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Balancing Riparian Management and River Recreation: Methods and Applications for Exploring Floater Behavior and Their Interaction with Large Wood

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Abstract River managers are tasked with meeting both ecological and human needs. In the Puget Sound lowland, riparian management often includes placing or allowing the presence of large wood to stabilize riverbanks and enhance salmon habitat. Although this practice benefits humans by protecting infrastructure and natural resources, it is unclear how such practices interact with an additional human interest, recreation. Furthermore, we were unable to find studies that describe how an agency can go about researching the interaction between recreation and large wood management practices. This study tested methods for describing and estimating the number of river floaters, where they float in relationship to river projects, the risks they take while floating, and their perceptions of large wood in the river. Selecting a high-use suburban river in Washington State, we used riverside observations, interviews, and an infrared counter to gather data in the summer of 2010. Statistical analyses provided general characteristics of users, trends in engaging in risky behaviors, and estimates of use for the entire season and on the busiest day. Data mapping with GIS presented the density of use along the river and frequency of use of specific float routes. Finally, qualitative analysis of interviews clarified floaters' perspectives of large wood. To address the multiple mandates of river managers, it is important to understand recreation users, the factors that could be putting them at risk, and how the actual users perceive large wood in the river. This study demonstrates methods for scientifically gathering such information and applying it when making riparian management decisions.

Keywords River recreation · Riparian management · Large wood

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Introduction

River management and restoration is as much about science as planning (Reuss 2005). While rivers are natural habitat to many economically and ecologically important species, they are also the backyards of homes and businesses; water and electricity sources for urban areas; recreation sites for fishermen, boaters, and picnickers; and potential threats to nearby transportation and other infrastructure through flooding and erosion. As a result, river managers need social as well as ecological and engineering knowledge to effectively address multiple objectives.

The primary objectives of most restoration projects in the US include enhancing water quality, improving riparian and in-stream habitat, and stabilizing banks (Bernhardt and others 2005). To do this, river management practices in the US have evolved from removing all wood and stabilizing banks with rock riprap to allowing naturally recruited wood to remain in rivers and occasionally adding live and felled plants to improve riparian habitat (Lee and others 1997; Petts and Welcomme 2003; Naiman and others 2005; Wohl and Merritts 2007). These practices are based on current recognition that large wood is a natural part of river ecosystems and plays a vital role in various ecological and

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geomorphic processes (Naiman and others 2005). While allowing large wood in river management fulfills both ecological and structural purposes, we know little about how this shift in large wood management may affect the experience of recreation users, including the relative risk it creates.

Our literature review found no published studies on the specific risks associated with river recreation, although several studies clarified general risks related to water recreation. The most dangerous risks to water recreationists are the use of alcohol, the absence of personal floatation devices (pfds), and entering the water from heights (Branch and others 1991; Driscoll and others 2004; Smith and others 2001; Cummings and others 2010). In fact, 30–70 % of drowning victims have alcohol in their blood (Driscoll 2004) and the use of pfds could prevent up to 50 % of drowning deaths in recreational boaters (Cummings and others 2010). While these factors are not specific to river recreation, we can assume that they play a role in river recreation injuries as well.

Some have argued that allowing large wood to remain in river systems could be another risk to recreation users. While there is no published evidence that this is true, it is certainly worth learning how wood interacts with river users and how they perceive the practice. Initial investigations in this area have included studies that asked students and researchers to identify preferred river aesthetics through photographs (Gregory and Davis 1993; Piégay and others 2005; Chin and others 2008). In nine countries and various US locations, the majority of respondents preferred rivers with less wood, believing that those with wood were more dangerous and in need of improvement. This was less true in Oregon, Germany, and Sweden, where the use of large wood in river management is more common, suggesting that a preference for wood-free rivers may be due to people's expectations based on the historic removal of wood in rivers (Wohl 2007). Though these photographic studies are important to understanding the general public's perception of large wood, the most important perception may be that of the actual river recreationists. Such a study has not yet been published.

To begin our understanding of how wood influences recreation users, we must first know how the two interact. Studies that demonstrate methods for collecting data on the characteristics and location of river recreation users are rare. Two surveys that determined river recreation density in Wisconsin and Puerto Rico used personal observations at a handful of access points and, in Wisconsin, mechanical counters in parking lots (Davenport and others 2003; Santiago and others 2008). These methods are particularly effective in situations where the access points are few and predictable. Recreation user characteristics are more commonly identified in forest-based recreation studies that use infrared (IR) counters and field-based interviews (i.e., Leung 2000; Muhar and others 2002; Shoji and others 2008; Peters and Dawson 2004; Fay and others 2010; Cope and others 1999). Though the use of an IR counter has not been published as a method for detecting river users, its success in forest systems makes it a promising instrument for rivers with multiple, unpredictable access points and limited staff.

This study explored methods for increasing our understanding of the characteristics of river recreationists and how they interact with large wood management on a river with dozens of access points. Using 16 miles of the suburban Cedar River in Washington State as a test site, we set out to characterize recreationists who float the river during the late spring, summer, and early fall of 2010. We attempted to answer the following questions: (1) Who are the river recreation users? (2) What is the recreation use near river management projects? (3) How do users perceive large wood compared to other risks? (4) What methods are most effective for estimating river recreation and determining the most actively used river reaches? We tested the combined use of an IR counter, field observations, exit interviews and regression models to estimate river use; field observations and exit interviews to measure the risky behaviors of alcohol use, lack of pfd use, inability to swim, and lack of steering devices; GIS for spatial comparison of recreation use to the location of large wood; and exit interviews to determine how large wood affects river recreationists and how users feel about wood in the river.

Location and Site Selection

The Cedar River begins in the Cascade Range of Washington State and flows northwest toward Lake Washington near Seattle. From the source to the Landsburg Dam, the watershed provides drinking water to the greater Seattle area. Recreation use in this section is restricted. For the remaining 22 miles, however, the river flows through medium and low density development where recreation users enjoy fishing, boating, picnicking and other river activities. A multiple-use trail follows the river for these 22 miles and, along with numerous roads, provides dozens of river access points. Fishing for salmon and trout occurs along the entire stretch from Landsburg Dam to Lake Washington from June–August (MacIlroy 2009). From the Landsburg Dam to about 4 miles from Lake Washington are Class II rapids used by kayaks and canoes year-round and national kayak championships are held at a slalom course just below the Landsburg Dam. Lastly, tubers, floaters, swimmers and waders use various sections of the river through the summer months.

