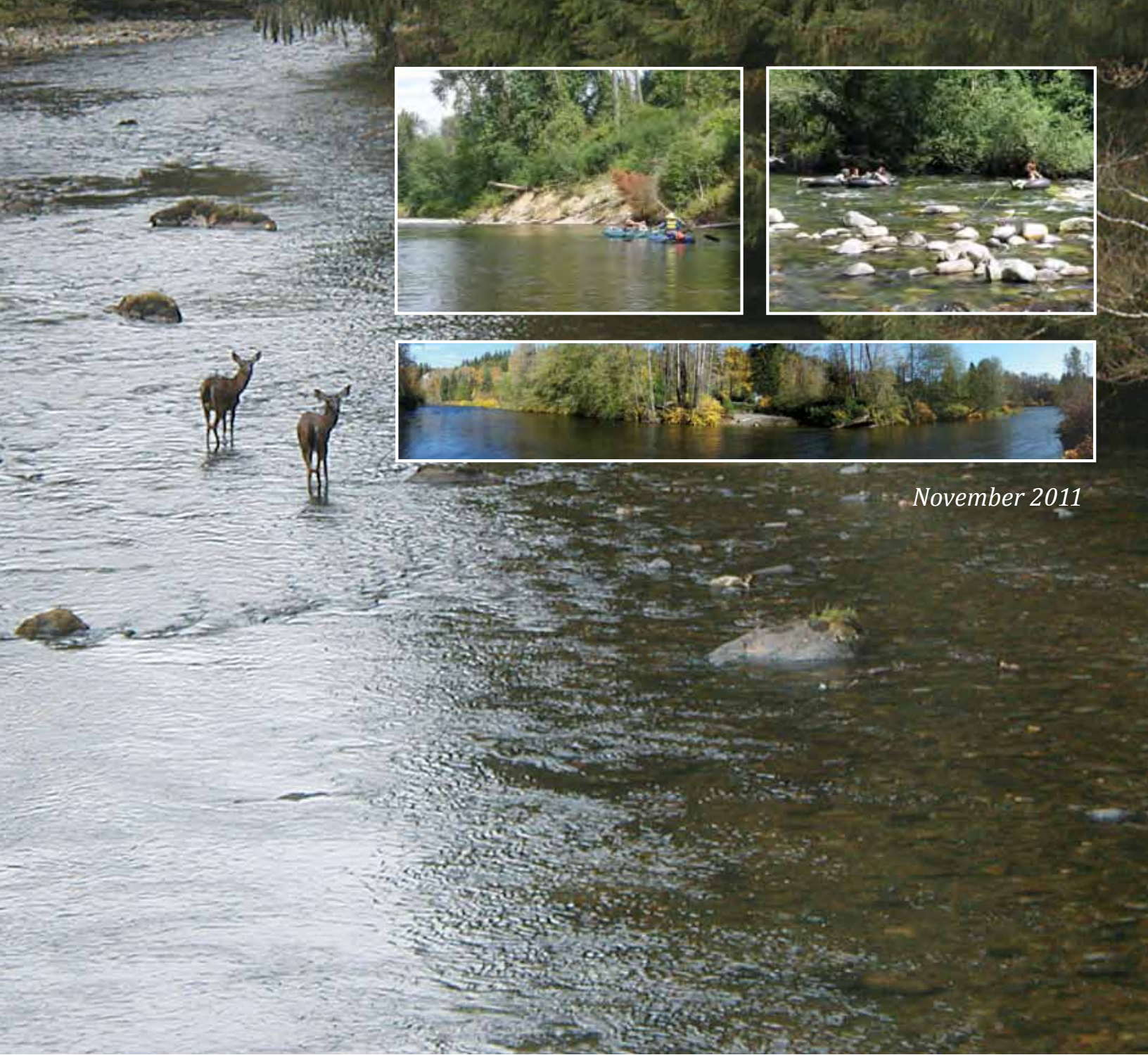


# CEDAR RIVER RECREATION STUDY

## Floating the Cedar River



*November 2011*



**King County**

Department of Natural Resources and Parks  
**Water and Land Resources Division**



**KING COUNTY**  
**FLOOD CONTROL**  
DISTRICT

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## Floating the Cedar River

November 2011

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**King County**

Department of Natural Resources and Parks  
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## Table of Contents

