	Y	0	0.2	2	0	Y
2	Y	0	0.3	3	1	Y
2	Y	0	0.2	2	1	Y
2	Y	0	0.45	4	0	Y
2	Y	0	0.25	3	0	Y
2	Y	0	0.45	12	1	Y
2	Y	0	0.4	4	0	Y
2	Y	0	0.3	3	1	Y
2	Y	0	0.2	5	1	Y
2	Y	0	0.7	10	1	Y
2	Y	0	0.3	3	0	Y
2	Y	0	0.3	3	0	Y
2	Y	0	0.3	3	0	Y
2	Y	0	0.2	3	2	Y
2	Y	0	0.1	4	0	Y
2	Y	0	0.3	10	1	Y

SR	B?	DR	D	L	BC	J?
2	Y	0	0.1	6	1	Y
2	Y	0	0.3	15	1	Y
2	Y	0	0.2	10	1	Y
2	Y	0	0.3	12	1	Y
2	Y	0	0.3	2	0	Y
2	Y	0	0.2	2	1	Y
2	Y	0	0.2	3	0	Y
2	Y	0	0.2	5	0	Y
2	Y	0	0.4	4	1	Y
3	Y	0	0.24	8	1	Y
3	Y	0	0.2	6	2	Y
3	Y	0	0.2	2	2	Y
4	Y	0	0.4	10	1	Y
4	Y	0	0.5	8	1	Y
4	Y	0	0.3	6	0	Y
4	Y	0	0.1	4	0	Y
4	Y	0	0.2	3	1	Y
4	Y	0	0.5	12	1	Y
4	Y	0	0.5	4	1	Y
4	Y	0	0.2	8	0	Y
4	Y	0	0.3	8	2	Y
4	Y	0	0.2	3	1	Y
4	Y	0	0.2	2	0	Y
4	Y	0	0.2	7	1	Y
4	Y	0	0.35	8	1	Y
4	Y	0	0.2	7	1	Y
4	Y	0	0.2	5	0	Y
4	Y	0	0.3	12	1	Y
4	Y	0	0.35	4	1	Y
4	Y	0	0.2	6	1	Y
4	Y	0	0.15	6	0	Y
4	Y	0	0.25	10	1	Y
4	Y	0	0.3	2	1	Y
4	Y	0	0.2	2	0	Y
4	Y	0	0.17	2.3	1	Y
4	Y	0	0.15	3	0	Y
4	Y	0	0.1	2.2	2	Y
4	Y	0	0.25	12	0	Y
4	Y	0	0.3	8	0	Y
4	Y	0	0.2	3	1	Y
4	Y	0	0.2	4	1	Y

SR	B?	DR	D	L	BC	J?
4	Y	0	0.2	9	1	Y
4	Y	0	0.4	6	1	Y
4	Y	0	0.4	6	1	Y
4	Y	0	0.1	1	0	Y
4	Y	0	0.1	2	1	Y
4	Y	0	0.4	6	0	Y
4	Y	0	0.6	15	1	Y
4	Y	0	0.25	13.5	0	Y
4	Y	0	0.2	6	0	Y
4	Y	0	0.15	2	1	Y
4	Y	0	0.3	7.5	1	Y
4	Y	0	0.15	7	0	Y
4	Y	0	0.15	7	0	Y
4	Y	0	0.15	2.5	0	Y
4	Y	0	0.5	9	1	Y
4	Y	0	0.35	9	1	Y
4	Y	0	0.55	9	1	Y
4	Y	0	0.4	4	2	Y
4	Y	0	0.3	4	1	Y
4	Y	0	0.6	12	1	Y
4	Y	0	0.2	8.5	1	Y
4	Y	0	0.5	1.5	1	Y
4	Y	0	0.5	2	1	Y
4	Y	0	0.3	20	1	Y
4	Y	0	0.3	7	1	Y
4	Y	0	0.25	1	1	Y
4	Y	0	0.1	4	1	Y
4	Y	0	0.15	5	1	Y
4	Y	0	0.2	6	1	Y
4	Y	0	0.4	13	1	Y
4	Y	0	0.3	2	2	Y
4	Y	0	0.2	3	2	Y
4	Y	0	0.2	10	1	Y
4	Y	0	0.3	5	1	Y
4	Y	0	0.15	8	1	Y
4	Y	0	0.3	4	2	Y
4	Y	0	0.2	6	1	Y
4	Y	0	0.2	14	1	Y
4	Y	0	0.15	10	1	Y
4	Y	0	0.1	7	1	Y
4	Y	0	0.15	3	2	Y

SR	B?	DR	D	L	BC	J?
4	Y	0	0.15	3	2	Y
4	Y	0	0.2	4	2	Y
4	Y	0	0.5	10	2	Y
4	Y	0	0.2	7	1	Y
4	Y	0	0.2	8	1	Y
4	Y	0	0.15	6	1	Y
4	Y	0	0.15	3	1	Y
4	Y	0	0.1	4	1	Y
4	Y	0	0.2	1	2	Y
4	Y	0	0.2	1.5	1	Y
4	Y	0	0.1	2	0	Y
4	Y	0	0.1	1.5	0	Y
4	Y	0	0.5	20	1	Y
4	Y	0	0.4	7	1	Y
4	Y	0	0.1	5	1	Y
4	Y	0	0.2	3	2	Y
4	Y	0	0.5	22	1	Y
4	Y	0	0.15	2	2	Y
4	Y	0	0.1	6	1	Y
4	Y	0	0.25	5	2	Y
4	Y	0	0.1	8	1	Y
4	Y	0	0.15	1	0	Y
4	Y	0	0.25	10	0	Y
4	Y	0	0.25	18	1	Y
4	Y	0	0.5	18	1	Y
4	Y	0	0.35	5	1	Y
4	Y	0	0.3	6	1	Y
4	Y	0	0.3	2	1	Y
4	Y	0	0.2	4	2	Y
4	Y	0	0.15	3	2	Y
4	Y	0	0.2	9	1	Y
4	Y	0	0.3	4	2	Y
4	Y	0	0.15	5	2	Y
4	Y	0	0.25	2	2	Y
4	Y	0	0.4	5	2	Y
4	Y	0	0.15	6	2	Y
4	Y	0	0.15	1.5	2	Y
4	Y	0	0.2	1	1	Y
4	Y	0	0.25	1.5	2	Y
4	Y	0	0.15	2	2	Y
4	Y	0	0.2	3	1	Y

SR	B?	DR	D	L	BC	J?
4	Y	0	0.4	1	1	Y
4	Y	0	0.3	9	1	Y
4	Y	0	0.25	6	1	Y
4	Y	0	0.3	3	1	Y
4	Y	0	0.2	5	1	Y
4	Y	0	0.25	2	1	Y
4	Y	0	0.3	3	1	Y
4	Y	0	0.25	5	1	Y
4	Y	0	0.3	11	2	Y
4	Y	0	0.3	3	1	Y
4	Y	0	0.35	6	1	Y
4	Y	0	0.3	3	1	Y
4	Y	0	0.25	10	1	Y
4	Y	0	0.2	8	2	Y
4	Y	0	0.15	5	2	Y
4	Y	0	0.35	6	2	Y
4	Y	0	0.4	6	2	Y
4	Y	0	0.6	11	1	Y
4	Y	0	0.3	6	1	Y
4	Y	0	0.3	6	2	Y
4	Y	0	0.5	4	2	Y
4	Y	0	0.3	3	0	Y
4	Y	0	0.15	1.5	2	Y
4	Y	0	0.4	1	1	Y
4	Y	0	0.5	12	2	Y
4	Y	0	0.3	6	1	Y
4	Y	0	0.3	7	1	Y
4	Y	0	0.4	12	1	Y
4	Y	0	0.15	5	1	Y
4	Y	0	0.1	3	1	Y
4	Y	0	0.2	2	0	Y
4	Y	0	0.3	5	1	Y
4	Y	0	0.1	4	0	Y
4	Y	0	0.25	4	1	Y
4	Y	0	0.4	1.5	0	Y
4	Y	0	0.5	4	1	Y
4	Y	0	0.35	1.5	1	Y
4	Y	0	0.25	1.5	1	Y
4	Y	0	0.5	10	1	Y
4	Y	0	0.4	8	2	Y
4	Y	0	0.15	2	2	Y

SR	B?	DR	D	L	BC	J?
4	Y	0	0.2	5	0	Y
4	Y	0	0.2	2	2	Y
4	Y	0	0.15	3	1	Y
4	Y	0	0.35	12	1	Y
4	Y	0	0.2	6	0	Y
4	Y	0	0.3	2	1	Y
4	Y	0	0.25	6	1	Y
4	Y	0	0.35	8	2	Y
4	Y	0	0.25	7	1	Y
4	Y	0	0.25	18	1	Y
4	Y	0	0.3	15	1	Y
4	Y	0	0.2	4	0	Y
4	Y	0	0.2	10	1	Y
4	Y	0	0.2	6	2	Y
4	Y	0	0.25	8	1	Y
4	Y	0	0.3	5	2	Y
4	Y	0	0.15	1	0	Y
4	Y	0	0.15	1	0	Y
4	Y	0	0.6	7	1	Y
4	Y	0	0.3	10	1	Y
4	Y	0	0.1	5	1	Y
4	Y	0	0.1	1.5	1	Y
4	Y	0	0.15	3	1	Y
5	Y	0	0.4	8	1	Y
5	Y	0	0.2	7	2	Y
5	Y	0	0.2	8	0	Y
5	Y	0	0.3	12	1	Y
5	Y	0	0.15	6	1	Y
5	Y	0	0.1	4	1	Y
5	Y	0	0.35	8	1	Y
5	Y	0	0.3	9	1	Y
5	Y	0	0.3	6	1	Y
5	Y	0	0.4	9	1	Y
5	Y	0	0.3	7	1	Y
5	Y	0	0.3	7	1	Y
5	Y	0	0.3	7	1	Y
5	Y	0	0.15	3	1	Y
5	Y	0	0.1	2	1	Y
5	Y	0	0.1	2	1	Y
5	Y	0	0.1	5	1	Y
5	Y	0	0.2	5	1	Y

SR	B?	DR	D	L	BC	J?
5	Y	0	1	6	1	Y
5	Y	0	0.15	1.5	2	Y
5	Y	0	0.15	3	1	Y
5	Y	0	0.15	3	1	Y
5	Y	0	0.4	5	0	Y
5	Y	0	0.4	6	2	Y
5	Y	0	0.3	8	1	Y
5	Y	0	0.3	10	2	Y
5	Y	0	0.3	8	1	Y
5	Y	0	0.25	8	1	Y
5	Y	0	0.2	4	1	Y
5	Y	0	0.3	10	2	Y
5	Y	0	0.4	5	0	Y
5	Y	0	0.3	6	2	Y
5	Y	0	1	8	1	Y
5	Y	0	0.25	4	1	Y
5	Y	0	0.2	6	1	Y
5	Y	0	0.2	4	2	Y
5	Y	0	0.3	3	1	Y
5	Y	0	0.15	1	0	Y
5	Y	0	0.15	5	1	Y
5	Y	0	0.2	3	0	Y
5	Y	0	0.3	2	1	Y
5	Y	0	0.3	13	1	Y
5	Y	0	0.6	6	1	Y
5	Y	0	0.5	6	2	Y
5	Y	0	0.4	7	1	Y
5	Y	0	0.25	8	0	Y
5	Y	0	0.35	5	1	Y
5	Y	0	0.2	12	1	Y
5	Y	0	0.3	12	1	Y
5	Y	0	0.1	4	1	Y
5	Y	0	0.4	2	1	Y
5	Y	0	0.2	2	1	Y
5	Y	0	0.2	5	0	Y
5	Y	0	0.2	3	0	Y
5	Y	0	0.2	6	1	Y
5	Y	0	0.2	3	1	Y
5	Y	0	0.1	5	0	Y
5	Y	0	0.2	5	1	Y
5	Y	0	0.4	5	1	Y

SR	B?	DR	D	L	BC	J?
5	Y	0	0.3	5	2	Y
5	Y	0	0.3	6	1	Y
5	Y	0	0.25	5	1	Y
5	Y	0	0.4	5	1	Y
5	Y	0	0.4	5	1	Y
5	Y	0	0.2	7	0	Y
5	Y	0	0.4	2	1	Y
5	Y	0	0.2	4	1	Y
5	Y	0	0.3	6	1	Y
5	Y	0	0.3	5	1	Y
5	Y	0	0.2	3	1	Y
5	Y	0	0.3	4	1	Y
5	Y	0	0.2	4	2	Y
5	Y	0	0.4	2	2	Y
5	Y	0	0.2	1	1	Y
5	Y	0	0.2	1	1	Y
5	Y	0	0.2	1	1	Y
5	Y	0	0.4	3	1	Y
5	Y	0	0.1	2	1	Y
5	Y	0	0.3	5	1	Y
5	Y	0	0.2	2	1	Y
5	Y	0	0.2	4	2	Y
5	Y	0	0.2	7	1	Y
5	Y	0	0.2	1.5	2	Y
5	Y	0	0.1	5	1	Y
5	Y	0	0.2	6	1	Y
6	N	0	0.3	15	0	Y
6	N	0	0.2	3	0	Y
6	N	0	0.15	3	0	Y
6	N	0	0.1	3	0	Y
6	N	0	0.15	2	2	Y
6	N	0	0.2	6	0	Y
6	N	0	0.25	4	0	Y
6	N	0	0.2	2	1	Y
6	N	0	0.2	3	0	Y
6	N	0	0.2	6	2	Y
6	N	0	0.3	4	0	Y
6	N	0	0.2	4	1	Y
6	N	0	0.3	3	0	Y
6	N	0	0.1	1	0	Y
6	N	0	0.7	10	0	Y