King County currently manages large wood in the Cedar River by placing some large wood as part of routine bank

stabilization project repairs and leaving most fallen trees in the river for bank stabilization and salmon habitat. Placed wood is always anchored, often using chain with rock ballast. Fallen trees are generally left alone unless they span the river or are at a particularly dangerous orientation for recreation users. Informal observations have shown that some river users enjoy swimming holes and bridges associated with these large logs. A couple of citizens have expressed concern, however, about the impact of the large wood management regime on recreational safety. Though there is little evidence that large wood is a primary cause of river accidents, large wood is occasionally relocated or repositioned when the King County Sherriff's Office deems its location and orientation a severe risk.

In 2009, King County (2009) hosted a Large Wood Stakeholder meeting in which the Sheriff's Office reported on river rescues and drownings since 2004. The report noted that several accidents occurred during hot days in late spring when high flows made river recreation treacherous. The primary cited cause of drowning was the lack of life jackets. Of the nine deaths by drowning reported in the county, only one victim was wearing a life jacket: an experienced kayaker who was trapped in the hydraulics surrounding two rocks. More than one drowning victim and several stranded swimmers had been recovered from submerged natural wood jams or other natural debris, but the cause of being stranded or drowning in each case was credited to lack of life jacket, alcohol or other factors. Large wood had only been attributed to one accident in which a raft flipped, but from which all floaters were rescued. The report concluded that the majority of river recreation incidents "involved alcohol use and poor choices."

The Sheriff's report was based on actual incidents to which the Sheriff's Office responded. It provides helpful information about incidents, but limited information about the extent of risky behaviors among floaters. To better understand the behaviors of river floaters and their interactions with large wood on the Cedar River, we selected seven sites for observations based on the likelihood to encounter all people who access the river at one of the 35 expected access points (Fig. 1). Three of the seven sites were popular public parks, two were public natural areas, and two were on other county properties.

Methods

Field Methods

Data were collected using three methods: an IR trail counter at one observation site, field observations at seven sites over 52 days, and exit interviews as groups finished floating.

The IR counter was placed at an observation site in the lower third of the study area. The site was chosen because it provided convenient features for hiding the counter, because it was surrounded by private property with limited public access, and because it was expected to have similar use to other sites. The transmitter was placed on a rocky revetment underneath a hollow synthetic rock with a hole drilled for the beam. The receiver was placed on the downriver side of an overhanging branch such that floaters would not see it as they passed. The counter was set to tally each time the IR beam was broken by an object passing approximately one foot above the high water mark. The counter operated continuously, 24 h per day, although only data from 11 am to 7 pm were used for analysis. The counter was calibrated by one researcher repeatedly passing the IR beam on the first day and by 7 days of field observations throughout the season. Based on calibration of the counter with visual confirmations, we found it was more accurate determining the number of groups passing by the counter than the number of individuals. As such, every count within 4 min of the last was considered one group. We also witnessed a flock of geese, a deer, and a dog crossing near the beam, none of which triggered the sensor. We can thus conclude that the sensor functioned adequately for counting recreation groups and omitting extraneous movements. The counter lasted 24 days until the transmitter was vandalized.

Field observations were conducted by two researchers between 17 May and 5 September. A field day was from 11 am to 7 pm at a single site, with the researcher counting and observing the characteristics of all floaters past that site. Characteristics included the number of people in the floating group; the types of floating vessels; general age category and gender; and whether they had personal flotation devices, alcohol, paddles or oars, or fishing gear. As floaters passed the observer, she asked two questions: "Where did you start your float?" and "Where will you finish your float?" Floaters were forewarned of these questions with a sign posted upstream from the interviewer.

Observation days were selected so that each site had a relatively equal number of field days that were weekends and weekdays and with temperatures over 70 °F. All weekends were sampled unless it was raining and at least the warmest day during each week was sampled. Any day that was over 70 °F was sampled unless the researchers had worked over 40 h that week. On days that were over 80 °F, every attempt was made to have both researchers at different sections of the river to gather more data on these high use days. The counter site was considered one of the seven standard observation sites and part of the general rotation for observation days.

Lastly, representatives of each float group that exited the river where an observer was stationed were asked to

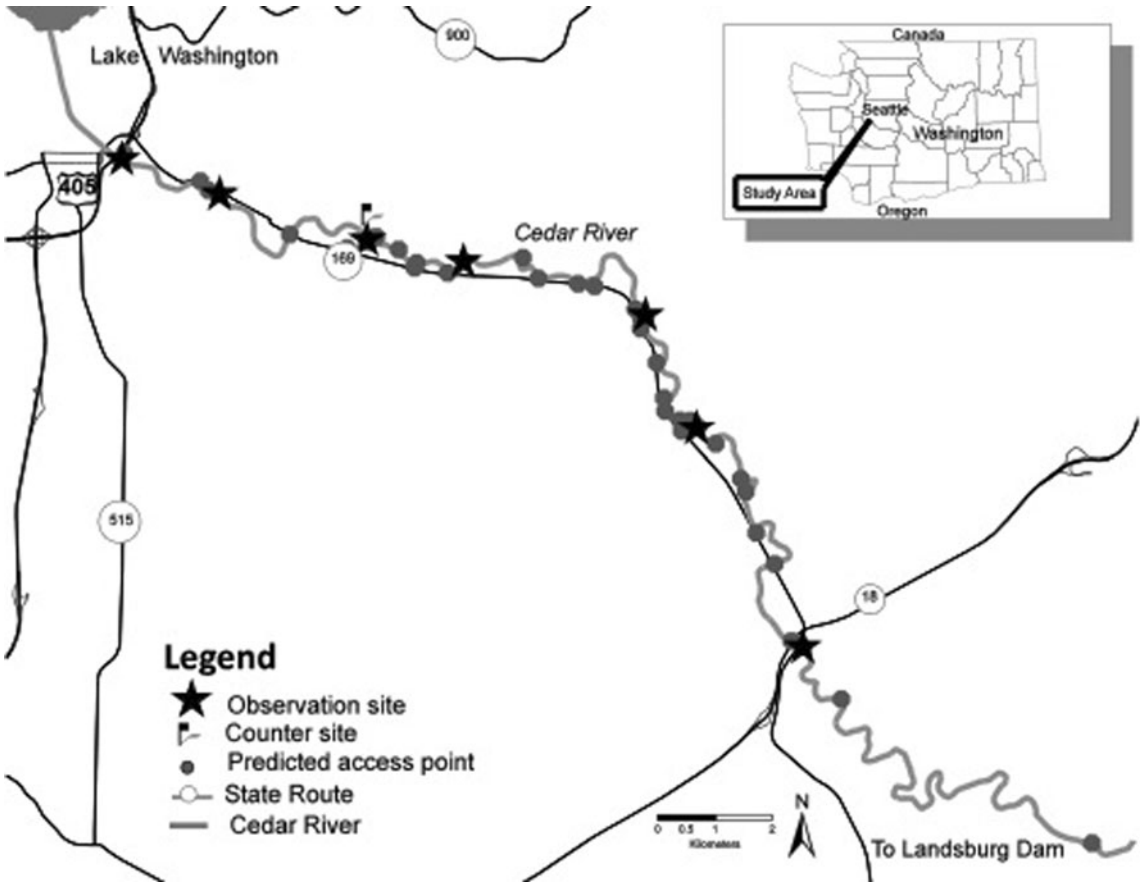


Fig. 1 Observation sites and expected access points along the Cedar River, Washington

participate in a 5-min interview. Interviews asked about prior experience floating the Cedar River, where they usually float, why they float there, how they prepared for their float, whether they encountered large wood and how they feel about it, what they consider the primary hazards to their float trip, and how many people in their group know how to swim. To maximize the number of interviews, two popular exit sites were given priority in the sampling rotation on very hot days.