Summary .....	5
Background to the study.....	5
Large wood in river management.....	6
River recreation studies .....	6
Water recreation risks .....	6
Studying river use .....	7
The Cedar River .....	8
Study Design .....	8
Observation sites .....	8
Field methods .....	9
<i>Infrared Counter</i> .....	9
<i>Field Observations</i> .....	10
<i>Interviews</i> .....	11
Data analysis .....	11
Findings .....	12
Basic floater characteristics .....	12
How prepared are floaters?.....	13
What influences river use? .....	14
How many floaters on the Cedar? .....	14
Where are they floating? .....	14
Why float there? .....	17
What do they think of large wood? .....	17
What is good about large wood?.....	18
How does wood relate to other hazards? .....	18

Predicting high risk areas and seasons .....	19
Conclusions .....	20
Recommendations .....	20
Managing the Cedar River .....	20
Recreation management plans.....	21
Recreation monitoring.....	21
Future study methods.....	22
Limits of this study.....	22
References .....	23
Appendix A: Regression model statistics using temperature to predict the number of floaters.....	26
Appendix B. Expense report .....	27
Appendix C. Suggestions for future research .....	28
Appendix D. Draft budgets for potential future studies.....	29
Appendix E. Observation Site Descriptions.....	30
Appendices F and G. Interview and observation guides. ....	32

## Summary

River management involves balancing multiple objectives for a dynamic public resource. River bank stabilization in the Puget Sound lowland may include placing large wood to stabilize riverbanks and enhance salmon habitat. Although this practice benefits humans by protecting infrastructure and natural resources, some citizens have expressed concern that it may be hazardous to recreation users. In particular, spontaneous summer recreationists such as inner-tubers may be at greatest risk because they are least likely to plan their float or take precautions. In order for King County river managers to fulfill their multiple mandates, they need to understand the location of recreation users, the factors that could be putting them at risk, and how the actual users perceive wood in rivers. This study explains methods for gathering this information and suggests that river recreationists may make choices that increase their risk for injury.

We used riverside observations, interviews, and an infrared counter to collect data between May and September of 2010 on the Cedar River in King County, Washington. ***Over 1,900 floaters were observed and over 6,700 floaters are estimated to have floated the river between Landsburg Dam and Carco Park.*** We found that 84% of the floating vessels on the Cedar River were inner tubes, 65% of floaters were male, 73% were adults, and 83% had floated multiple times. When asked how they prepared for their float trip, 38% said they checked the weather, 17% grabbed drinks and shoes, and 11% checked river conditions. Eight percent did not check anything because they live nearby. Though 98% of those interviewed knew how to swim, only 14% had access to a life vest, with only half of those with access to vests actually wearing them. At least 26% were visibly drinking alcohol, and only 13% of vessels had an oar or paddle. Although these behaviors are known to increase risk of injury, few accidents happened on the Cedar River during summer 2010 and there were no fatalities.

Of the 1,900 observed floaters, 64 were interviewed upon exiting the river. Of these, 88% percent said they had encountered large wood. Ninety-one percent believed the wood got there naturally and 7% did not know how the wood got into the river. Feelings about large wood varied on a spectrum of acceptance: 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; 21% felt it was generally ok but that the pieces that spanned the river and stuck out could be removed; 3% had no feelings but didn't believe it should be removed; 16% didn't like it but saw the benefit; 14% were not bothered by it at all; 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.

When asked to rank seven potential hazards to floaters, large wood and rocks were considered the most hazardous (95% and 92% respectively) followed by fast water (74%), and cold water (66%). Access points, deep pools, other users, trash, and beer were other hazards mentioned.

# Background to the study

## Large wood in river management

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 infrastructure. As a result, river managers need social as well as ecological and engineering knowledge to effectively address multiple objectives. The primary objectives of most river restoration projects in the U.S. include enhancing water quality, managing riparian zones, improving in-stream habitat, and stabilizing banks (Bernhardt et al. 2005). To do this, river management practices in the U.S. have evolved from removing all wood and stabilizing banks with rocks to allowing some wood to remain in rivers and occasionally adding live and felled plants to improve riparian habitat (Lee 1997, Petts and Welcomme 2003, Naiman 2005, Wohl and Merritts 2007). This is based on current recognition, particularly in the Pacific Northwest, that large wood is a natural part of river ecosystems and plays a role in various ecological and geomorphic processes (Naiman et al. 2005). While large wood in rivers fulfills both ecological and structural purposes, we know little about how this shift in management of large wood in rivers may increase the relative risk to recreation users or how users feel about wood in the river. Without this knowledge, river managers face a challenge in crafting a balanced approach to managing wood in rivers that are valued both for ecological services and recreation values.