SR	B?	DR	D	L	BC	J?
6	N	0	0.25	10	0	Y
6	N	0	0.1	8	0	Y
6	N	0	0.2	6	0	Y
6	N	0	0.2	4	0	Y
6	N	0	0.3	2	0	Y
6	N	0	0.4	4	1	Y
6	N	0	0.3	3	0	Y
6	N	0	0.1	1	0	Y
6	N	0	0.2	5	0	Y
6	N	0	0.3	1.5	0	Y
6	N	0	0.2	4	1	Y
6	N	0	0.4	6	0	Y
6	N	0	0.2	6	0	Y
6	N	0	0.15	3	0	Y
6	N	0	0.2	1	2	Y
6	N	0	0.2	5	0	Y
6	N	0	0.3	8	0	Y
6	N	0	0.2	7	0	Y
6	N	0	0.1	4	0	Y
6	N	0	0.2	3	0	Y
6	N	0	0.15	2	0	Y
6	N	0	0.1	2	1	Y
6	N	0	0.2	2	0	Y
6	N	0	0.2	3	0	Y
6	N	0	0.1	3	0	Y
6	N	0	0.1	3	0	Y
6	N	0	0.7	28.4	0	Y
7	N	0	0.2	28	0	Y
7	N	0	0.25	28	0	Y
7	N	0	0.4	25	0	Y
7	N	0	0.2	1	2	Y
7	N	0	0.15	4	0	Y
8	N	0	0.5	12	0	Y
8	N	0	0.2	7	0	Y
8	N	0	0.3	3	1	Y
8	N	0	0.1	4	0	Y
8	N	0	0.25	1	1	Y
8	N	0	0.6	3	0	Y
8	N	0	0.4	20	0	Y
8	N	0	0.25	5	0	Y
8	N	0	0.25	3	0	Y

SR	B?	DR	D	L	BC	J?
8	N	0	0.1	2	0	Y
8	N	0	0.15	1.5	2	Y
8	N	0	0.2	2	0	Y
8	N	0	0.15	2	0	Y
8	N	0	0.15	2.5	0	Y
8	N	0	0.2	4	0	Y
8	N	0	0.2	1	0	Y
8	N	0	0.3	1.5	1	Y
8	N	0	0.2	4	2	Y

Table 23. River Jam Data

SR	Jam #	DR	# LW Pieces	JL	JW	JH	p	Piece Vol. (m^3)	Rect. Vol. (m^3)	Avg. BC	% Diff
1	R01	0	6	1.5	2.3	1.1	0.60	0.77	1.5	0.80	65%
1	R02	0	4	2	2.2	1	0.40	0.58	2.6	1.00	128%
2	R03	0	5	2.8	2.5	1.5	0.30	1.59	7.4	0.80	129%
2	R04	0	3	1	3.6	0.5	0.85	0.24	0.3	1.00	11%
2	R05	0	42	10	12	3	0.50	27.94	180.0	0.67	146%
3	R06	0	3	6	0.5	0.5	0.60	0.61	0.6	1.67	-2%
4	R07	0	5	1.5	7	1	0.70	3.38	3.2	0.60	-7%
4	R08	0	6	10	2	2	0.45	4.12	22.0	0.83	137%
4	R09	0	12	6	6	1	0.40	3.59	21.6	0.73	143%
4	R10	0	3	3.5	0.5	0.5	0.50	0.12	0.4	1.00	113%
4	R11	0	6	12	2	1	0.70	2.41	7.2	0.67	100%
4	R12	0	5	NA	NA	NA	NA	5.77	NA	0.60	NA
4	R13	0	9	20	1	1	0.60	4.34	8.0	0.44	59%
4	R14	0	37	25	4	2	0.50	16.32	100.0	1.19	144%
4	R15	0	11	20	4	1	0.60	10.16	32.0	1.09	104%
4	R16	0	77	31	7	3	0.20	34.67	520.8	1.21	175%
4	R17	0	5	1.5	10	2	0.50	2.79	15.0	1.00	137%
5	R18	0	3	3	16	1.5	0.45	1.48	39.6	1.50	186%
5	R19	0	3	12	2.5	1.5	0.60	0.99	18.0	1.00	179%
5	R20	0	25	27	6	1	0.45	14.64	89.1	1.13	144%
5	R21	0	3	3	7	2	0.70	6.90	12.6	1.33	58%
5	R22	0	7	5	2	0.5	0.55	0.87	2.3	0.86	89%
5	R23	0	5	6	3	1	0.70	5.07	5.4	1.25	6%
5	R24	0	22	20	11	2	0.40	6.71	264.0	0.86	190%
5	R25	0	8	2	4	1	0.60	1.20	3.2	1.25	91%
5	R26	0	9	5	3	2	0.60	1.43	12.0	1.22	157%
6	R27	0	10	10	2	1	0.50	2.00	10.0	0.50	133%
6	R28	0	4	2	4	0.5	0.80	0.63	0.8	0.25	24%

SR	Jam #	DR	# LW Pieces	JL	JW	JH	p	Piece Vol. (m^3)	Rect. Vol. (m^3)	Avg. BC	% Diff
6	R29	0	6	12	4	1	0.80	4.86	9.6	0.00	66%
6	R30	0	6	5	4	1.5	0.65	1.11	10.5	0.33	162%
6	R31	0	5	6	2	3	0.50	1.18	18.0	0.40	175%
6	R32	0	3	1	8	1	0.30	0.82	5.6	0.00	149%
6	R33	0	4	2	4	0.5	0.60	0.21	1.6	0.25	154%
6	R34	0	3	1	3	0.5	0.40	0.14	0.9	0.00	146%
7	R35	0	5	28	4	1	0.70	5.50	33.6	0.40	144%
8	R36	0	6	12	2	1	0.60	3.72	9.6	0.33	88%
8	R37	0	12	10	3	2	0.20	3.48	48.0	0.42	173%
6	R38	0	NA	NA	NA	3	0.10	NA	2531.3	NA	NA

Table 24. Floodplain Large Wood Data

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
1	1	Y	8.2	9.4	0.87	0.1	NA	N
1	2	Y	7.2	23.3	0.31	0.7	NA	N
1	2	Y	18.6	23.3	0.8	0.2	NA	N
1	3	Y	2.8	28.5	0.1	0.1	NA	N
1	3	Y	11.7	28.5	0.41	0.2	NA	N
1	3	Y	12.8	28.5	0.45	0.1	NA	N
1	3	Y	21.9	28.5	0.77	0.4	NA	N
1	3	Y	25.9	28.5	0.91	0.1	NA	N
1	4	Y	28.2	42.5	0.66	0.1	NA	N
1	4	Y	29.8	42.5	0.7	0.1	NA	N
2	1	Y	13.3	77	0.17	0.15	NA	N
2	1	Y	24.1	77	0.31	0.55	NA	N
2	1	Y	28.6	77	0.37	0.55	NA	N
2	1	Y	62.7	77	0.81	0.1	NA	N
2	1	Y	65.1	77	0.85	0.3	NA	N
2	1	Y	69.7	77	0.91	0.15	NA	N
2	1	Y	70.3	77	0.91	0.35	NA	N
2	1	Y	75.3	77	0.98	0.4	NA	N
2	1	Y	76.6	77	0.99	0.1	NA	N
2	2	Y	6.1	95.7	0.06	0.2	NA	N
2	2	Y	9.2	95.7	0.1	0.4	NA	N
2	2	Y	22	95.7	0.23	0.2	NA	N
2	2	Y	24.2	95.7	0.25	0.5	NA	N
2	2	Y	25.9	95.7	0.27	0.35	NA	N
2	2	Y	31.1	95.7	0.32	0.35	NA	N
2	2	Y	33.1	95.7	0.35	0.2	NA	N
2	2	Y	57.8	95.7	0.6	0.15	NA	N

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
2	2	Y	59.4	95.7	0.62	0.3	NA	N
2	2	Y	59.3	95.7	0.62	0.25	NA	N
2	2	Y	59	95.7	0.62	0.2	NA	N
2	2	Y	68.6	95.7	0.72	0.35	NA	N
2	2	Y	69.8	95.7	0.73	0.3	NA	N
2	2	Y	76.8	95.7	0.8	0.2	NA	N
2	2	Y	76.6	95.7	0.8	0.25	NA	N
2	2	Y	79.3	95.7	0.83	0.5	NA	N
2	2	Y	80	95.7	0.84	0.6	NA	N
2	2	Y	82.7	95.7	0.86	0.2	NA	N
2	2	Y	86.4	95.7	0.9	0.15	NA	N
2	2	Y	93.3	95.7	0.97	0.2	NA	N
2	3	Y	10.2	71.1	0.14	0.15	NA	N
2	3	Y	12.4	71.1	0.17	0.1	NA	N
2	3	Y	15.7	71.1	0.22	0.25	NA	N
2	3	Y	19.4	71.1	0.27	0.2	NA	N
2	3	Y	19.4	71.1	0.27	0.2	NA	N
2	3	Y	21.8	71.1	0.31	0.25	NA	N
2	3	Y	23	71.1	0.32	0.15	NA	N
2	3	Y	24.5	71.1	0.34	0.2	NA	N
2	3	Y	24.9	71.1	0.35	0.15	NA	N
2	3	Y	32.1	71.1	0.45	0.1	NA	N
2	3	Y	32.9	71.1	0.46	0.2	NA	N
2	3	Y	37.7	71.1	0.53	0.15	NA	N
2	3	Y	39.4	71.1	0.55	0.2	NA	N
2	3	Y	50.4	71.1	0.71	0.15	NA	N
2	3	Y	52	71.1	0.73	0.2	NA	N
2	3	Y	54.5	71.1	0.77	0.35	NA	N
2	3	Y	58	71.1	0.82	0.45	NA	N
3	1	Y	0	85	0	0.1	NA	N
3	1	Y	1.9	85	0.02	0.1	NA	N
3	1	Y	2.3	85	0.03	0.1	NA	N
3	1	Y	11.8	85	0.14	0.1	NA	N
3	1	Y	5.5	85	0.06	0.3	1	Y
3	1	Y	5.5	85	0.06	0.2	1	Y
3	1	Y	5.5	85	0.06	0.2	2	Y
3	1	Y	5.5	85	0.06	0.4	2	Y
3	1	Y	64	85	0.75	0.5	2	Y
3	1	Y	64	85	0.75	0.25	2	Y
3	1	Y	64	85	0.75	0.25	2	Y
3	1	Y	64	85	0.75	0.35	2	Y

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
3	1	Y	64	85	0.75	0.3	2	Y
3	1	Y	64	85	0.75	0.4	1	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.3	1	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.1	1	Y
3	1	Y	64	85	0.75	0.25	1	Y
3	1	Y	64	85	0.75	0.3	2	Y
3	1	Y	64	85	0.75	0.25	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.1	0	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.15	1	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.4	2	Y
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.1	0	Y
3	1	Y	64	85	0.75	0.2	1	Y
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.25	2	Y
3	1	Y	64	85	0.75	0.3	2	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.2	1	Y
3	1	Y	64	85	0.75	0.25	1	Y
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.45	1	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.2	1	Y

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.4	2	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.45	2	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.3	2	Y
3	1	Y	64	85	0.75	0.25	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.15	1	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.25	1	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.3	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.3	2	Y
3	1	Y	64	85	0.75	0.2	2	Y
3	1	Y	64	85	0.75	0.1	2	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	1	Y	64	85	0.75	0.15	2	Y
3	2	Y	37	190.1	0.19	0.3	NA	N
3	2	Y	60.7	190.1	0.32	0.15	NA	N
3	2	Y	67.7	190.1	0.36	0.4	NA	N
3	2	Y	81.1	190.1	0.43	0.25	NA	N
3	2	Y	82.6	190.1	0.43	0.15	NA	N
3	2	Y	85.5	190.1	0.45	0.3	NA	N
3	2	Y	91.9	190.1	0.48	0.1	NA	N
3	2	Y	96.6	190.1	0.51	0.25	NA	N
3	2	Y	96.9	190.1	0.51	0.1	NA	N

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
3	2	Y	98.9	190.1	0.52	0.25	NA	N
3	2	Y	101	190.1	0.53	0.15	NA	N
3	2	Y	108.7	190.1	0.57	0.15	NA	N
3	2	Y	111.2	190.1	0.58	0.15	NA	N
3	2	Y	125.6	190.1	0.66	0.1	NA	N
3	2	Y	128.5	190.1	0.68	0.1	NA	N
3	2	Y	134.8	190.1	0.71	0.1	NA	N
3	2	Y	138.8	190.1	0.73	0.15	NA	N
3	2	Y	146.9	190.1	0.77	0.1	NA	N
3	2	Y	147	190.1	0.77	0.25	NA	N
3	2	Y	150.3	190.1	0.79	0.1	NA	N
3	2	Y	184.8	190.1	0.97	0.2	NA	N
3	2	Y	188.1	190.1	0.99	0.15	NA	N
3	2	Y	188.9	190.1	0.99	0.15	NA	N
3	3	Y	26.7	108	0.25	0.1	NA	N
3	3	Y	31	108	0.29	0.2	NA	N
3	3	Y	33.4	108	0.31	0.25	NA	N
3	3	Y	33.7	108	0.31	0.2	NA	N
3	3	Y	34.1	108	0.32	0.3	NA	N
3	3	Y	34.4	108	0.32	0.1	NA	N
3	3	Y	43.1	108	0.4	0.35	NA	N
3	3	Y	45.2	108	0.42	0.1	NA	N
3	3	Y	51	108	0.47	0.2	NA	N
3	3	Y	101.4	108	0.94	0.15	NA	N
3	3	Y	107	108	0.99	0.35	NA	N
3	3	Y	92	108	0.85	0.2	2	Y
3	3	Y	92	108	0.85	0.4	1	Y
3	3	Y	92	108	0.85	0.25	1	Y
3	3	Y	92	108	0.85	0.15	2	Y
3	3	Y	92	108	0.85	0.25	2	Y
3	3	Y	92	108	0.85	0.2	1	Y
3	3	Y	92	108	0.85	0.1	2	Y
3	3	Y	92	108	0.85	0.15	2	Y
3	3	Y	92	108	0.85	0.15	2	Y
3	3	Y	92	108	0.85	0.1	1	Y
3	3	Y	92	108	0.85	0.2	2	Y
3	3	Y	92	108	0.85	0.15	2	Y
3	3	Y	92	108	0.85	0.1	1	Y
3	3	Y	92	108	0.85	0.15	1	Y
3	3	Y	92	108	0.85	0.1	1	Y
3	3	Y	92	108	0.85	0.1	1	Y