Data Analysis

Data from the IR counter were used to determine the highest use day, the percentage of groups floating outside the 11 am–7 pm observation day, and the potential of this tool to replace field-based observations. Observation data were compiled and access points were coded into 41 unique locations. SPSS was used to analyze the daily and overall statistics of the observations including descriptive stats for number of people; number of groups; percent males per group; percent adults (appeared 18 and older), youth (appeared 12–17) and children (appeared younger than 12) per group; percent of people wearing life vests by age grouping; number of groups having boats with paddles; number of groups with alcohol visible; number of groups with coolers; number of groups with fishing equipment; number and percent of floating devices; and most popular access points. Descriptive characteristics were correlated with each other to determine trends. They were also compared across the seven locations using Kruskal–Wallis to determine potential differences in floater characteristics by location seen.

Stepwise linear regression models were then generated to predict the number of floaters passing each of the seven observation sites based on temperature, flow, and whether the day of the week was a weekend or weekday. For each location, we selected the most parsimonious model with the highest R^2, a fit that was significant at the 0.05 α level, and in which each predictor variable had a significant relationship to the dependent variable at 95 % CI. For six of the seven locations, temperature was sufficient to predict recreation use. One low-use site was not well predicted by any variables; thus, estimates from this site were omitted from the total estimate. To generate an estimate of total river use for the entire season and the busiest day, the percentage of people that had put in before the previous

observation site or taken out below the next observation site was subtracted from the estimated number of people passing each site. This ensured that we were only estimating unique floaters.

Interview data were coded and summarized with descriptive statistics. Open-ended questions were coded using inductive coding and verified by a second reader. Access points of interviewees were compared to observation access points to confirm a representative sample based on floating location. The average rank and Smith's salience of hazards were determined for all hazards mentioned more than once. Smith's salience is the weighted average rank, taking into consideration both the number of people who named the hazard and the rank it was given. As such, it is a more appropriate measurement of perceived importance than average rank.

Finally, each access point was geographically located on a new feature-class in GIS and floating routes were tallied and represented spatially with graduated colors demonstrating frequency of use.

Results

User Characteristics

Between May and September of 2010, we observed over 1,900 floaters in 550 groups, with a median group size of three. Sixty-four floaters representing these groups participated in the exit interview. In addition to people, 19 dogs were observed. Sixty-five percent of floaters were male, 73 % adults, 18 % youth, and 9 % children. Eighty-four percent of vessels were inner tubes or mattresses. Another 12 % were rafts and a total of 5 % were kayaks, canoes or pontoon boats. Of the floaters interviewed, 83 % were repeat floaters who indicated they averaged about 19 trips over the past 5 years. Since fishermen rarely floated and were largely off the river before 11 am, they were not observed as part of this study.

Preparedness

When asked how they had prepared for their float trip, 38 % of floaters said they checked the weather, 17 % said they grabbed drinks and shoes, and 11 % checked river conditions. Eight percent said they did not check anything because they lived nearby. Ninety-eight percent of floaters knew how to swim and 14 % had access to a pfd, with 39 % of children wearing them, 21 % of dogs wearing them, and only 2 % of youth and 5 % of adults wearing pfds (Table 1). Thirteen percent of floating vessels had paddles or oars and 26 % of the groups were visibly drinking alcohol. Another 15 % may have had alcohol in observed coolers and containers, but these were unable to be confirmed as groups floated by. The rate of alcohol use and lack of pfds indicate that many floaters were engaging in the riskiest behaviors for a water-based activity.

Table 1 Measures of preparedness for river floaters

Percentage who know how to swim	98 %
Percentage people with access to a PFD	14 %
Children wearing a PFD	39 %
Adults wearing a PFD	5 %
Youth wearing a PFD	2 %
Percentage of dogs wearing a PFD	21 %
Percentage of boats with paddles	13 %
Percentage of groups with alcohol visible	26 %
Additional percentage that might have had alcohol[a]	15 %

[a] In coolers or other containers

Some measures of preparedness varied significantly by user type. Tubers generally did not wear pfds; have oars or paddles; or float with boats that required oars such as canoes and kayaks. Floaters in kayaks and canoes were often males who wore pfds and carried oars. Youth were the least likely to wear pfds and have oars or paddles. Men were less likely than women to wear pfds. Alcohol use, on the other hand, could not be statistically correlated to any particular floater characteristic because variation among demographics was insignificant.

Large Wood

Of the 64 people interviewed, 81 % had encountered large wood. Several people offered examples of how the wood affected them, including having to portage or get out of their tube ($n = 7$), getting caught ($n = 5$), having a tube pop ($n = 4$), running into wood ($n = 3$), and one response each for having to rescue others, snagging their bathing suit, going under a log, and having to duck under branches. Two respondents described positive interactions, saying it provided preferred swimming holes. When asked how they believed large wood got into the river, 91 % of respondents believed the wood got there naturally and 7 % did not know how the wood got into the river.