## River recreation studies

In fact, we know little about river recreation in general. Several studies explain that social norms, economics, past experience, and use permits affect river use (i.e., Siderelis and Moore 2006; Schrestha 2007; Robertson and Budge 1993), but the majority of these studies describe canoe, kayak, and whitewater rafting trips. Few studies are specific to the common practice of floating down a river in an inflatable tube or plastic raft, also known as inner tubing.

## Water recreation risks

On a broader scale, several studies have looked at risks related to water recreation in general. They highlight that 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 (Branche et al. 1991, Driscoll et al 2004, Smith et al. 2001, Cummings et al. 2010). In fact, 30-70% of drowning victims have alcohol in their blood (Driscoll et al. 2004) and the use of PFDs could prevent up to 50% of drownings in recreational boaters (Cummings et al. 2010).

Some have argued that allowing large wood to remain in river systems could be another risk to recreation users. While there are no known deaths or serious injuries in King County, WA as a direct result of interactions with large wood, it is certainly worth learning how wood affects the safety of river

users and how these users perceive the practice of maintaining wood in rivers for bank stabilization and habitat formation. Initial investigations in this area asked students and researchers to identify preferred river aesthetics through photographs (Gregory and Davis 1993; Piégay et al. 2005; Chin et al. 2009). In nine countries and various U.S. 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. This suggests that a preference for wood-free rivers may be due to people's expectations based on the historic removal of wood in rivers (Wohl and Merritts 2007). Though these photographic studies are important to understand the general public's perception of large wood, the most important perception may be that of the actual river recreationists. We are not aware of any prior study on the perceptions of large wood by actual river recreationists.

## Studying river use

Studies that describe who river recreation users are and where they float are also rare. Two surveys that determined river recreation density in Wisconsin and Puerto Rico used personal observations at access points and, in one case, mechanical counters at parking lots (Davenport 2003; Santiago 2008).

These methods are particularly effective in situations where there are a small number of well-established access points. Forest-based recreation studies are more common and often use infrared counters and field-based interviews (i.e., USFS 200, Muhar 2020, Shoji 2007, Peters and Dawson 2003, Fay 2010, and Cope 1999).

This study describes the frequency and types of river use, and the attributes of river users. This information lays the foundation for more detailed analyses of the risk of large wood placement for river recreationists. Using 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) What are the basic characteristics of floaters?
- 2) How prepared are the floaters?
- 3) What influences river use?
- 4) Where are they floating?
- 5) Why float there?
- 6) What do they think of large wood?
- 7) What is good about large wood, according to floaters?
- 8) How does large wood relate to other hazards?
- 9) What are the high risk areas and seasons?

We tested the combined use of an infrared counter, field observations, and exit interviews to estimate river use; field observations and exit interviews to measure risky behaviors; and exit interviews to determine how large wood affects river recreationists and how users feel about wood in the river. Our



field methods were designed to efficiently capture recreationists originating from multiple, unpredictable access points.

## **The Cedar River**

This study focuses on the Cedar River, which begins in the Cascade Range of Washington State and flows northwest toward Lake Washington near Seattle. From the source to the Landsburg Dam about 22 miles from Lake Washington, 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 multiple 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 Landsburg 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. Tubers, floaters, swimmers and waders use various sections of the river through the summer months.

Large wood is a common part of the Cedar River. Wood often falls into the river due to natural causes, including routine bank erosion and larger erosive events such as the Nisqually earthquake in 2001 which created a large log jam near Ron Regis Park. Current wood management on the Cedar River includes placing large wood as part of bank stabilization projects and managing fallen trees in the river on a case-by-case basis, favoring leaving naturally recruited logs in-stream for bank stabilization and salmon habitat. As a result of joint investigations with the King County Sherriff's Marine Unit, some large wood is repositioned or removed, particularly pieces that span the channel or have potential to harm infrastructure due to their orientation. In-stream wood management is always done with authorized permits from the Washington Department of Fish and Wildlife. Informal observations have shown that some river users enjoy swimming holes and informal bridges associated with large logs, and that wood has occasionally served as a rescue aid. There is some citizen concern, however, about the impact of large wood and the current management regime on recreational safety.