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
3	3	Y	92	108	0.85	0.1	0	Y
3	4	Y	8	75.9	0.11	0.2	NA	N
3	4	Y	10.2	75.9	0.13	0.2	NA	N
3	4	Y	27.1	75.9	0.36	0.15	NA	N
3	4	Y	42.4	75.9	0.56	0.2	NA	N
3	4	Y	67.8	75.9	0.89	0.1	NA	N
3	4	Y	15	75.9	0.2	0.2	1	Y
3	4	Y	15	75.9	0.2	0.15	1	Y
3	4	Y	15	75.9	0.2	0.3	2	Y
3	4	Y	15	75.9	0.2	0.2	2	Y
3	4	Y	15	75.9	0.2	0.1	2	Y
3	4	Y	15	75.9	0.2	0.25	2	Y
3	4	Y	35	75.9	0.46	0.15	2	Y
3	4	Y	35	75.9	0.46	0.2	2	Y
3	4	Y	35	75.9	0.46	0.4	1	Y
3	4	Y	35	75.9	0.46	0.1	2	Y
3	4	Y	35	75.9	0.46	0.2	2	Y
3	4	Y	49	75.9	0.65	0.2	2	Y
3	4	Y	49	75.9	0.65	0.4	2	Y
3	4	Y	49	75.9	0.65	0.1	2	Y
3	4	Y	49	75.9	0.65	0.4	1	Y
3	4	Y	49	75.9	0.65	0.2	2	Y
3	4	Y	49	75.9	0.65	0.15	2	Y
3	4	Y	49	75.9	0.65	0.2	1	Y
3	4	Y	49	75.9	0.65	0.15	0	Y
3	4	Y	49	75.9	0.65	0.1	2	Y
3	4	Y	49	75.9	0.65	0.2	2	Y
3	4	Y	49	75.9	0.65	0.1	1	Y
3	4	Y	49	75.9	0.65	0.2	2	Y
3	4	Y	49	75.9	0.65	0.25	1	Y
3	4	Y	49	75.9	0.65	0.3	2	Y
3	4	Y	49	75.9	0.65	0.1	1	Y
3	4	Y	49	75.9	0.65	0.1	2	Y
3	4	Y	49	75.9	0.65	0.15	1	Y
3	4	Y	49	75.9	0.65	0.15	2	Y
3	4	Y	49	75.9	0.65	0.2	2	Y
3	4	Y	49	75.9	0.65	0.1	2	Y
3	4	Y	49	75.9	0.65	0.15	2	Y
3	4	Y	49	75.9	0.65	0.4	1	Y
3	4	Y	49	75.9	0.65	0.25	1	Y
3	4	Y	49	75.9	0.65	0.1	2	Y

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
3	4	Y	49	75.9	0.65	0.3	1	Y
3	4	Y	49	75.9	0.65	0.15	2	Y
3	4	Y	49	75.9	0.65	0.1	2	Y
4	1	Y	19.3	129.8	0.15	0.2	NA	N
4	1	Y	19.3	129.8	0.15	0.1	NA	N
4	1	Y	28.4	129.8	0.22	0.35	NA	N
4	1	Y	33.6	129.8	0.26	0.2	NA	N
4	1	Y	54.9	129.8	0.42	0.2	NA	N
4	1	Y	56.4	129.8	0.43	0.2	NA	N
4	1	Y	57.9	129.8	0.45	0.1	NA	N
4	1	Y	59.8	129.8	0.46	0.2	NA	N
4	1	Y	74.2	129.8	0.57	0.15	NA	N
4	1	Y	88.3	129.8	0.68	0.2	NA	N
4	1	Y	94.8	129.8	0.73	0.3	NA	N
4	1	Y	97	129.8	0.75	0.15	NA	N
4	1	Y	116.3	129.8	0.9	0.1	NA	N
4	1	Y	62	129.8	0.48	0.2	2	Y
4	1	Y	62	129.8	0.48	0.3	1	Y
4	1	Y	62	129.8	0.48	0.2	1	Y
4	1	Y	62	129.8	0.48	0.2	0	Y
4	1	Y	62	129.8	0.48	0.25	1	Y
4	1	Y	62	129.8	0.48	0.25	1	Y
4	1	Y	62	129.8	0.48	0.25	1	Y
4	1	Y	62	129.8	0.48	0.2	2	Y
4	1	Y	62	129.8	0.48	0.4	1	Y
4	1	Y	62	129.8	0.48	0.3	1	Y
4	1	Y	62	129.8	0.48	0.25	1	Y
4	1	Y	62	129.8	0.48	0.25	1	Y
4	1	Y	62	129.8	0.48	0.1	0	Y
4	1	Y	62	129.8	0.48	0.15	1	Y
4	1	Y	62	129.8	0.48	0.5	2	Y
4	1	Y	62	129.8	0.48	0.2	1	Y
4	1	Y	107.5	129.8	0.83	0.25	2	Y
4	1	Y	107.5	129.8	0.83	0.25	1	Y
4	1	Y	107.5	129.8	0.83	0.1	1	Y
4	1	Y	107.5	129.8	0.83	0.25	1	Y
4	1	Y	107.5	129.8	0.83	0.2	1	Y
4	1	Y	107.5	129.8	0.83	0.15	1	Y
4	1	Y	107.5	129.8	0.83	0.1	2	Y
4	1	Y	107.5	129.8	0.83	0.15	1	Y
4	1	Y	107.5	129.8	0.83	0.15	2	Y

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
4	1	Y	107.5	129.8	0.83	0.35	2	Y
4	1	Y	107.5	129.8	0.83	0.3	1	Y
4	1	Y	107.5	129.8	0.83	0.25	1	Y
4	1	Y	107.5	129.8	0.83	0.3	1	Y
4	1	Y	107.5	129.8	0.83	0.15	2	Y
4	1	Y	107.5	129.8	0.83	0.1	1	Y
4	2	Y	13.4	127	0.11	0.25	NA	N
4	2	Y	40.8	127	0.32	0.1	NA	N
4	2	Y	41	127	0.32	0.1	NA	N
4	2	Y	41	127	0.32	0.1	NA	N
4	2	Y	41.4	127	0.33	0.2	NA	N
4	2	Y	41.8	127	0.33	0.2	NA	N
4	2	Y	42.3	127	0.33	0.3	NA	N
4	2	Y	43.4	127	0.34	0.1	NA	N
4	2	Y	43.9	127	0.35	0.35	NA	N
4	2	Y	45.3	127	0.36	0.4	NA	N
4	2	Y	47.7	127	0.38	0.25	NA	N
4	2	Y	49.8	127	0.39	0.5	NA	N
4	2	Y	50.4	127	0.4	0.25	NA	N
4	2	Y	50.9	127	0.4	0.45	NA	N
4	2	Y	52.9	127	0.42	0.1	NA	N
4	2	Y	55.3	127	0.44	0.35	NA	N
4	2	Y	57.8	127	0.46	0.2	NA	N
4	2	Y	58.8	127	0.46	0.15	NA	N
4	2	Y	59.1	127	0.47	0.3	NA	N
4	2	Y	68.6	127	0.54	0.4	NA	N
4	2	Y	71.2	127	0.56	0.4	NA	N
4	2	Y	72.8	127	0.57	0.1	NA	N
4	2	Y	78.7	127	0.62	0.1	NA	N
4	2	Y	95.7	127	0.75	0.15	NA	N
4	2	Y	100	127	0.79	0.15	NA	N
4	2	Y	105.2	127	0.83	0.25	NA	N
4	2	Y	106	127	0.83	0.15	NA	N
4	2	Y	117	127	0.92	0.3	NA	N
4	2	Y	119.6	127	0.94	0.15	NA	N
4	2	Y	119.8	127	0.94	0.15	NA	N
4	2	Y	33	127	0.26	0.25	2	Y
4	2	Y	33	127	0.26	0.35	2	Y
4	2	Y	33	127	0.26	0.2	1	Y
4	2	Y	33	127	0.26	0.15	2	Y
4	2	Y	33	127	0.26	0.25	2	Y

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
4	2	Y	33	127	0.26	0.3	2	Y
4	2	Y	33	127	0.26	0.1	2	Y
4	2	Y	33	127	0.26	0.2	2	Y
4	2	Y	33	127	0.26	0.2	2	Y
4	2	Y	33	127	0.26	0.3	2	Y
4	2	Y	33	127	0.26	0.15	2	Y
4	2	Y	33	127	0.26	0.2	2	Y
4	2	Y	33	127	0.26	0.2	1	Y
4	2	Y	33	127	0.26	0.15	2	Y
4	2	Y	33	127	0.26	0.2	2	Y
4	2	Y	33	127	0.26	0.2	2	Y
4	2	Y	33	127	0.26	0.15	1	Y
4	2	Y	33	127	0.26	0.15	2	Y
4	2	Y	33	127	0.26	0.1	1	Y
4	2	Y	33	127	0.26	0.15	2	Y
4	2	Y	33	127	0.26	0.25	2	Y
4	2	Y	33	127	0.26	0.1	2	Y
4	2	Y	33	127	0.26	0.2	2	Y
4	2	Y	33	127	0.26	0.2	2	Y
4	2	Y	33	127	0.26	0.2	2	Y
4	2	Y	33	127	0.26	0.15	2	Y
4	2	Y	33	127	0.26	0.25	1	Y
4	2	Y	33	127	0.26	0.25	2	Y
4	2	Y	33	127	0.26	0.15	1	Y
4	2	Y	33	127	0.26	0.2	2	Y
4	2	Y	33	127	0.26	0.15	2	Y
4	2	Y	33	127	0.26	0.2	0	Y
4	2	Y	33	127	0.26	0.25	2	Y
4	2	Y	33	127	0.26	0.15	2	Y
4	2	Y	33	127	0.26	0.2	2	Y
4	2	Y	33	127	0.26	0.2	2	Y
4	2	Y	33	127	0.26	0.2	1	Y
4	2	Y	33	127	0.26	0.3	2	Y
4	2	Y	33	127	0.26	0.2	2	Y
4	2	Y	33	127	0.26	0.15	2	Y
4	2	Y	33	127	0.26	0.1	2	Y
4	2	Y	33	127	0.26	0.25	2	Y
4	2	Y	33	127	0.26	0.3	1	Y
4	2	Y	33	127	0.26	0.25	1	Y
4	2	Y	33	127	0.26	0.2	2	Y
4	2	Y	33	127	0.26	0.2	2	Y

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
4	3	Y	25.2	157.4	0.16	0.25	NA	N
4	3	Y	37.6	157.4	0.24	0.3	NA	N
4	3	Y	60.9	157.4	0.39	0.15	NA	N
4	3	Y	61.3	157.4	0.39	0.25	NA	N
4	3	Y	69.6	157.4	0.44	0.15	NA	N
4	3	Y	153.4	157.4	0.97	0.35	NA	N
4	3	Y	152.4	157.4	0.97	0.2	NA	N
4	3	Y	140.1	157.4	0.89	0.3	NA	N
4	3	Y	114.7	157.4	0.73	0.2	NA	N
4	3	Y	113.8	157.4	0.72	0.3	NA	N
4	3	Y	112.1	157.4	0.71	0.3	NA	N
4	3	Y	108.9	157.4	0.69	0.2	NA	N
4	3	Y	49.8	157.4	0.32	0.35	1	Y
4	3	Y	49.8	157.4	0.32	0.15	2	Y
4	3	Y	49.8	157.4	0.32	0.15	2	Y
4	3	Y	49.8	157.4	0.32	0.15	2	Y
4	3	Y	49.8	157.4	0.32	0.2	1	Y
4	3	Y	49.8	157.4	0.32	0.2	2	Y
4	3	Y	49.8	157.4	0.32	0.2	1	Y
4	3	Y	49.8	157.4	0.32	0.2	2	Y
4	3	Y	49.8	157.4	0.32	0.25	2	Y
4	3	Y	49.8	157.4	0.32	0.15	2	Y
4	3	Y	49.8	157.4	0.32	0.25	2	Y
4	3	Y	49.8	157.4	0.32	0.15	2	Y
4	3	Y	49.8	157.4	0.32	0.15	2	Y
4	3	Y	49.8	157.4	0.32	0.3	2	Y
4	3	Y	49.8	157.4	0.32	0.4	2	Y
4	3	Y	49.8	157.4	0.32	0.2	2	Y
4	3	Y	49.8	157.4	0.32	0.2	2	Y
4	3	Y	49.8	157.4	0.32	0.2	2	Y
4	3	Y	49.8	157.4	0.32	0.1	2	Y
4	3	Y	49.8	157.4	0.32	0.15	2	Y
4	3	Y	49.8	157.4	0.32	0.15	1	Y
4	3	Y	49.8	157.4	0.32	0.3	2	Y
4	3	Y	49.8	157.4	0.32	0.1	2	Y
4	3	Y	49.8	157.4	0.32	0.15	0	Y
4	3	Y	49.8	157.4	0.32	0.2	1	Y
4	3	Y	49.8	157.4	0.32	0.1	2	Y
4	3	Y	49.8	157.4	0.32	0.15	2	Y
4	3	Y	49.8	157.4	0.32	0.2	2	Y
4	3	Y	49.8	157.4	0.32	0.3	2	Y