Perceptions about wood were obtained from an open-ended question that was coded inductively: "How do you feel about large wood in the river?". Responses varied on a spectrum of acceptance to concern (Fig. 2): 13 % immediately responded that it should be removed; another 13 % felt it was scary and dangerous but did not suggest what should be done about it; 5 % were a bit annoyed, but also did not suggest a management response; 21 % felt that large wood was generally not a problem along the sides of rivers, but that pieces that spanned the river and stuck out could be removed; 3 % had no specific perceptions about wood, but did not believe it should be removed; 16 % did not like it but saw the

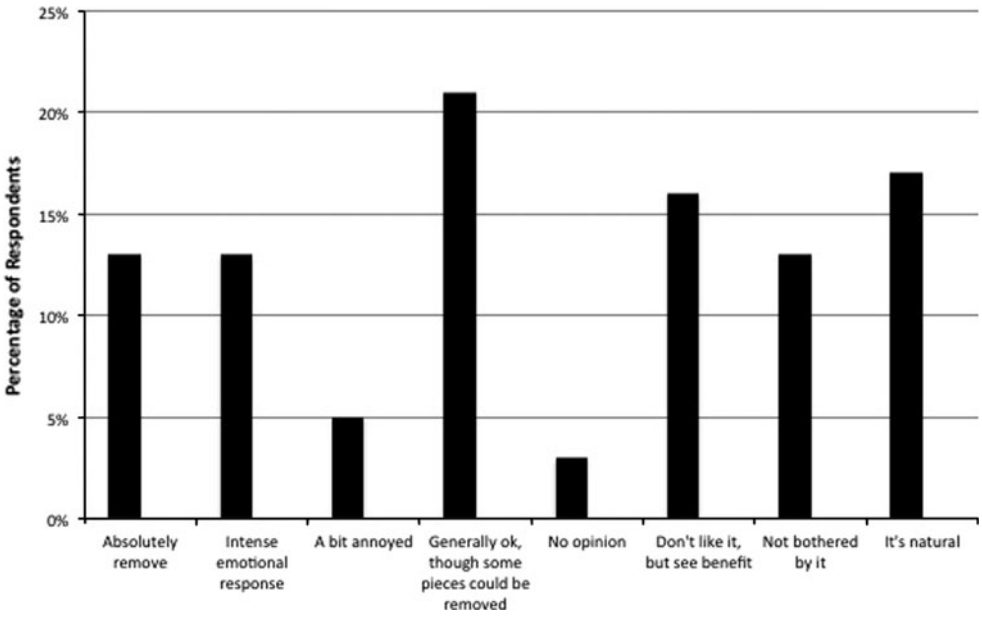


Fig. 2 Spectrum of perspectives about large wood in rivers. Responses coded from the open-ended question, "How do you feel about large wood in the river?"

benefit; 14 % were not bothered by it at all and in fact found it useful for creating desired swimming holes; and 17 % thought it was natural and had a right to be there. Of the benefits perceived, 38 % said that it was good for salmon habitat. This high percentage of respondents who understood the ecological benefits of large wood could extend the suggestion made by Chin and others (2008) to Washington, that Oregon residents are knowledgeable about the ecological importance of wood in rivers.

Hazards

When asked to select and rank among seven pre-determined hazards, 95 % of interviewees thought that wood was a hazard to their float trip and 92 % thought rocks were a hazard. All other potential hazards were acknowledged by only 74 % or less of respondents (Table 2). When asked to rank the expected hazards against each other, large wood was considered the most hazardous of six hazards identified by the interviewer (salience of 0.9) followed by rocks (0.7), fast water (0.4), and cold water (0.3). After selecting among the pre-determined hazards, floaters were invited to name any other things that might be hazards to their trip. Trash, concrete and beer were mentioned by few people. All other interviewees believed that the pre-determined hazards were exhaustive. The high recognition of rocks and wood as hazards demonstrates that floaters are concerned about large obstructions, regardless of their composition, more than other aspects of the river or other users. These concerns had minimal effect on their overall decisions to float, however, although some floaters explained that their choice of where to float was sometimes influenced by where there was less wood.

Table 2 Floater perception of river recreation risks

	% People who selected item	Salience
Pre-determined risks		
Large wood	95	0.9
Rocks	92	0.7
Fast water	74	0.4
Cold water	66	0.3
Access points	58	0.2
Deep pools	58	0.3
Other users	53	0.2
Additional risks		
Trash	3	0.0
Concrete	3	0.0
Beer	2	0.0

The second column represents the percent of people who selected the risk as a perceived risk for them. The salience (1 = highest) is based on the average rank per percent of respondents

Estimated Use

For six of the seven locations, actual temperature was sufficient to predict the number of floaters (Table 3). Site 2 was not well predicted by any variables, and was thus left out of the total for estimated use. Fortunately, this was one of the lowest use sites and would affect the overall numbers by only a few hundred floaters. As a result, the estimated river use should be considered a low estimation. Based on the regression models, we estimate that over 6,680 floaters went down the Cedar River between May and September 2010, with 640 of them on the busiest days. The busiest days were a 93 °F Saturday and Sunday in mid-August.

Table 3 Statistics for regression models using temperature to predict number of floaters at each of seven locations along the Cedar River

Model	*R* (SE)	Coefficient (SE)	*t* (Sig.)
Site 1	0.71 (0.57)	0.04 (0.15)	2.69 (0.03)*
Site 2	0.42 (0.52)	0.02 (0.02)	1.13 (0.30)
Site 3	0.87 (0.45)	0.06 (0.01)	4.29 (0.00)*
Site 4	0.88 (0.40)	0.09 (0.02)	5.00 (0.00)*
Site 5	0.83 (0.50)	0.08 (0.02)	3.67 (0.01)*
Site 6	0.87 (0.45)	0.06 (0.01)	4.75 (0.00)*
Site 7	0.68 (0.61)	0.05 (0.02)	2.47 (0.04)*

R square root of R^2, a measure of model fit, *SE* standard error, *coefficient* the standardized coefficient of temperature as a predictor variable, *t t* statistic for temperature with significance at a 95 % confidence interval

* Significant to 0.05

Inner tubers were regularly seen on the river on days when temperatures exceeded the mid-70 °F's, whereas kayaks, canoes and pontoon boats were seen sporadically throughout the entire season independent of temperature, weather, or day of week. A few tubers were seen on days in the 60 °F's, but this could have been because these days were forecast to be in the 80 °F's. Most floaters were seen between 4 pm and 7 pm, especially on weekdays.

Geographic Distribution of Floaters

Floaters entered at 41 unique access points, creating 135 floating routes that averaged 5 miles long (std = 3.5 miles, mode = 3 miles) (Fig. 3). The relationship between number of recreation users and temperature was slightly different for each of the seven observation sites, resulting in areas that were more highly used than others. Use was low at the upper reaches toward the dam (Fig. 4), with about 520 floaters estimated to have passed the upstream reaches of the study area over the season, and only 25 on the busiest day. Use gradually increased downstream with the highest use toward the town of Renton and Lake Washington. Over 2,000 floaters passed the busiest locations over the season, and almost 400 on the busiest day.

Location of Floaters in Relationship to Large Wood

The primary mechanism for large wood to enter the Cedar River is through natural wood loading from bank erosion.

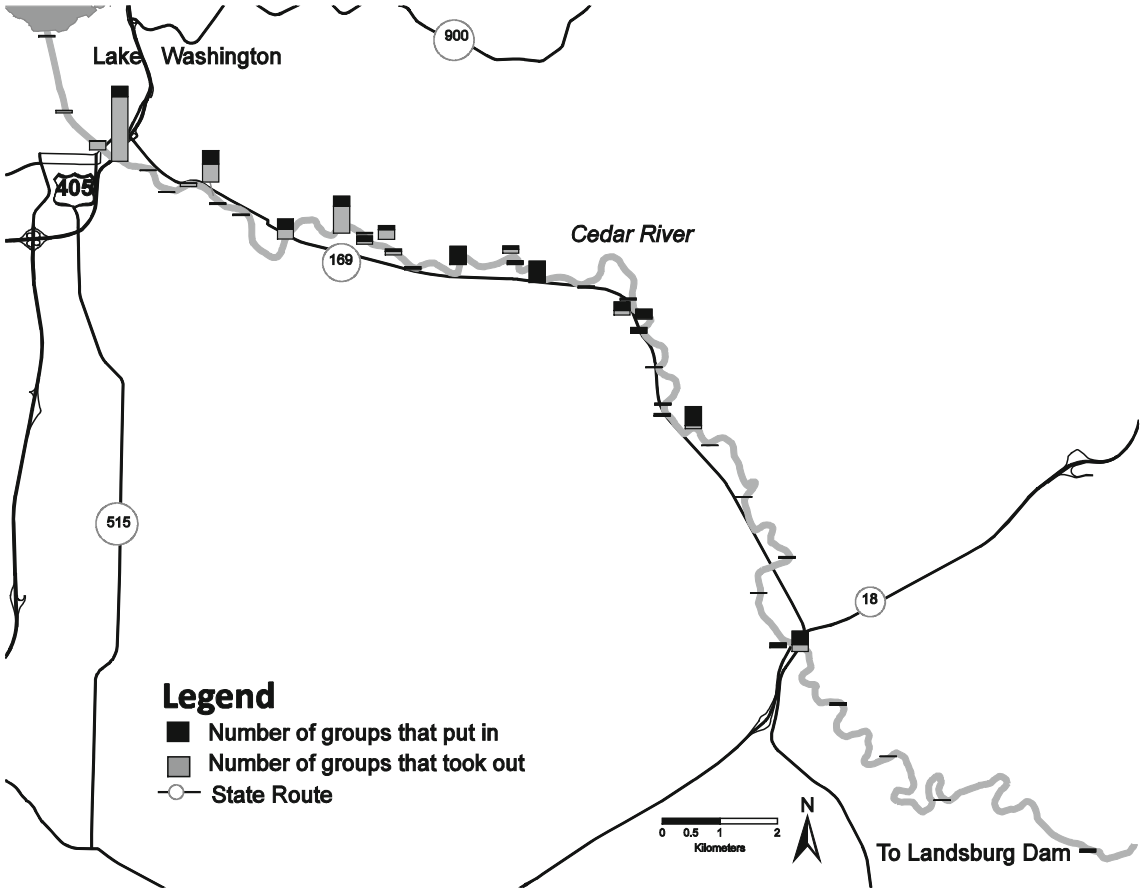


Fig. 3 Actual access points with relative number of groups that entered and exited the river at 41 locations

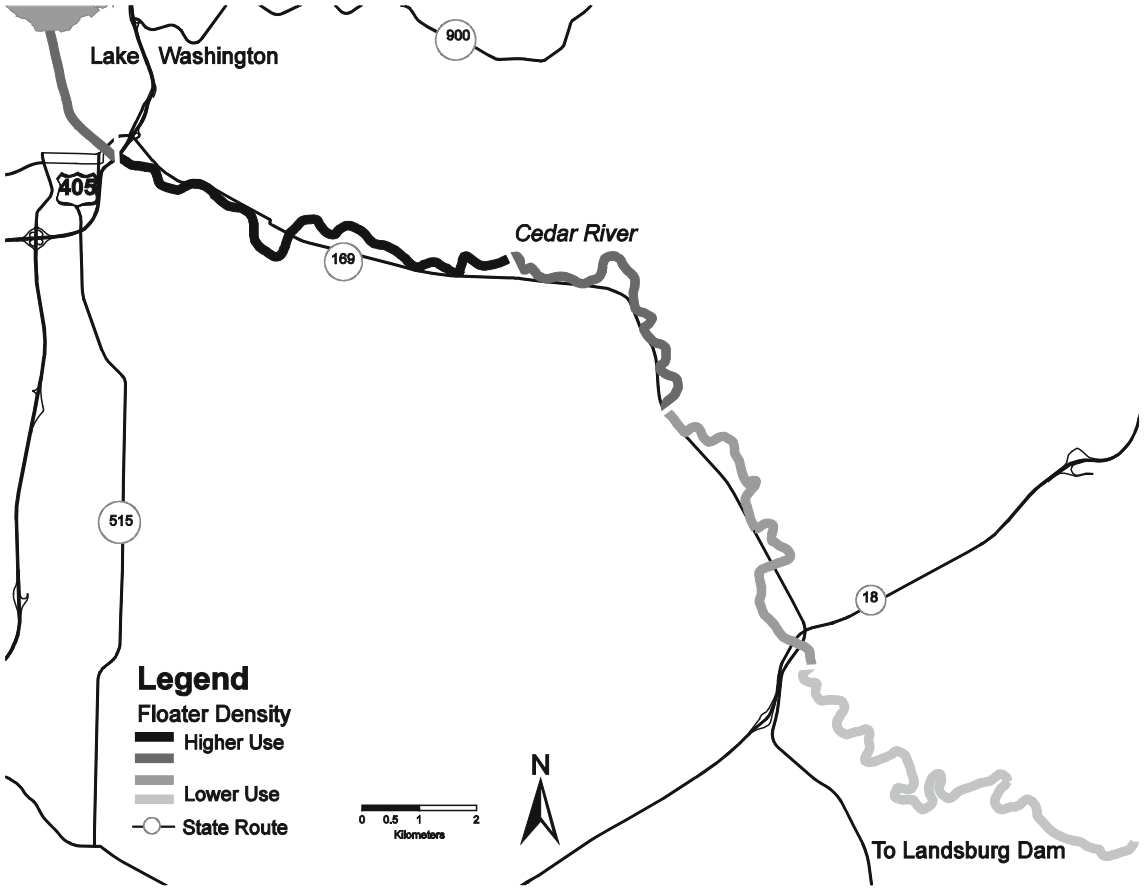


Fig. 4 Floater use density along the Cedar River

Small amounts of additional wood are placed in the river through bank stabilization projects. Figures 5 and 6 show how floater density interacted with the 2010 location of naturally-recruited large wood and levee and revetment setback projects proposed in the 2006 King County Flood Hazard Management Plan. The location of naturally-recruited large wood was determined through aerial photography analysis and ground-truthing in an unreported study (Akyuz pers. comm.). Reaches of the Cedar River with low channel confinement were found to have higher numbers of large wood per mile than highly confined reaches and the presence of levee or revetment setback projects may have increased recruitment and trapping of naturally-eroded large wood. Over half the river miles slated for levee setback projects in 2010 were in high use recreation areas. Similarly, the majority of naturally-recruited large wood coincided with high recreation areas.