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
4	3	Y	49.8	157.4	0.32	0.2	1	Y
4	3	Y	49.8	157.4	0.32	0.2	2	Y
4	3	Y	49.8	157.4	0.32	0.1	2	Y
4	3	Y	49.8	157.4	0.32	0.2	2	Y
4	3	Y	49.8	157.4	0.32	0.25	1	Y
4	3	Y	49.8	157.4	0.32	0.2	2	Y
4	3	Y	49.8	157.4	0.32	0.3	2	Y
4	3	Y	49.8	157.4	0.32	0.5	2	Y
4	3	Y	140.1	157.4	0.89	0.15	1	Y
4	3	Y	140.1	157.4	0.89	0.2	1	Y
4	3	Y	140.1	157.4	0.89	0.2	2	Y
4	3	Y	140.1	157.4	0.89	0.2	2	Y
4	3	Y	140.1	157.4	0.89	0.15	1	Y
4	3	Y	140.1	157.4	0.89	0.25	2	Y
4	3	Y	140.1	157.4	0.89	0.2	2	Y
4	3	Y	140.1	157.4	0.89	0.2	2	Y
4	3	Y	140.1	157.4	0.89	0.25	2	Y
4	3	Y	140.1	157.4	0.89	0.3	2	Y
4	3	Y	140.1	157.4	0.89	0.1	1	Y
4	3	Y	140.1	157.4	0.89	0.25	2	Y
4	3	Y	140.1	157.4	0.89	0.2	2	Y
4	3	Y	140.1	157.4	0.89	0.2	2	Y
4	3	Y	140.1	157.4	0.89	0.1	1	Y
4	3	Y	140.1	157.4	0.89	0.25	2	Y
4	3	Y	140.1	157.4	0.89	0.15	2	Y
4	3	Y	140.1	157.4	0.89	0.2	2	Y
4	3	Y	140.1	157.4	0.89	0.2	1	Y
4	3	Y	140.1	157.4	0.89	0.4	2	Y
4	3	Y	140.1	157.4	0.89	0.4	1	Y
4	3	Y	140.1	157.4	0.89	0.2	2	Y
4	3	Y	140.1	157.4	0.89	0.15	2	Y
4	4	Y	0.7	96.7	0.01	0.7	NA	N
4	4	Y	1.7	96.7	0.02	0.3	NA	N
4	4	Y	4.6	96.7	0.05	0.25	NA	N
4	4	Y	9.1	96.7	0.09	0.3	NA	N
4	4	Y	47.4	96.7	0.49	0.25	NA	N
4	4	Y	76.1	96.7	0.79	0.4	NA	N
4	4	Y	90	96.7	0.93	0.3	NA	N
4	4	Y	90.5	96.7	0.94	0.15	NA	N
4	4	Y	95.3	96.7	0.99	0.15	NA	N
5	1	Y	27.7	113.8	0.24	0.2	NA	N

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
5	1	Y	27.7	113.8	0.24	0.1	NA	N
5	1	Y	45.5	113.8	0.4	0.1	NA	N
5	1	Y	45.8	113.8	0.4	0.15	NA	N
5	1	Y	50.5	113.8	0.44	0.5	NA	N
5	1	Y	60.3	113.8	0.53	0.1	NA	N
5	1	Y	66.3	113.8	0.58	0.5	NA	N
5	1	Y	67.2	113.8	0.59	0.1	NA	N
5	1	Y	71.4	113.8	0.63	0.1	NA	N
5	1	Y	72.4	113.8	0.64	0.4	NA	N
5	1	Y	74.9	113.8	0.66	0.15	NA	N
5	1	Y	75.7	113.8	0.67	0.1	NA	N
5	1	Y	87.1	113.8	0.77	0.3	NA	N
5	1	Y	110.1	113.8	0.97	0.1	NA	N
5	1	Y	93.8	113.8	0.82	0.6	1	Y
5	1	Y	93.8	113.8	0.82	0.1	1	Y
5	1	Y	93.8	113.8	0.82	0.1	1	Y
5	1	Y	93.8	113.8	0.82	0.1	1	Y
5	1	Y	93.8	113.8	0.82	0.1	1	Y
5	1	Y	93.8	113.8	0.82	0.15	1	Y
5	1	Y	93.8	113.8	0.82	0.15	2	Y
5	1	Y	93.8	113.8	0.82	0.15	2	Y
5	1	Y	93.8	113.8	0.82	0.15	2	Y
5	1	Y	93.8	113.8	0.82	0.15	2	Y
5	1	Y	93.8	113.8	0.82	0.15	1	Y
5	1	Y	93.8	113.8	0.82	0.2	1	Y
5	1	Y	93.8	113.8	0.82	0.2	2	Y
5	1	Y	93.8	113.8	0.82	0.2	1	Y
5	1	Y	93.8	113.8	0.82	0.2	2	Y
5	1	Y	93.8	113.8	0.82	0.2	2	Y
5	1	Y	93.8	113.8	0.82	0.2	2	Y
5	1	Y	93.8	113.8	0.82	0.25	0	Y
5	1	Y	93.8	113.8	0.82	0.25	2	Y
5	1	Y	93.8	113.8	0.82	0.25	2	Y
5	1	Y	93.8	113.8	0.82	0.3	1	Y
5	1	Y	93.8	113.8	0.82	0.4	2	Y
5	1	Y	93.8	113.8	0.82	0.4	2	Y
5	1	Y	3	113.8	0.03	0.3	1	Y
5	1	Y	3	113.8	0.03	0.2	2	Y
5	1	Y	3	113.8	0.03	0.25	1	Y
5	1	Y	3	113.8	0.03	0.1	0	Y
5	1	Y	3	113.8	0.03	0.2	0	Y

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
5	1	Y	3	113.8	0.03	0.2	0	Y
5	1	Y	3	113.8	0.03	0.15	0	Y
5	1	Y	3	113.8	0.03	0.3	0	Y
5	1	Y	3	113.8	0.03	0.2	0	Y
5	1	Y	3	113.8	0.03	0.3	1	Y
5	1	Y	3	113.8	0.03	0.3	1	Y
5	1	Y	3	113.8	0.03	0.15	1	Y
5	1	Y	3	113.8	0.03	0.3	2	Y
5	1	Y	3	113.8	0.03	0.15	2	Y
5	1	Y	3	113.8	0.03	0.1	0	Y
5	1	Y	3	113.8	0.03	0.15	0	Y
5	1	Y	3	113.8	0.03	0.15	0	Y
5	1	Y	3	113.8	0.03	0.15	1	Y
5	1	Y	3	113.8	0.03	0.1	0	Y
5	1	Y	3	113.8	0.03	0.15	1	Y
5	1	Y	3	113.8	0.03	0.1	1	Y
5	1	Y	3	113.8	0.03	0.25	0	Y
5	1	Y	3	113.8	0.03	0.2	1	Y
5	1	Y	3	113.8	0.03	0.2	0	Y
5	1	Y	3	113.8	0.03	0.25	1	Y
5	1	Y	3	113.8	0.03	0.3	0	Y
5	1	Y	3	113.8	0.03	0.1	0	Y
5	1	Y	57.8	113.8	0.51	0.25	1	Y
5	1	Y	57.8	113.8	0.51	0.2	2	Y
5	1	Y	57.8	113.8	0.51	0.15	1	Y
5	2	Y	8.7	105	0.08	0.3	NA	N
5	2	Y	12.5	105	0.12	0.2	NA	N
5	2	Y	37.3	105	0.36	0.2	NA	N
5	2	Y	42.4	105	0.4	0.15	NA	N
5	2	Y	51.7	105	0.49	0.25	NA	N
5	2	Y	52.2	105	0.5	0.3	NA	N
5	2	Y	59.3	105	0.56	0.2	NA	N
5	2	Y	61.3	105	0.58	0.2	NA	N
5	2	Y	72.7	105	0.69	0.3	NA	N
5	2	Y	76.8	105	0.73	0.2	NA	N
5	2	Y	83.5	105	0.8	0.3	NA	N
5	2	Y	101.4	105	0.97	0.25	NA	N
5	2	Y	31	105	0.3	0.1	1	Y
5	2	Y	31	105	0.3	0.1	1	Y
5	2	Y	31	105	0.3	0.1	1	Y
5	2	Y	31	105	0.3	0.1	0	Y

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
5	2	Y	31	105	0.3	0.1	0	Y
5	2	Y	31	105	0.3	0.1	1	Y
5	2	Y	31	105	0.3	0.1	0	Y
5	2	Y	31	105	0.3	0.15	2	Y
5	2	Y	31	105	0.3	0.15	2	Y
5	2	Y	31	105	0.3	0.15	1	Y
5	2	Y	31	105	0.3	0.15	2	Y
5	2	Y	31	105	0.3	0.15	0	Y
5	2	Y	31	105	0.3	0.15	0	Y
5	2	Y	31	105	0.3	0.15	1	Y
5	2	Y	31	105	0.3	0.2	2	Y
5	2	Y	31	105	0.3	0.2	0	Y
5	2	Y	31	105	0.3	0.2	2	Y
5	2	Y	31	105	0.3	0.25	1	Y
5	2	Y	31	105	0.3	0.25	1	Y
5	2	Y	31	105	0.3	0.25	1	Y
5	2	Y	31	105	0.3	0.25	1	Y
5	2	Y	31	105	0.3	0.25	1	Y
5	2	Y	31	105	0.3	0.25	1	Y
5	2	Y	31	105	0.3	0.3	1	Y
5	2	Y	31	105	0.3	0.3	1	Y
5	2	Y	31	105	0.3	0.3	1	Y
5	2	Y	31	105	0.3	0.3	1	Y
5	2	Y	31	105	0.3	0.3	1	Y
5	2	Y	31	105	0.3	0.4	2	Y
5	2	Y	31	105	0.3	0.4	1	Y
5	2	Y	31	105	0.3	0.4	1	Y
5	2	Y	31	105	0.3	0.4	1	Y
5	2	Y	31	105	0.3	0.45	1	Y
5	2	Y	31	105	0.3	0.5	1	Y
5	2	Y	31	105	0.3	0.5	0	Y
5	3	Y	12	163	0.07	0.1	NA	N
5	3	Y	16.9	163	0.1	0.25	NA	N
5	3	Y	32.1	163	0.2	0.4	NA	N
5	3	Y	37.8	163	0.23	0.35	NA	N
5	3	Y	37.7	163	0.23	0.1	NA	N
5	3	Y	57.5	163	0.35	0.25	NA	N
5	3	Y	57.7	163	0.35	0.1	NA	N
5	3	Y	59.5	163	0.37	0.25	NA	N
5	3	Y	65.4	163	0.4	0.1	NA	N
5	3	Y	69.2	163	0.42	0.15	NA	N

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
5	3	Y	85.6	163	0.53	0.25	NA	N
5	3	Y	87.2	163	0.53	0.2	NA	N
5	3	Y	88.1	163	0.54	0.25	NA	N
5	3	Y	88.6	163	0.54	0.35	NA	N
5	3	Y	127.1	163	0.78	0.25	NA	N
5	3	Y	141.5	163	0.87	0.2	NA	N
5	3	Y	142.9	163	0.88	0.35	NA	N
5	3	Y	153.1	163	0.94	0.4	NA	N
5	3	Y	156.6	163	0.96	0.1	NA	N
5	3	Y	159.5	163	0.98	0.1	NA	N
5	3	Y	161.9	163	0.99	0.1	NA	N
5	3	Y	29	163	0.18	0.3	2	Y
5	3	Y	29	163	0.18	0.3	1	Y
5	3	Y	29	163	0.18	0.25	1	Y
5	3	Y	29	163	0.18	0.3	2	Y
5	3	Y	29	163	0.18	0.25	2	Y
5	3	Y	44.4	163	0.27	0.2	2	Y
5	3	Y	44.4	163	0.27	0.3	1	Y
5	3	Y	44.4	163	0.27	0.2	1	Y
5	3	Y	74.7	163	0.46	0.3	1	Y
5	3	Y	74.7	163	0.46	0.15	1	Y
5	3	Y	74.7	163	0.46	0.1	1	Y
5	3	Y	74.7	163	0.46	0.15	2	Y
5	3	Y	74.7	163	0.46	0.15	1	Y
5	3	Y	74.7	163	0.46	0.3	1	Y
5	3	Y	74.7	163	0.46	0.2	1	Y
5	3	Y	74.7	163	0.46	0.2	2	Y
5	3	Y	74.7	163	0.46	0.1	2	Y
5	3	Y	74.7	163	0.46	0.1	1	Y
5	3	Y	74.7	163	0.46	0.1	2	Y
5	3	Y	74.7	163	0.46	0.2	2	Y
5	3	Y	74.7	163	0.46	0.2	2	Y
5	3	Y	74.7	163	0.46	0.1	1	Y
5	3	Y	74.7	163	0.46	0.1	1	Y
5	3	Y	74.7	163	0.46	0.2	2	Y
5	3	Y	74.7	163	0.46	0.15	2	Y
5	3	Y	74.7	163	0.46	0.2	2	Y
5	3	Y	74.7	163	0.46	0.15	2	Y
5	3	Y	74.7	163	0.46	0.1	2	Y
5	3	Y	74.7	163	0.46	0.2	2	Y
5	3	Y	74.7	163	0.46	0.15	1	Y