Management Implications

On the Cedar River, the decision to float was primarily determined by temperature and although floaters explained that large wood was the primary hazard to floating, they chose to float in locations strongly correlated with the presence of large wood. Based on previous experience, King County knows that the high flows during the months of May and June may increase floating danger by decreasing reaction time and concealing potential hazards such as rocks and locks. Based on the literature, the county also knows that user behavior can increase risk including alcohol use, lack of oars or paddles, and not knowing how to swim. In the past 15 years, there has been an average of 4.7 days (range 0–9) over 80 °F in the months of May and June when high flows and warm weather have the greatest potential to coincide. In the 2010 season of an estimated 6,680 floaters, there were four cited river rescues on the Cedar River, all of which were in the high flows of June. For a management agency, recreation relationships to weather trends and potential hazards can help determine when and where recreation concerns need to be taken into consideration. Specifically, if an agency concludes that large wood is a legitimate risk, weather information can be combined with maps of large wood locations to get a better picture of risk hotspots during the May to early June time period.

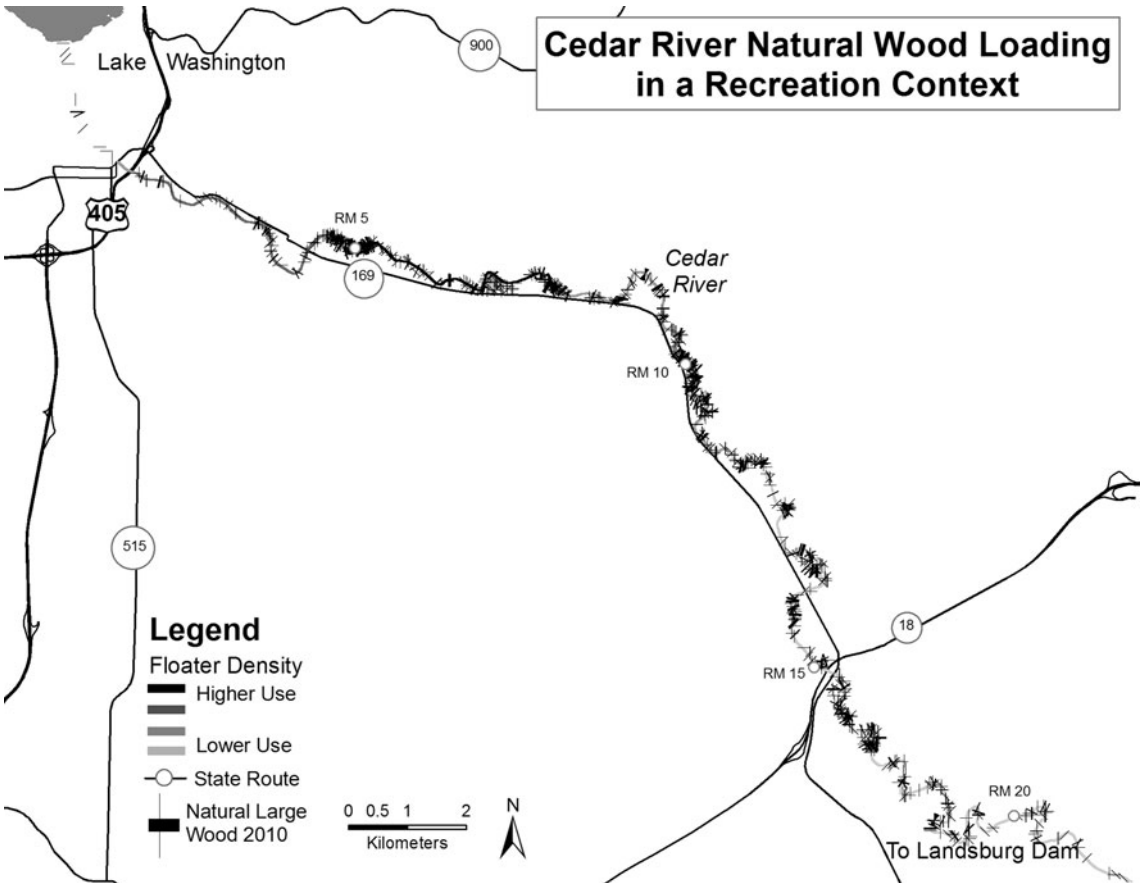


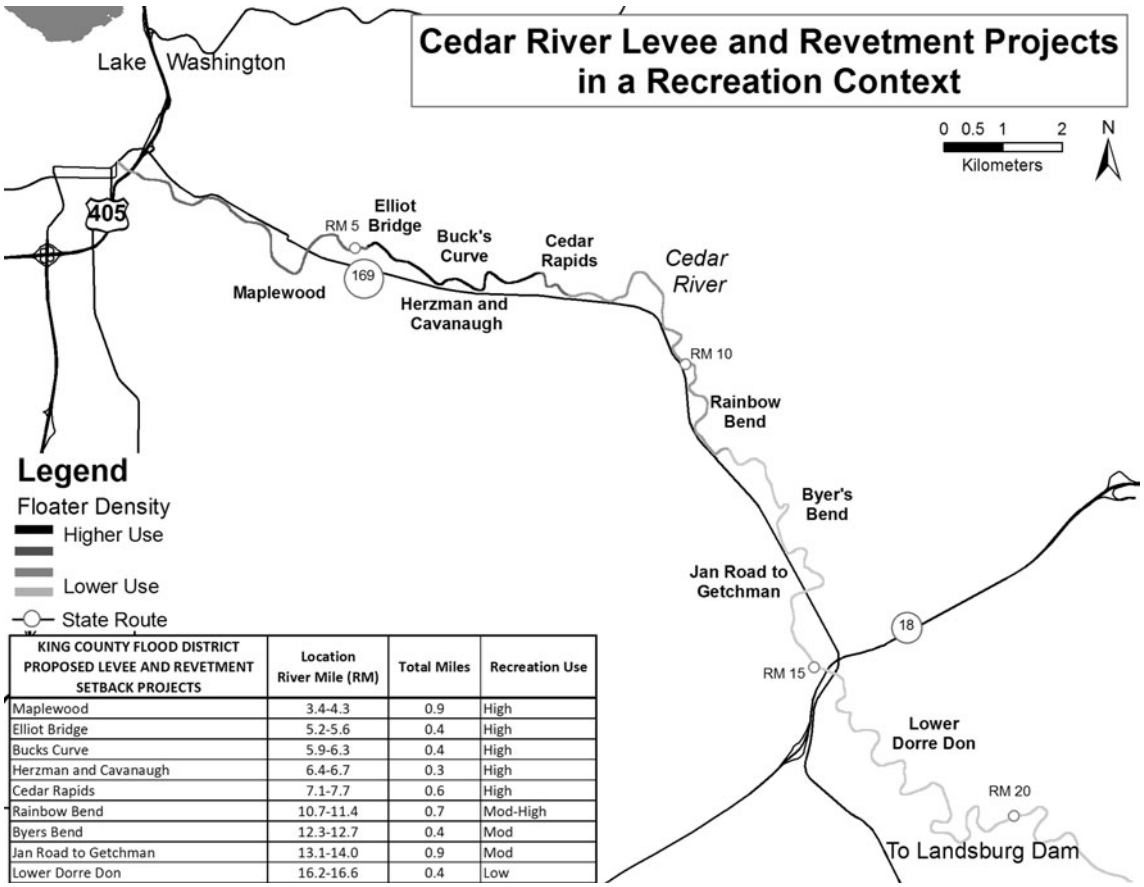
Fig. 5 The overlap of recreation use and naturally-recruited large wood in 2010 based on aerial surveys

While wood may pose some danger to river recreationists, particularly in high flows, we also observed that casual river floaters, and tubers in particular, tend to make decisions that increase their risk for injury. Only 14 % of floaters had access to life vests and the majority who wore them were children. Only 13 % of boats had paddles or oars for steering and at least 26 % of groups were observed to be drinking alcohol. These behaviors are known to significantly increase the risk for injury and death in water recreation. In response, some public agencies in the United States have developed regulations to require recreationists to avoid risky behaviors. The City of New Braunfels, Texas, for example, requires pfd use with certain ages at specific flow levels (www.ci.new-braunfels.tx.us). The river managers also recognize that some risks are uncontrollable and restrict recreation at certain flows. Other agencies may want to consider similar regulations and/or educational campaigns.

King County Application

The geographic location and intensity of recreation use can be combined with information about riparian management projects to assist management decisions. In the summer of 2010 the King County Sheriff's Office and Rivers and Floodplain Management Program were requested to determine whether to remove a large spanning log that entered the Cedar Rapids levee setback project area during high springtime flows. At the time of the decision, data on recreation use was unavailable. Based on only anecdotal information regarding the type and quantity of recreation use and the uncertainty of a successful response to a complete river closure, decision makers determined to reposition the log to a less hazardous location along the river margins. The repositioning may have resulted in a loss of ecological functioning, as the log's original orientation likely was of high benefit to salmon habitat due to the hydraulics around the rootwad end forming a pool, a rare and potentially habitat-limiting feature on the Cedar River, but it was considered the best option to meet recreation safety at the time.

The results of this current study can contribute significant information to future decisions of this nature. First, we now know more about Cedar River floaters and have concluded that their characteristics do not differ by location on the river. Thus, most of the floaters that passed the log's



KING COUNTY FLOOD DISTRICT PROPOSED LEVEE AND REVETMENT SETBACK PROJECTS	Location River Mile (RM)	Total Miles	Recreation Use
Maplewood	3.4-4.3	0.9	High
Elliot Bridge	5.2-5.6	0.4	High
Bucks Curve	5.9-6.3	0.4	High
Herzman and Cavanaugh	6.4-6.7	0.3	High
Cedar Rapids	7.1-7.7	0.6	High
Rainbow Bend	10.7-11.4	0.7	Mod-High
Byers Bend	12.3-12.7	0.4	Mod
Jan Road to Getchman	13.1-14.0	0.9	Mod
Lower Dorre Don	16.2-16.6	0.4	Low

Fig. 6 The overlap of 2010 recreation use and proposed levee and revetment projects

original location were in inner tubes, did not have pfds or a steering device, and many were drinking alcohol. By summarizing the information from the float data for the Cedar Rapids site, we can also note that over one thousand floaters passed the log's original location, that they entered the river at one of a dozen locations, and that they exited the river at one of a dozen more (Fig. 7). Choosing to close the river at strategic access points would have been very difficult. The information from this study, then, supports the decision to move the log. If a river section closure were chosen as an alternative, however, the study would have provided other critical information, such as the best places to post warning signs about the spanning log and river closure.

Discussion

Understanding how recreation use interacts with river management strategies is critical for successfully fulfilling multiple-use mandates. This study tested research methods for characterizing recreation users and exploring the relationship between floaters and large wood. In assessing methods, we came across several interesting findings. First, we found that an IR counter, often used to count trail use and wildlife behavior, would effectively count floating groups but not individuals. Although we did not test it, the IR counter could have been enhanced to capture all floaters and their characteristics with the addition of a still camera, as is often used in wildlife studies. While field observations worked well for collecting access and user characteristic data in this study, other studies may not have the personnel necessary to replicate. In such cases, management agencies may want to consider the use of IR counters with cameras at strategic locations to count and characterize recreation users. An IR counter would not, however, clarify access points, and thus it is most appropriate in situations where access points are known. Because the public can be curious, particular care needs to be taken to ensure that counters are secure from vandalism.

Second, we set out to estimate river use based on regression models. We tested predictors based on hypothetical relationships between recreation use in one location versus another, recreation use and temperature, and recreation use and day of the week. We originally believed that recreation numbers at the IR counter would have a