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
5	3	Y	74.7	163	0.46	0.15	2	Y
5	3	Y	74.7	163	0.46	0.1	2	Y
5	3	Y	74.7	163	0.46	0.15	1	Y
5	3	Y	74.7	163	0.46	0.2	2	Y
5	3	Y	80	163	0.49	0.2	2	Y
5	3	Y	80	163	0.49	0.15	2	Y
5	3	Y	80	163	0.49	0.2	2	Y
5	3	Y	80	163	0.49	0.2	2	Y
5	3	Y	80	163	0.49	0.15	2	Y
5	3	Y	80	163	0.49	0.2	2	Y
5	3	Y	80	163	0.49	0.2	1	Y
5	3	Y	80	163	0.49	0.15	2	Y
5	3	Y	96.8	163	0.59	0.25	1	Y
5	3	Y	96.8	163	0.59	0.2	1	Y
5	3	Y	96.8	163	0.59	0.2	2	Y
5	3	Y	96.8	163	0.59	0.25	1	Y
5	3	Y	96.8	163	0.59	0.1	2	Y
5	3	Y	96.8	163	0.59	0.4	2	Y
5	3	Y	114.5	163	0.7	0.25	1	Y
5	3	Y	114.5	163	0.7	0.2	2	Y
5	3	Y	114.5	163	0.7	0.3	2	Y
5	3	Y	114.5	163	0.7	0.2	1	Y
5	3	Y	114.5	163	0.7	0.25	2	Y
5	3	Y	114.5	163	0.7	0.4	1	Y
5	3	Y	114.5	163	0.7	0.5	1	Y
5	3	Y	114.5	163	0.7	0.15	1	Y
5	3	Y	114.5	163	0.7	0.1	2	Y
5	3	Y	114.5	163	0.7	0.3	2	Y
5	3	Y	114.5	163	0.7	0.2	2	Y
5	3	Y	114.5	163	0.7	0.1	2	Y
5	3	Y	114.5	163	0.7	0.15	2	Y
5	3	Y	114.5	163	0.7	0.25	1	Y
5	3	Y	114.5	163	0.7	0.2	2	Y
5	3	Y	114.5	163	0.7	0.3	2	Y
5	3	Y	114.5	163	0.7	0.25	2	Y
5	3	Y	114.5	163	0.7	0.4	1	Y
5	3	Y	114.5	163	0.7	0.25	2	Y
5	3	Y	114.5	163	0.7	0.4	1	Y
5	3	Y	114.5	163	0.7	0.5	1	Y
5	3	Y	114.5	163	0.7	0.3	2	Y
5	3	Y	114.5	163	0.7	0.2	2	Y

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
5	3	Y	114.5	163	0.7	0.3	2	Y
5	3	Y	114.5	163	0.7	0.5	2	Y
5	3	Y	114.5	163	0.7	0.25	2	Y
5	3	Y	114.5	163	0.7	0.1	2	Y
5	3	Y	114.5	163	0.7	0.4	1	Y
5	3	Y	114.5	163	0.7	0.2	1	Y
5	3	Y	114.5	163	0.7	0.5	1	Y
5	3	Y	114.5	163	0.7	0.4	1	Y
5	3	Y	114.5	163	0.7	0.3	2	Y
5	3	Y	114.5	163	0.7	0.3	2	Y
5	3	Y	114.5	163	0.7	0.15	1	Y
5	4	Y	84.5	267.2	0.32	0.15	NA	N
5	4	Y	85.9	267.2	0.32	0.15	NA	N
5	4	Y	81.4	267.2	0.3	0.4	NA	N
5	4	Y	87.3	267.2	0.33	0.1	NA	N
5	4	Y	99.4	267.2	0.37	0.2	NA	N
5	4	Y	107.5	267.2	0.4	0.15	NA	N
5	4	Y	116.5	267.2	0.44	0.1	NA	N
5	4	Y	116.9	267.2	0.44	0.1	NA	N
5	4	Y	118	267.2	0.44	0.25	NA	N
5	4	Y	121	267.2	0.45	0.15	NA	N
5	4	Y	123.5	267.2	0.46	0.3	NA	N
5	4	Y	124.4	267.2	0.47	0.15	NA	N
5	4	Y	125.2	267.2	0.47	0.25	NA	N
5	4	Y	127.5	267.2	0.48	0.1	NA	N
5	4	Y	128.7	267.2	0.48	0.25	NA	N
5	4	Y	130.3	267.2	0.49	0.25	NA	N
5	4	Y	131	267.2	0.49	0.3	NA	N
5	4	Y	134.7	267.2	0.5	0.2	NA	N
5	4	Y	135.3	267.2	0.51	0.25	NA	N
5	4	Y	139	267.2	0.52	0.1	NA	N
5	4	Y	139.5	267.2	0.52	0.35	NA	N
5	4	Y	143.8	267.2	0.54	0.15	NA	N
5	4	Y	152.6	267.2	0.57	0.45	NA	N
5	4	Y	155.7	267.2	0.58	0.35	NA	N
5	4	Y	169.7	267.2	0.64	0.1	NA	N
5	4	Y	177.3	267.2	0.66	0.4	NA	N
5	4	Y	178.5	267.2	0.67	0.15	NA	N
5	4	Y	182.1	267.2	0.68	0.1	NA	N
5	4	Y	193.4	267.2	0.72	0.15	NA	N
5	4	Y	194.1	267.2	0.73	0.15	NA	N

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
5	4	Y	214	267.2	0.8	0.4	NA	N
5	4	Y	231.6	267.2	0.87	0.25	NA	N
5	4	Y	231.6	267.2	0.87	0.3	NA	N
5	4	Y	263.1	267.2	0.98	0.25	NA	N
5	4	Y	263.1	267.2	0.98	0.3	NA	N
5	4	Y	263.7	267.2	0.99	0.5	NA	N
5	4	Y	265.8	267.2	0.99	0.15	NA	N
5	4	Y	205.5	267.2	0.77	0.35	2	Y
5	4	Y	205.5	267.2	0.77	0.1	2	Y
5	4	Y	205.5	267.2	0.77	0.1	2	Y
5	4	Y	205.5	267.2	0.77	0.2	2	Y
5	4	Y	205.5	267.2	0.77	0.15	2	Y
5	4	Y	205.5	267.2	0.77	0.2	2	Y
5	4	Y	205.5	267.2	0.77	0.25	2	Y
6	1	N	3.6	36.3	0.1	0.1	NA	N
6	1	N	13.3	36.3	0.37	0.15	NA	N
6	1	N	14.6	36.3	0.4	0.15	NA	N
6	1	N	16.3	36.3	0.45	0.2	NA	N
6	1	N	16.5	36.3	0.45	0.2	NA	N
6	1	N	17.3	36.3	0.48	0.3	NA	N
6	1	N	21	36.3	0.58	0.25	NA	N
6	1	N	22.4	36.3	0.62	0.35	NA	N
6	1	N	26.7	36.3	0.74	0.1	NA	N
6	1	N	27.5	36.3	0.76	0.3	NA	N
6	1	N	29.6	36.3	0.82	0.3	NA	N
6	1	N	32.5	36.3	0.9	0.15	NA	N
6	1	N	36.2	36.3	1	0.15	NA	N
6	1	N	0.9	36.3	0.02	0.2	0	Y
6	1	N	0.9	36.3	0.02	0.15	0	Y
6	1	N	0.9	36.3	0.02	0.15	0	Y
6	1	N	9.5	36.3	0.26	0.5	0	Y
6	1	N	9.5	36.3	0.26	0.1	0	Y
6	1	N	9.5	36.3	0.26	0.25	0	Y
6	2	N	0.5	27.8	0.02	0.3	NA	N
6	2	N	0.8	27.8	0.03	0.1	NA	N
6	2	N	3.8	27.8	0.14	0.2	NA	N
6	2	N	3.8	27.8	0.14	0.3	NA	N
6	2	N	4.1	27.8	0.15	0.2	NA	N
6	2	N	3.9	27.8	0.14	0.15	NA	N
6	2	N	4.6	27.8	0.17	0.2	NA	N
6	2	N	4.9	27.8	0.18	0.5	NA	N

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
6	2	N	5.8	27.8	0.21	0.35	NA	N
6	2	N	6.2	27.8	0.22	0.1	NA	N
6	2	N	6.2	27.8	0.22	0.15	NA	N
6	2	N	7.7	27.8	0.28	0.2	NA	N
6	2	N	7.7	27.8	0.28	0.15	NA	N
6	2	N	16.5	27.8	0.59	0.15	NA	N
6	2	N	18.9	27.8	0.68	0.15	NA	N
6	2	N	22.7	27.8	0.82	0.15	0	Y
6	2	N	22.7	27.8	0.82	0.3	0	Y
6	2	N	22.7	27.8	0.82	0.2	0	Y
6	3	N	2.8	6.3	0.44	0.25	NA	N
7	3	N	1.1	4.3	0.26	0.3	NA	N
7	4	N	42.9	43.7	0.98	0.3	NA	N
7	4	N	40.5	43.7	0.93	0.21	NA	N
7	4	N	39.5	43.7	0.9	0.2	NA	N
7	4	N	37.8	43.7	0.86	0.35	NA	N
7	4	N	25.3	43.7	0.58	0.2	NA	N
7	4	N	20	43.7	0.46	0.3	NA	N
7	4	N	18.5	43.7	0.42	0.1	NA	N
7	4	N	10	43.7	0.23	0.3	0	Y
7	4	N	10	43.7	0.23	0.2	0	Y
7	4	N	10	43.7	0.23	0.2	0	Y
7	4	N	10	43.7	0.23	0.15	0	Y
7	4	N	10	43.7	0.23	0.1	1	Y
7	4	N	10	43.7	0.23	0.2	0	Y
7	4	N	10	43.7	0.23	0.1	0	Y
7	4	N	10	43.7	0.23	0.25	0	Y
7	4	N	10	43.7	0.23	0.1	0	Y
7	4	N	10	43.7	0.23	0.2	0	Y
7	4	N	10	43.7	0.23	0.1	0	Y
7	4	N	10	43.7	0.23	0.25	0	Y
7	4	N	10	43.7	0.23	0.2	0	Y
7	4	N	10	43.7	0.23	0.5	0	Y
7	4	N	10	43.7	0.23	0.1	0	Y
7	4	N	10	43.7	0.23	0.3	0	Y
7	4	N	10	43.7	0.23	0.2	0	Y
8	1	N	1.3	3.5	0.37	0.3	0	Y
8	1	N	1.3	3.5	0.37	0.3	0	Y
8	1	N	1.3	3.5	0.37	0.35	0	Y
8	2	N	1.4	6.5	0.22	0.35	NA	N
8	2	N	2.8	6.5	0.43	0.13	NA	N

SR	T	B?	DR	FPW	DR/FPW	D	BC	J?
8	3	N	8.5	11.4	0.75	0.12	NA	N
8	3	N	8.6	11.4	0.75	0.1	NA	N
8	3	N	8.6	11.4	0.75	0.45	NA	N
8	3	N	9.6	11.4	0.84	0.2	NA	N
8	4	N	4.7	7.9	0.59	0.2	NA	N
8	4	N	2.2	7.9	0.28	0.2	0	Y
8	4	N	2.2	7.9	0.28	0.1	0	Y
8	4	N	2.2	7.9	0.28	0.15	0	Y
8	4	N	2.2	7.9	0.28	0.1	0	Y
8	4	N	2.2	7.9	0.28	0.2	0	Y
8	4	N	2.2	7.9	0.28	0.11	0	Y
8	4	N	2.2	7.9	0.28	0.25	0	Y
8	4	N	2.2	7.9	0.28	0.1	0	Y
8	4	N	2.2	7.9	0.28	0.13	0	Y

Table 25. Floodplain Jam Data

SR	T	Jam #	DR	# LW Pieces	JL	JW	H	p	Piece Volume (m^3)	Rectangle Volume (m^3)	Avg. BC	% Diff.
3	1	FP01	5.5	4	13	2	1	0.6	1.96	10.4	1.5	137%
3	1	FP02	64	77	8	15	1	0.35	14.55	78	1.79	137%
3	3	FP03	92	17	2.5	12	1	0.35	1.32	19.5	1.41	175%
3	4	FP04	15	6	8	1.5	0.3	0.55	1.32	1.4	1.67	3%
3	4	FP05	35	5	1.5	9	0.5	0.4	0.78	4.1	1.8	135%
3	4	FP06	49	27	5	11	0.8	0.2	3.65	33	1.59	160%
4	1	FP07	62	16	2.5	10	0.5	0.55	1.96	5.6	1.06	97%
4	1	FP08	107.5	15	5	10	0.3	0.6	2.6	5	1.33	63%
4	2	FP09	33	46	4	16	1	0.4	5.84	38.4	1.76	147%
4	3	FP10	49.8	37	7	11	0.5	0.35	5.39	25	1.76	129%
4	3	FP11	140.1	23	5	7	0.5	0.5	3.53	8.8	1.7	85%
5	1	FP12	3	27	10	7.5	0.5	0.6	5.09	15	0.59	99%
5	1	FP13	57.8	3	1	2	0.5	0.4	0.6	0.6	1.33	0%
5	1	FP14	93.8	23	5	13	0.5	0.65	7.94	11.4	1.48	36%
5	2	FP15	31	35	15	6	0.5	0.1	5.52	40.5	0.97	152%
5	3	FP16	29	5	5	1	0.3	0.7	1.42	0.4	1.6	-116%
5	3	FP17	44.4	3	4	2	0.5	0.5	0.45	2	1.33	127%
5	3	FP18	74.7	26	8	2	0.5	0.5	2.14	4	1.58	61%
5	3	FP19	80	8	4	3	0.5	0.6	0.44	2.4	1.88	137%
5	3	FP20	96.8	6	2	5	0.5	0.7	1.36	1.5	1.5	10%
5	3	FP21	114.5	34	12	8	0.5	0.55	10.72	21.6	1.59	67%
5	4	FP22	205.5	7	4	1	0.3	0.45	0.98	0.6	2	-56%