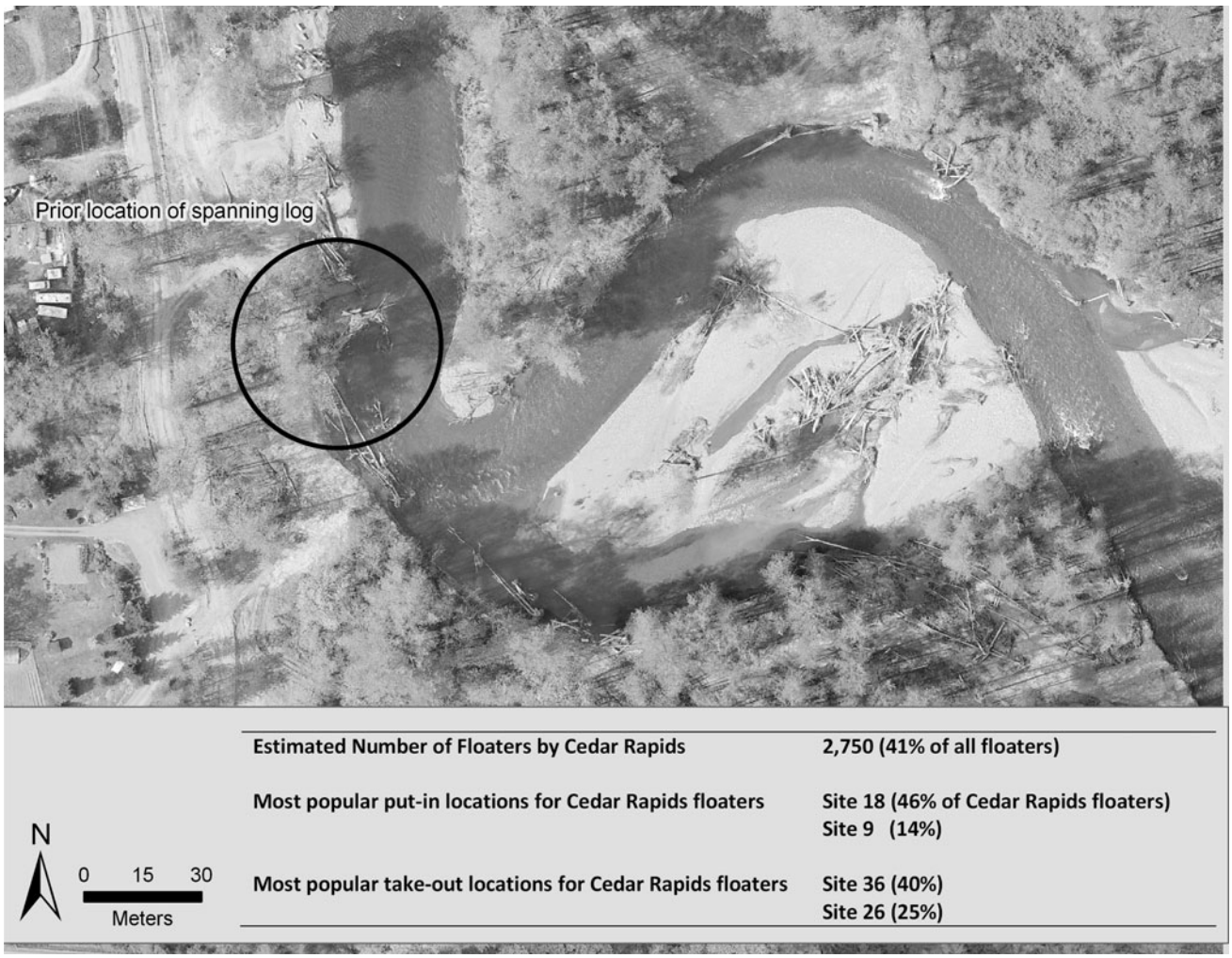


Fig. 7 Cedar Rapids levee setback project site and location of spanning log removal

predictable relationship to other sites. Based on stepwise regressions, however, we found that the best model for predicting recreation use relied on temperature. It was also surprising to us that the day of week was not an important predictor. While the temperature based models were robust, they are not valid for predicting use on other rivers. They may also not be valid for predicting use on the Cedar River in years with different climatic patterns. While we can clarify the factors that affect river use by conducting a study during one season, we cannot use the same equation to predict use in another year. We can, however, predict when and where recreation use will be highest.

Lastly, one of the primary methodological contributions of this study is the large wood perspectives from actual recreation users immediately following their floating experience. Prior studies on public perception of large wood have relied on the general public responding to photos of rivers with and without wood. Interviewees in these studies were not necessarily river recreationists. We found our interviews with actual river users soon after their float to be particularly insightful and possibly more valid for making management decisions. Because the sampling for interviews in this study was limited to the interviewer being in the location where floaters exited the water, we cannot extrapolate interview data to represent the entire floating population. Interview data provided, however, a significant amount of information from a diverse cross-section of river recreationists.

In terms of content, we found inconclusive relationships between floaters' opinions of large wood management, floating behavior, and the perceived risk of large wood from the interviews. The majority of interviewees chose large wood and rocks as primary hazards to their recreation experience from a list of pre-determined risks, though their responses to the open-ended question of how they felt about large wood were more diverse, sometimes considering the benefits of large wood and the responsibility of the individual to be prepared in nature. Additionally,

although some floaters expressed concern about large wood, these perceptions had limited influence on their behaviors. A couple of interviewees explained that they chose to float a different section of the river because of known log jams, but others talked about wood more as an annoyance. Lastly, although we were able to identify in the literature the primary risks of being intoxicated while floating, not wearing a pfd and not carrying a steering device, these actions were not mentioned as potential hazards by the majority of interviewees. Because there were no cited accidents that attributed large wood or alcohol as causes during our study season, we cannot compare the actual relative risks in this paper. It is clear, however, that there is an important discussion to be had about what floaters are saying about large wood, how they are behaving, how often large wood is actually responsible for accidents, and where the responsibilities lie between the management agency and the river users.

Conclusion

It is easy understand why river management projects often intersect with recreation use. Bank stabilization projects generally occur in places where flood risks are higher, which correlates to higher population. Habitat protection is prioritized for places that are degraded yet critical, and thus often near development. And river floating in locations such as the Cedar River is commonly driven by local knowledge and casual neighborhood access. It follows that more populated areas will require greater attention to recreation safety, flood mitigation, and habitat protection. Meeting all these needs as a riparian manager requires not only the standard knowledge of engineering, hydrology and ecology, but an understanding of riparian users' actions and perspectives. Unfortunately, river recreation studies are rare in published literature and riparian management agencies are often limited in budget and personnel to conduct such studies.

This paper fills a gap by describing innovative methods for gathering data on one specific user group, recreational floaters, and applying such information to riparian management planning. The methods demonstrate how to quantify the behaviors of actual river users, their perspectives on recreation hazards, and compare floater use to the presence of naturally-recruited and project-placed large wood in rivers. Prior studies have generally been incomplete in such assessments: riparian perspective studies have often been conducted with individuals who do not necessarily use rivers, floating density studies have focused on rivers with few access points or have based the quantification of use on one location along the river, and no studies that we found looked at the relationship of floater density to a specific management topic of concern (in this case large wood). While the exact results of this study are limited in their external application due to our focus on the Cedar River, the methods we present are widely applicable and timely.

Researching the characteristics, behaviors, and distribution of recreation users is a crucial step to understanding how river managers can ensure the safety of recreation users when developing riparian management plans. Whether the primary onus for safety falls on the shoulders of public agencies or river recreationists is a topic of debate, but it is a more informed debate when there is complete information about the source and location of safety risks. Future studies should continue to improve on the methods described in this paper and test their usefulness on other rivers with different physical and recreation characteristics. Additionally, future studies should systematically determine the specific causes of river injuries and the relative risk of floater behavior as compared to management practices.

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