SR	T	Jam #	DR	# LW Pieces	JL	JW	H	p	Piece Volume (m^3)	Rectangle Volume (m^3)	Avg. BC	% Diff.
6	1	FP23	0.9	3	5	2	0.5	0.55	0.25	2.3	0	160%
6	1	FP24	9.5	3	3	3.5	0.5	0.45	0.75	2.9	0	117%
6	2	FP25	22.7	3	1	4	0.5	0.2	0.44	1.6	0	114%
7	4	FP26	10	17	8	8.2	0.5	0.4	1.54	19.7	0.06	171%
8	1	FP27	1.3	3	2	2	0.5	0.25	0.34	1.5	0	125%
8	4	FP28	2.2	9	8	2.5	0.5	0.4	0.68	6	0	159%

Table 26. Valley Bottom Large Wood Data

SR	T	DR	VBW	DR/VBW (m/m)	D	BC	J?
1	2	28	23.3	1.2	0.3	NA	N
1	2	30.3	23.3	1.3	0.35	NA	N
1	2	31.4	23.3	1.35	0.2	NA	N
1	2	32.5	23.3	1.39	0.15	NA	N
1	2	56.6	23.3	2.43	0.1	NA	N
1	3	32	28.5	1.12	0.35	NA	N
1	3	34.9	28.5	1.22	0.6	NA	N
1	3	38.9	28.5	1.36	0.1	NA	N
1	4	43.1	42.5	1.01	0.1	NA	N
1	4	45.4	42.5	1.07	0.3	NA	N
1	4	48	42.5	1.13	0.25	NA	N
1	4	50	42.5	1.18	0.1	NA	N
1	4	50.4	42.5	1.19	0.1	NA	N
1	4	51	42.5	1.2	0.45	NA	N
2	1	82.4	77	1.07	0.4	NA	N
2	2	97.5	95.7	1.02	0.3	NA	N
2	2	98.6	95.7	1.03	0.1	NA	N
2	2	98.6	95.7	1.03	0.1	NA	N
2	2	99.7	95.7	1.04	0.4	NA	N
2	2	100.6	95.7	1.05	0.4	NA	N
2	2	103	95.7	1.08	0.1	NA	N
2	3	74.7	71.1	1.05	0.25	NA	N
2	3	76.5	71.1	1.08	0.1	NA	N
3	1	88	85	1.04	0.5	NA	N
3	3	111.2	108	1.03	0.3	NA	N
3	3	112	108	1.04	0.25	NA	N
3	3	117.4	108	1.09	0.2	NA	N
3	3	131.7	108	1.22	0.2	NA	N
3	3	134	108	1.24	0.3	NA	N
3	4	77	75.9	1.01	0.2	NA	N

SR	T	DR	VBW	DR/VBW (m/m)	D	BC	J?
4	1	130.7	129.8	1.01	0.1	NA	N
4	1	136.4	129.8	1.05	0.2	NA	N
4	1	140.5	129.8	1.08	0.25	NA	N
4	1	150.3	129.8	1.16	0.2	NA	N
4	1	152.8	129.8	1.18	0.15	NA	N
4	1	167.3	129.8	1.29	0.5	NA	N
4	1	168	129.8	1.29	0.1	NA	N
4	1	187.9	129.8	1.45	0.15	NA	N
4	1	294	129.8	2.27	0.15	NA	N
4	1	293	129.8	2.26	0.15	NA	N
4	1	286.1	129.8	2.2	0.2	NA	N
4	1	266.1	129.8	2.05	0.15	NA	N
4	1	256.3	129.8	1.97	0.2	NA	N
4	1	252.8	129.8	1.95	0.15	NA	N
4	1	245.6	129.8	1.89	0.15	NA	N
4	1	241.6	129.8	1.86	0.25	NA	N
4	1	237.7	129.8	1.83	0.25	NA	N
4	1	237.3	129.8	1.83	0.25	NA	N
4	1	233	129.8	1.8	0.1	NA	N
4	1	231	129.8	1.78	0.1	NA	N
4	1	222.3	129.8	1.71	0.15	NA	N
4	1	219.8	129.8	1.69	0.3	NA	N
4	1	219.8	129.8	1.69	0.15	NA	N
4	1	305.7	129.8	2.36	0.5	NA	N
4	1	306.2	129.8	2.36	0.15	NA	N
4	1	311.9	129.8	2.4	0.25	NA	N
4	1	326.7	129.8	2.52	0.35	NA	N
4	2	128.1	127	1.01	0.15	NA	N
4	2	128.9	127	1.01	0.3	NA	N
4	2	129.7	127	1.02	0.35	NA	N
4	2	139.6	127	1.1	0.3	NA	N
4	2	158.7	127	1.25	0.35	NA	N
4	2	164.8	127	1.3	0.15	NA	N
4	2	166.1	127	1.31	0.3	NA	N
4	2	183	127	1.44	0.3	NA	N
4	2	202	127	1.59	0.25	NA	N
4	2	206.5	127	1.63	0.15	NA	N
4	3	196.5	157.4	1.25	0.45	NA	N
4	3	195	157.4	1.24	0.45	NA	N
4	3	186.3	157.4	1.18	0.2	NA	N
4	3	185	157.4	1.18	0.3	NA	N

SR	T	DR	VBW	DR/VBW (m/m)	D	BC	J?
4	3	184	157.4	1.17	0.1	NA	N
4	3	183.3	157.4	1.16	0.1	NA	N
4	3	183.3	157.4	1.16	0.1	NA	N
4	3	183.7	157.4	1.17	0.3	NA	N
4	3	180.1	157.4	1.14	0.15	NA	N
4	3	179.7	157.4	1.14	0.15	NA	N
4	3	176.7	157.4	1.12	0.1	NA	N
4	3	175.7	157.4	1.12	0.25	NA	N
4	3	174.4	157.4	1.11	0.15	NA	N
4	3	172.8	157.4	1.1	0.3	NA	N
4	3	172.7	157.4	1.1	0.15	NA	N
4	3	169.9	157.4	1.08	0.15	NA	N
4	3	158.4	157.4	1.01	0.2	NA	N
4	3	293.9	157.4	1.87	0.15	NA	N
4	3	270.6	157.4	1.72	0.1	NA	N
4	3	244.1	157.4	1.55	0.1	NA	N
4	3	229	157.4	1.45	0.1	NA	N
4	3	220.9	157.4	1.4	0.15	NA	N
4	3	219.2	157.4	1.39	0.1	NA	N
4	3	219.2	157.4	1.39	0.2	NA	N
4	3	211.6	157.4	1.34	0.15	NA	N
4	3	211	157.4	1.34	0.3	NA	N
5	1	118.6	113.8	1.04	0.25	NA	N
5	2	110.9	105	1.06	0.2	NA	N
5	2	111.7	105	1.06	0.31	NA	N
5	2	110.7	105	1.05	0.15	NA	N
5	2	118.3	105	1.13	0.3	NA	N
5	2	119.2	105	1.14	0.15	NA	N
5	2	120.5	105	1.15	0.2	NA	N
5	2	161.2	105	1.54	0.15	NA	N
5	3	170.2	163	1.04	0.6	NA	N
5	3	173.8	163	1.07	0.5	NA	N
5	3	179.4	163	1.1	0.35	NA	N
5	3	182.2	163	1.12	0.4	NA	N
5	3	197.5	163	1.21	0.15	NA	N
5	3	198.1	163	1.22	0.2	NA	N
5	3	290.6	163	1.78	0.2	NA	N
5	3	290	163	1.78	0.1	NA	N
5	3	289.4	163	1.78	0.2	NA	N
5	3	286.6	163	1.76	0.2	NA	N
5	3	281.7	163	1.73	0.15	NA	N

SR	T	DR	VBW	DR/VBW (m/m)	D	BC	J?
5	3	279.7	163	1.72	0.1	NA	N
5	3	275.6	163	1.69	0.2	NA	N
5	3	275.3	163	1.69	0.3	NA	N
5	3	274	163	1.68	0.3	NA	N
5	3	270.9	163	1.66	0.1	NA	N
5	3	254.1	163	1.56	0.15	NA	N
5	3	251.7	163	1.54	0.15	NA	N
5	3	249.6	163	1.53	0.3	NA	N
5	3	249.6	163	1.53	0.1	NA	N
5	3	249.6	163	1.53	0.15	NA	N
5	3	248.9	163	1.53	0.15	NA	N
5	3	247.9	163	1.52	0.35	NA	N
5	3	247.5	163	1.52	0.2	NA	N
5	3	246.4	163	1.51	0.1	NA	N
5	3	273.6	163	1.68	0.35	NA	N
5	3	226.6	163	1.39	0.3	NA	N
5	3	224.3	163	1.38	0.35	NA	N
5	3	222.5	163	1.37	0.1	NA	N
5	3	206.9	163	1.27	0.3	NA	N
5	3	206.4	163	1.27	0.2	NA	N
5	3	205.3	163	1.26	0.1	NA	N
5	3	203.3	163	1.25	0.1	NA	N
5	4	271.9	267.2	1.02	0.25	NA	N
5	4	278.3	267.2	1.04	0.15	NA	N
5	4	280.8	267.2	1.05	0.1	NA	N
5	4	301.3	267.2	1.13	0.25	NA	N
5	4	310.4	267.2	1.16	0.15	NA	N
5	4	314	267.2	1.18	0.25	NA	N
5	4	324.7	267.2	1.22	0.15	NA	N
5	4	326.4	267.2	1.22	0.1	NA	N
5	4	330	267.2	1.24	0.35	NA	N
5	4	351.8	267.2	1.32	0.1	NA	N
5	4	352.7	267.2	1.32	0.1	NA	N
5	4	355.3	267.2	1.33	0.1	NA	N
5	4	355.6	267.2	1.33	0.1	NA	N
5	4	365.3	267.2	1.37	0.4	NA	N
5	4	366.2	267.2	1.37	0.15	NA	N
5	4	369.1	267.2	1.38	0.3	NA	N
5	4	371.5	267.2	1.39	0.15	NA	N
5	4	372.5	267.2	1.39	0.15	NA	N
5	4	387.6	267.2	1.45	0.25	NA	N

SR	T	DR	VBW	DR/VBW (m/m)	D	BC	J?
5	4	392.6	267.2	1.47	0.2	NA	N
5	4	396.8	267.2	1.49	0.3	NA	N
5	4	399.3	267.2	1.49	0.25	NA	N
5	4	400.7	267.2	1.5	0.25	NA	N
5	4	415.8	267.2	1.56	0.1	NA	N
5	4	416	267.2	1.56	0.15	NA	N
5	4	427.6	267.2	1.6	0.3	NA	N
5	4	430	267.2	1.61	0.4	NA	N
5	4	441.8	267.2	1.65	0.15	NA	N
5	4	447.4	267.2	1.67	0.1	NA	N
5	4	456.3	267.2	1.71	0.2	NA	N
5	4	468	267.2	1.75	0.4	NA	N
6	2	29.2	27.8	1.05	0.1	NA	N
6	2	32.3	27.8	1.16	0.15	NA	N
7	4	47	43.7	1.08	0.3	NA	N
7	4	46.6	43.7	1.07	0.3	NA	N
7	4	46.3	43.7	1.06	0.35	NA	N
7	4	45.5	43.7	1.04	0.15	NA	N
7	4	45.1	43.7	1.03	0.3	NA	N
7	4	44	43.7	1.01	0.25	NA	N
8	1	7.2	3.5	2.06	0.2	NA	N
8	1	11.9	3.5	3.4	0.6	NA	N
8	1	17.3	3.5	4.94	0.7	NA	N
8	2	9.5	6.5	1.46	0.1	NA	N
8	3	15.3	11.4	1.34	0.3	NA	N

Table 27. Floodplain and Valley Bottom Water Features Data

SR	T	Tag	DR	FPW	DR/FPW (m/m)	D
1	2	FPSC	22	23.3	0.94	3.5
1	3	FPSC	15	28.5	0.53	2
1	3	FPSC	27.3	28.5	0.96	2
1	4	FPSC	31	42.5	0.73	6
1	4	FPSC	39.9	42.5	0.94	3.5
1	4	FPGW	26	42.5	0.61	2
2	1	FPSC	40	77	0.52	3
2	1	FPSC	58.6	77	0.76	2
2	1	FPGW	50.6	77	0.66	1.5
2	1	FPGW	53.8	77	0.7	1.5
2	1	FPGW	63.5	77	0.82	2
2	2	FPSC	46	95.7	0.48	10

SR	T	Tag	DR	FPW	DR/FPW (m/m)	D
2	2	FPSC	87.2	95.7	0.91	2.5
2	2	FPGW	15.3	95.7	0.16	2
2	2	FPGW	19	95.7	0.2	2.5
2	3	FPSC	20.4	71.1	0.29	3
2	3	FPSC	64	71.1	0.9	2.3
3	1	FPSC/AM	49	85	0.58	64
3	2	FPSC	28	190.1	0.15	15.8
3	2	FPSC	47	190.1	0.25	7.8
3	2	FPSC/AM	130.3	190.1	0.69	119.6
3	2	FPGW	58	190.1	0.31	6
3	2	FPGW	176	190.1	0.93	4.5
3	2	FPGW/ BANK OVERFLOW	6.5	190.1	0.03	1
3	2	FPGW/ BANK OVERFLOW	13	190.1	0.07	2
3	3	FPSC	17	108	0.16	9
3	3	FPSC	34	108	0.31	7
3	3	FPSC	90	108	0.83	7
3	3	FPGW	70	108	0.65	9.5
3	4	FPSC	28	75.9	0.37	23
3	4	FPSC	58	75.9	0.76	4
4	1	FPSC	13.4	129.8	0.1	5
4	1	FPSC	46	129.8	0.35	11.5
4	1	FPSC	82	129.8	0.63	8
4	1	FPSC	109.4	129.8	0.84	7.5
4	1	VGW	174.7	129.8	1.35	2.5
4	2	FPSC	33	127	0.26	7
4	2	FPSC	39	127	0.31	27.7
4	2	FPSC/AM	94	127	0.74	39
4	2	FPGW	47.7	127	0.38	1.5
4	3	FPSC	145.5	157.4	0.92	50
4	3	FPSC/AM	76	157.4	0.48	18.2
4	3	FPSC/FLOODED FP	14.5	157.4	0.09	28.9
4	4	FPSC	51.7	96.7	0.53	9.5
4	4	FPSC	77.9	96.7	0.81	37.7
4	4	FPGW	9.6	96.7	0.1	3
5	1	FPSC	53.9	113.8	0.47	9
5	1	FPSC	92.3	113.8	0.81	16.2
5	2	FPSC	31	105	0.3	11
5	2	FPSC	95.2	105	0.91	7
5	2	FPGW	22.5	105	0.21	0.8
5	2	FPGW	82.5	105	0.79	1
5	3	FPPOND	116.4	163	0.71	93.2

SR	T	Tag	DR	FPW	DR/FPW (m/m)	D
5	3	VGW	239.2	163	1.47	1
5	3	FPGW	5.5	163	0.03	3.5
5	4	FPSC	18.2	267.2	0.07	3.5
5	4	FPSC	30	267.2	0.11	2.5
5	4	FPSC	75.7	267.2	0.28	9.5
5	4	FPSC/AM	174	267.2	0.65	6.5
5	4	FPSC/AM	252.9	267.2	0.95	28.6
5	4	VGW	298.2	267.2	1.12	1
5	4	VGW	381.2	267.2	1.43	2
5	4	VGW	444	267.2	1.66	2
5	4	FPGW	48.5	267.2	0.18	3
5	4	FPGW	60	267.2	0.22	3.5
5	4	FPGW	165	267.2	0.62	2.5
5	4	FPGW	236	267.2	0.88	2
6	1	FPSC	32.7	36.3	0.9	7.4
6	2	FPSC	14	27.8	0.5	4
7	4	FPSC	41.2	43.7	0.94	3.2

Table 28. Location Widths Data

SR	T	BFW	FPW	VBW
1	2	15.6	23.3	36.4
1	3	31.8	28.5	27.1
1	4	26.7	42.5	10.7
1	1	19.8	9.4	0
1		17.3	NA	NA
1		21.9	NA	NA
1		24.7	49.1	NA
1		29.3	NA	NA
2	1	41.2	77	8.2
2	2	26.1	95.7	7.3
2	3	28.3	71.1	6.2
2	4	15.8	3	0
2		28.9	28.9	NA
2		27	NA	NA
2		36.3	NA	NA
2		36.7	NA	NA
2		39.9	NA	NA
2		49	NA	NA
2		51.5	NA	NA
2		54	NA	NA

SR	T	BFW	FPW	VBW
3	3	30.6	108	28
3	1	22.6	85	11.6
3		30	113.4	6.4
3	4	19.7	75.9	5.4
3	2	28.4	190.1	0
3		31	NA	NA
3		33	NA	NA
3		33.6	NA	NA
3		47	NA	NA
3		53	NA	NA
3		72	NA	NA
4		32	24.2	260.1
4	1	24	129.8	202.2
4		55	19	201.4
4		38	56.7	178
4		22	172	174.5
4	3	31.2	157.4	172.8
4		35.9	205.5	168.2
4		33.6	112.3	159
4		21.5	161.5	150
4		31.8	88.5	145.5
4		NA	NA	132.5
4		28.6	138.4	121.1
4		30.3	137.8	119.6
4		40	100.7	108.7
4		39.4	116.1	98
4	2	39.2	127	83
4		25	147	36.8
4		22.8	69.7	9.9
4	4	24.1	96.7	0
4		28.9	74	0
5		31	198.2	249.7
5	4	35.1	267.2	233.3
5		29	117.6	210
5		27	106.7	198.6
5		70	133.8	186.7
5	3	65.3	163	181.5
5		38.1	107.9	174.8
5		43.5	196.4	174.5
5		26.3	112.3	160
5		30.8	81.6	147.6

SR	T	BFW	FPW	VBW
5	2	23.7	105	124.5
5	1	32.6	113.8	13.5
6		30	6.8	136
6		32.2	28.2	19.1
6		30	19.7	15.7
6		30.1	15.7	14.2
6		29	9	14.2
6	2	22.4	27.8	10.8
6		21.1	2.7	8
6		30.2	13.6	6.5
6		37.7	9.9	5.7
6		33.3	17.3	5.6
6	1	26.1	36.3	5.3
6		28.2	3	5
6		32	24.2	4
6		39.4	38.5	3.7
6		30.3	19.8	3.7
6		29.5	15.1	3.5
6		31.8	9.4	2.8
6		26.9	14.1	2.5
6		45	13.1	2.3
6		30	10.8	2.3
6		27.3	9.4	2.1
6	3	30.5	6.3	1.4
6		33.6	4.8	1
6		22	16.9	0
6		23.9	7.5	0
6		24.2	6.4	0
6	4	28.2	5	0
6		21.4	4.5	0
6		29.8	1.5	0
6		31	1	0
6		31	34.5	NA
6		27	28.9	NA
7	4	30.7	43.7	6.5
7	1	27.5	4.7	3.4
7		31	1	1
7	3	25.9	4.3	0.8
7	2	30.9	5.6	0.6
7		36.8	1.5	0
7		31	1	0

SR	T	BFW	FPW	VBW
7		34.1	1	0
7		38	8	NA
7		35	3.2	NA
7		39.6	30	NA
8	1	33.5	3.5	18.3
8	2	32.2	6.5	7.5
8	3	27.1	11.4	5.1
8	4	34.2	7.9	2.1
8		36.4	1.9	1.1
8		30.4	3.6	0
8		33.2	0	0
8		39	0	0
8		36.1	6.2	NA
8		46.6	3	NA

Table 29. Sub-Reach Summary Data

Sub-Reach	1	2	3	4	5	6	7	8
SR Length (m)	166.3	536.4	306.1	1393.7	669.9	1462.6	360.1	221.3
S	1.02	1.09	1.17	1.36	1.22	1.19	1.04	1.03
B?	Y	Y	Y	Y	Y	N	N	N
# Water Features	6	11	14	15	21	2	1	0
# Mapped Wetlands	0	0	1	3	3	1	0	0
# River Jams	2	3	1	11	9	9	1	2
# Floodplain Jams	0	0	6	5	11	3	1	2
Total LW Load (m^3/m^2)	0.0868	0.1286	0.0776	0.0567	0.0794	0.0856	0.1068	0.1351
River LW Load (m^3/m^2)	0.0003	0.0015	0.0001	0.0020	0.0016	0.0589	0.0005	0.0009
Avg. Floodplain LW Load (m^3/m^2)	0.0100	0.0142	0.0276	0.0263	0.0342	0.0231	0.0157	0.0508
Avg. Valley Bottom LW Load (m^3/m^2)	0.0765	0.1129	0.0499	0.0284	0.0436	0.0037	0.0906	0.0834
Avg. River LW D	0.2630	0.2994	0.2133	0.2647	0.2747	0.2286	0.2400	0.2500
Avg. Floodplain LW D	0.2100	0.2598	0.1930	0.2189	0.2224	0.2145	0.2164	0.2021
Avg. Valley Bottom LW D	0.2464	0.2389	0.2786	0.2087	0.2161	0.1250	0.2750	0.3800
Avg. BFW	23.39	36.23	36.45	31.74	37.70	29.53	32.77	34.87
Avg. FPW	30.56	55.14	114.48	117.23	141.96	14.43	9.45	4.40
Avg. VBW	18.55	5.43	10.28	119.01	171.23	9.18	1.54	4.26
FPW/VBW (m/m)	1.65	10.16	11.14	0.99	0.83	1.57	6.15	1.03
# River Jams/SR Length	0.0120	0.0056	0.0033	0.0079	0.0134	0.0062	0.0028	0.0090
# Floodplain Jams/FPW	0.0000	0.0000	0.0524	0.0427	0.0775	0.2079	0.1058	0.4545
# Water Features/FPW	0.1963	0.1995	0.1223	0.1280	0.1479	0.1386	0.1058	0.0000
# Mapped Wetlands/SR Length	0.0000	0.0000	0.0033	0.0022	0.0045	0.0007	0.0000	0.0000

Table 30. Transect Summary Data

SR	T	FPW	VBW	Floodplain LW Load (m^3/m^2)	Valley Bottom LW Load (m^3/m^2)	B?
1	1	9.4	0	0.001	0	Y
1	2	23.3	36.4	0.028	0.01	Y
1	3	28.5	27.1	0.01	0.022	Y
1	4	42.5	10.7	0.001	0.044	Y
2	1	77	8.2	0.017	0.024	Y
2	2	95.7	7.3	0.026	0.074	Y
2	3	71.1	6.2	0.014	0.014	Y
2	4	3	0	0	0	Y
3	1	85	11.6	0.06	0.027	Y
3	2	190.1	0	0.006	0	Y
3	3	108	28	0.013	0.014	Y
3	4	75.9	5.4	0.031	0.009	Y
4	1	129.8	202.2	0.023	0.009	Y
4	2	127	83	0.039	0.011	Y
4	3	157.4	172.8	0.03	0.009	Y
4	4	96.7	0	0.014	0	Y
5	1	113.8	13.5	0.039	0.006	Y
5	2	105	54.5	0.038	0.008	Y
5	3	163	131.5	0.048	0.021	Y
5	4	267.2	203.3	0.012	0.01	Y
6	1	36.3	5.3	0.036	0	N
6	2	27.8	10.8	0.044	0.004	N
6	3	6.3	1.4	0.012	0	N
6	4	5	0	0	0	N
7	1	4.7	3.4	0	0	N
7	2	5.6	0.6	0	0	N
7	3	4.3	0.8	0.026	0	N
7	4	43.7	6.5	0.037	0.091	N
8	1	3.5	18.3	0.107	0.06	N
8	2	6.5	7.5	0.026	0.002	N
8	3	11.4	5.1	0.029	0.022	N
8	4	7.9	2.1	0.041	0	N

Data Used for Multivariate Analysis (before transformation)

Table 31. Transect Data Used for Multivariate Analysis

FP LW Load (m^3/m^2)	SR	T	B?	FPW	VBW	VB LW Load (m^3/m^2)	Nearest Basal Area	# Water Features	Portion of LW in Jams
0.001312	1	1	Y	9.4	0.001	1E-10	11	1E-10	1E-10
0.028063	1	2	Y	23.3	36.4	0.009659	11	1	1E-10
0.009956	1	3	Y	28.5	27.1	0.022421	11	2	1E-10
0.000581	1	4	Y	42.5	10.7	0.04439	3	3	1E-10
0.016703	2	1	Y	77	8.2	0.024072	5	5	1E-10
0.026008	2	2	Y	95.7	7.3	0.07436	5	4	1E-10
0.014272	2	3	Y	71.1	6.2	0.014426	13	2	1E-10
1E-10	2	4	Y	3	0.001	1E-10	3	1E-10	1E-10
0.060234	3	1	Y	85	11.6	0.026588	3	1	0.952941
0.005711	3	2	Y	190.1	0.001	1E-10	7	7	1E-10
0.013108	3	3	Y	108	28	0.01421	2	4	0.607143
0.031371	3	4	Y	75.9	5.4	0.009139	2	2	0.883721
0.022573	4	1	Y	129.8	202.2	0.008847	4	4	0.704545
0.038978	4	2	Y	127	83	0.010925	8	4	0.605263
0.029843	4	3	Y	157.4	172.8	0.008621	8	3	0.833333
0.013906	4	4	Y	96.7	0.001	1E-10	3	3	1E-10
0.038784	5	1	Y	113.8	13.5	0.005712	8	2	0.791045
0.037863	5	2	Y	105	54.5	0.007552	8	4	0.744681
0.048023	5	3	Y	163	131.5	0.020687	4	2	0.796117
0.01227	5	4	Y	267.2	203.3	0.009634	4	9	0.159091
0.035771	6	1	N	36.3	5.3	1E-10	9	1	0.315789
0.044267	6	2	N	27.8	10.8	0.003713	14	1	0.166667
0.012239	6	3	N	6.3	1.4	1E-10	11	1E-10	1E-10
1E-10	6	4	N	5	0.001	1E-10	6	1E-10	1E-10
1E-10	7	1	N	4.7	3.4	1E-10	4	1E-10	1E-10
1E-10	7	2	N	5.6	0.6	1E-10	2	1E-10	1E-10
0.025822	7	3	N	4.3	0.8	1E-10	7	1E-10	1E-10
0.036816	7	4	N	43.7	6.5	0.09063	10	1	0.708333
0.106627	8	1	N	3.5	18.3	0.06	4	1E-10	1
0.026458	8	2	N	6.5	7.5	0.001645	4	1E-10	1E-10
0.028884	8	3	N	11.4	5.1	0.021771	4	1E-10	1E-10
0.041227	8	4	N	7.9	2.1	1E-10	4	1E-10	1E-10

Notes:

[1] The floodplain and valley bottom widths that were originally = 0 m were changed to 0.001 m; and floodplain LW load, valley bottom LW load, number of water features, and portion of LW in floodplain jams that were originally = 0 were changed to 1 x 10^{-10} for the square root and natural logarithm transformations.

[2] The basal area values are approximate, as I used whatever value (floodplain or valley bottom) was closest to the transect. Sub-reaches 5 and 8 did not have any basal area measurements in them, so I used the closets values from other sub-reaches.

Multivariate Final Model Diagnostic Plots

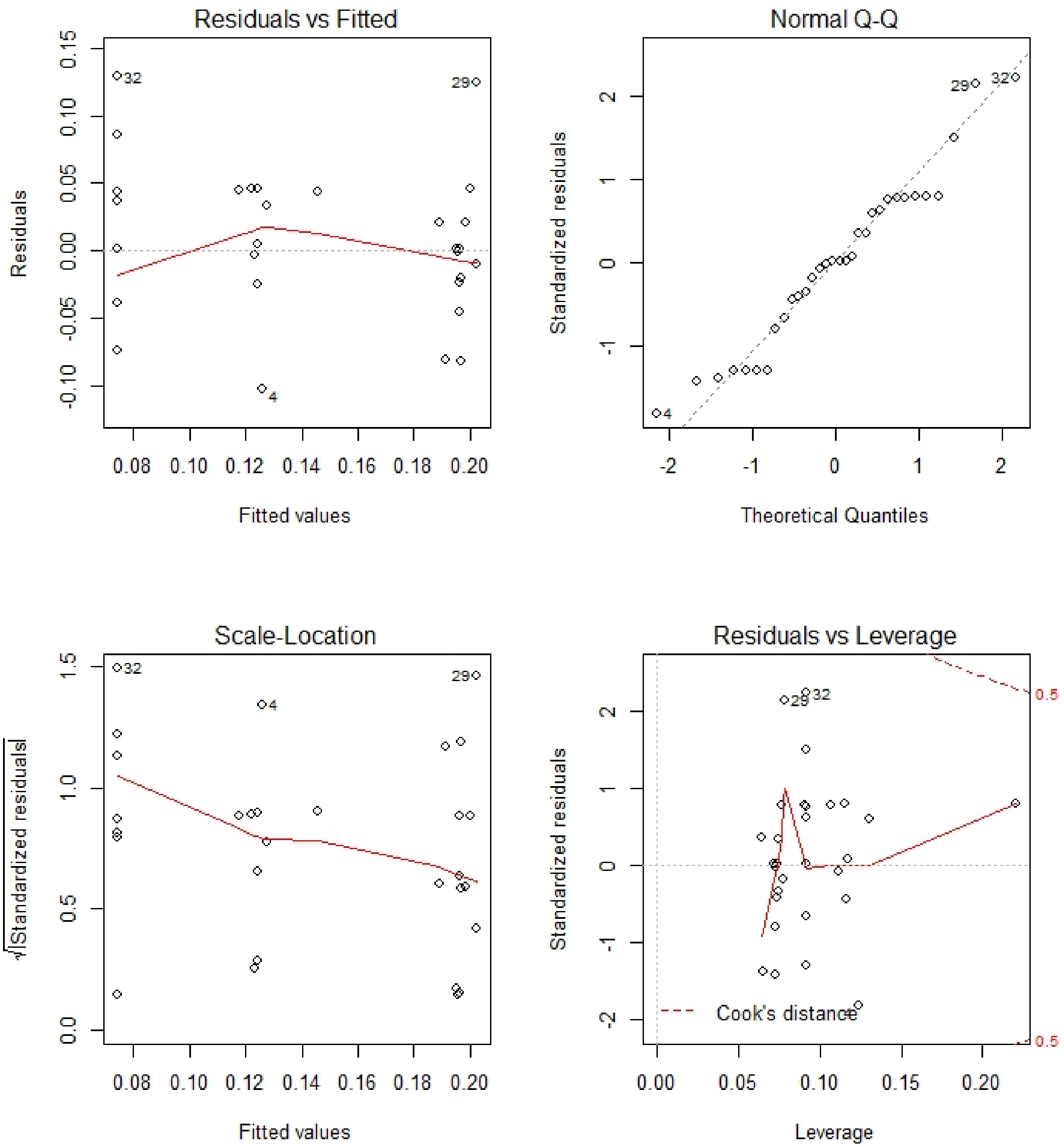

Figure 36. Diagnostic plots for transect model with all transects

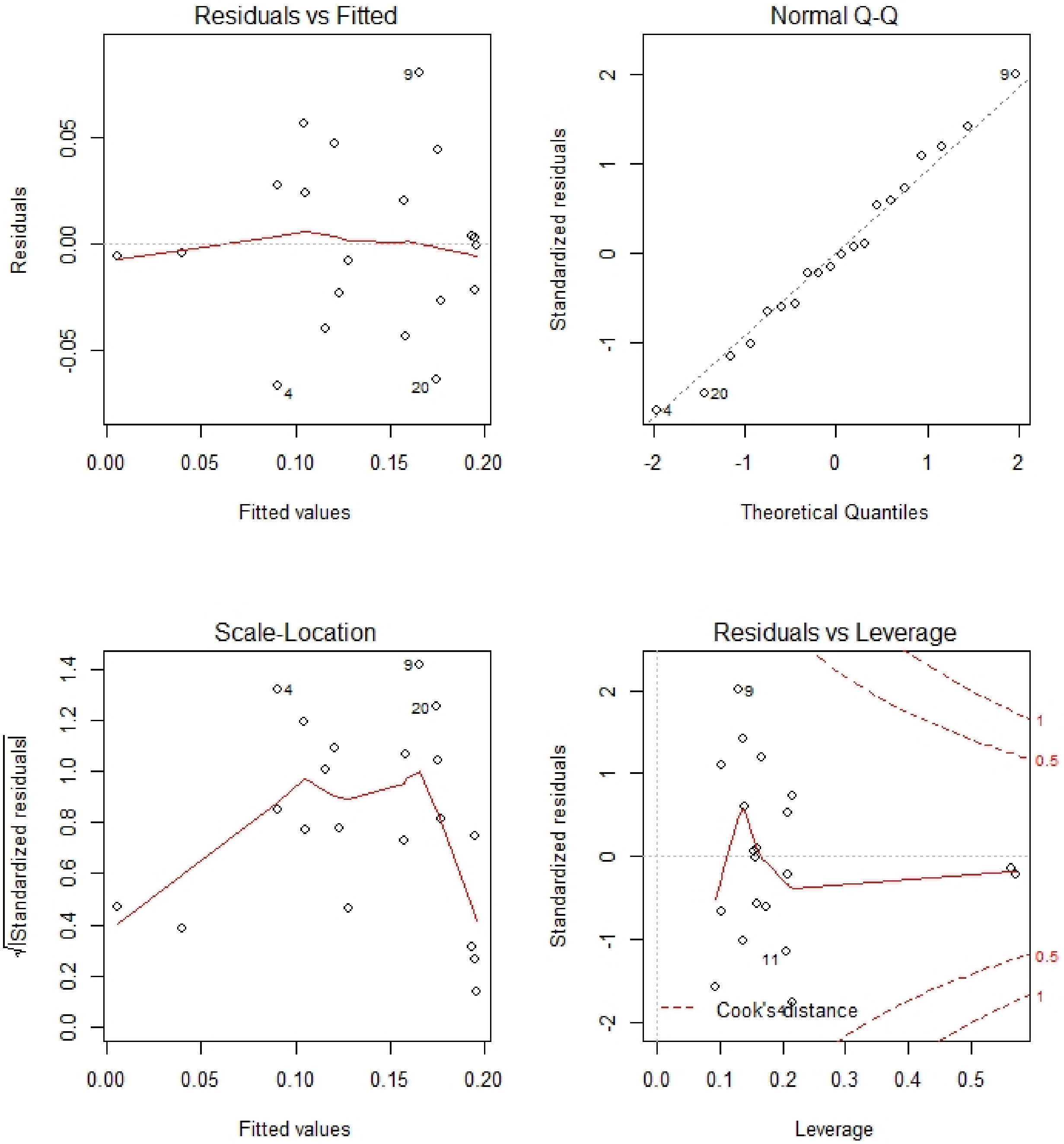

Figure 37. Diagnostic plots for transect model with burned transects

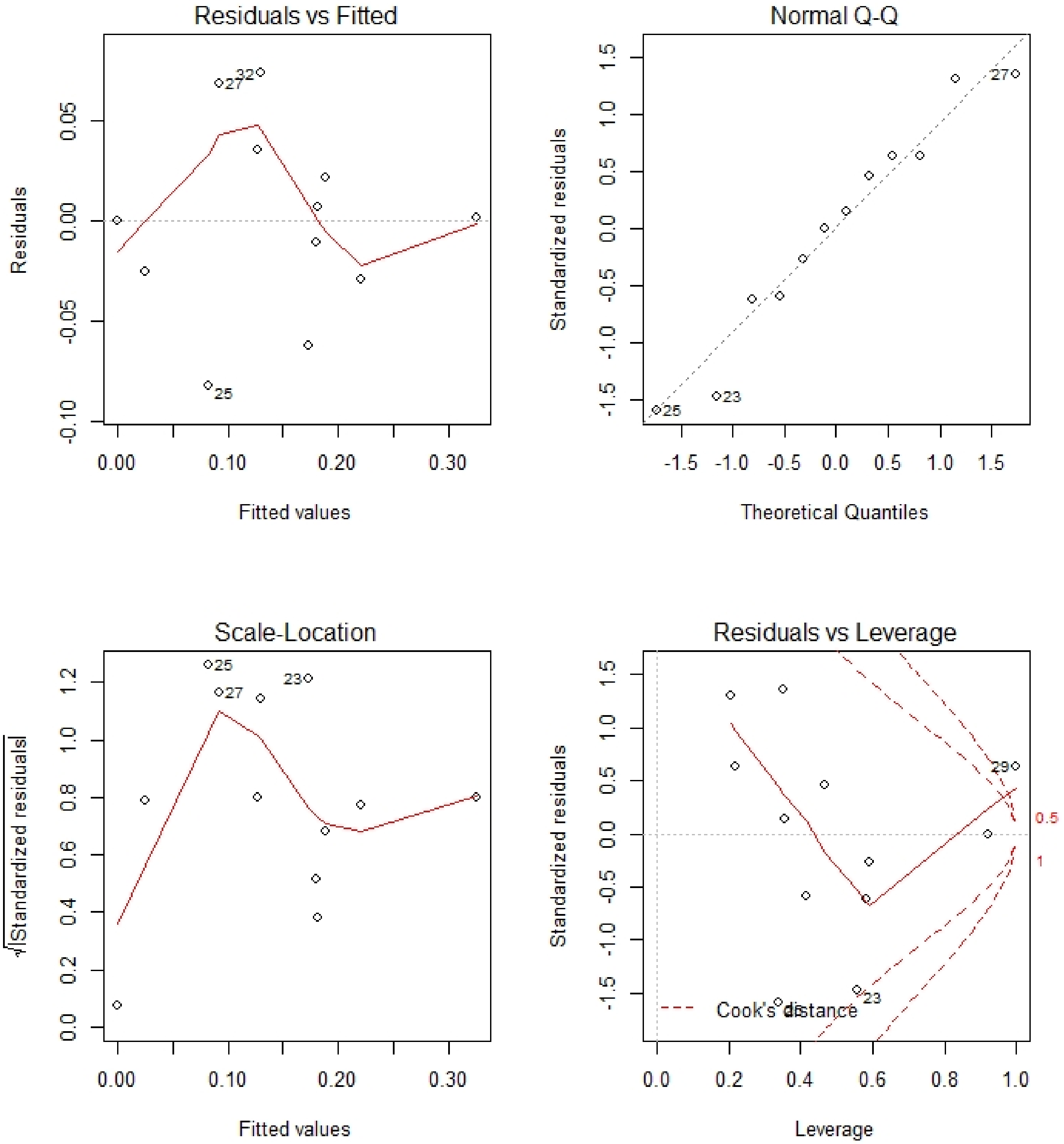

Figure 38. Diagnostic plots for transect model with unburned transects

ABBREVIATIONS

Abbreviation	Definition/ Meaning
BFE	Bankfull edge: channel's "completely full" edge, as determined in the field. Especially at the beginning of the field season, the water's edge was often on the floodplain and therefore higher than bankfull.
CWD	Coarse woody debris: downed wood pieces on the valley bottom, not fluvially transported or inundated. Size categories vary in forest ecology, but I only measured wood on the valley bottom if it met the same size criteria for LW.
Floodplain	Active floodplain: area within the channel migration belt, underlain by fluvial sediments, and subject to overbank inundation at least every 5 years (2019 mean water year discharge of 550 cfs; recurrence interval of 8 years at the USGS Happy Isles gage)
ha	Hectare: 1 ha = 10,000 m^2
IGsd	Inclusive graphic standard deviation (Folk and Ward, 1957)
Jam	Logjam: a fluvially transported/arranged group of three or more pieces of LW
LW	Large wood: downed wood pieces with a diameter $\geq$ 10 cm and a length $\geq$ 1 m in the river and on the active floodplain
LYV	Little Yosemite Valley
NPS	National Park Service
Riparian area	Area that includes the bankfull channel, underlying hyporheic zone, and floodplain
River corridor	Area that includes the bankfull channel, underlying hyporheic zone, floodplain, and valley bottom
Valley bottom	Area beyond the active floodplain that was not inundated in 2019 (mean water year discharge recurrence interval of 8 years) and is of similar elevation to the active floodplain (e.g. not terraces or hillslopes)
Wood load	Volume of LW per unit area (m^3/m^2 or m^3/ha, units are be noted)
Yosemite	Yosemite National Park