The Cedar River Recreation Study was conducted in the context of a broader Cedar River Large Wood Study expected to be completed in winter 2012. Other elements of the study include classifying wood on air photos to detect trends in wood abundance and location over time, a field study of large wood to characterize key pieces and jams, lidar evaluation of forest stands that serve as sources of large wood, and analysis of public infrastructure adjacent to the river.

## **Study Design**

### **Observation sites**

During a pilot study in 2008, 35 potential river access points were identified from a river float trip, driving along Highway 169 and Jones Rd., and analysis of aerial photographs. Potential access points

were places where cars could be parked easily or there were clear signs of river access (i.e., foot trails). Seven sites were selected for observations based on the likelihood to encounter people who access the river at any of the 35 predicted access points (Figure 1). Three of the seven sites were popular public parks, two were public natural areas, and two were on other county properties.



Figure 1. Observation Sites along the Cedar River, WA.

## Field methods

To determine who river floaters were, where they were floating, and estimate their numbers, we collected data using three methods: an infrared trail counter at one observation site, field observations at seven sites over 52 days, and exit interviews as groups finished floating. We used these same interviews to learn how floaters felt about large wood in the river.

### *Infrared Counter*

The infrared counter was an important tool to determine baseline user numbers for comparison to other sites that were sampled only occasionally. It was also used to test as a method for measuring river use instead of field observations. The 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 counter was calibrated to field observations by one researcher repeatedly

floating by the counter on the first day and by seven days of regular field observations throughout the season. The counter lasted 24 days until it was vandalized.

### Field Observations

Field observations were the primary method used to collect data on user characteristics, numbers, and floating routes. Observations were conducted by two researchers between May 17 and September 5 (Figure 2). Observation days were selected so that each of the seven sites had approximately the same number of weekend days and mid-week days 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 were reaching overtime for that week. On days that were over 80°F, every attempt was made to have both researchers out at different sections of the river. The counter site was considered one of the seven standard observation sites and part of the general rotation for observation days.

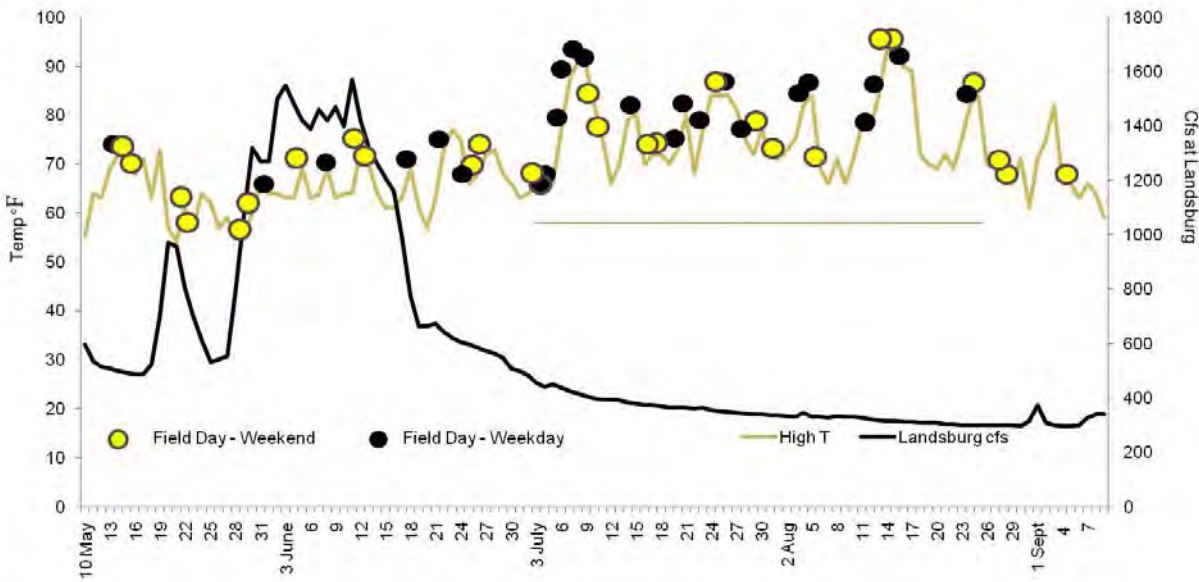


Figure 2. Field observation days with reference to temperature, river flow, and day of the week from May 10-September 7, 2010.

A field day was from 11am-7pm at a single site, with one researcher counting and observing the characteristics of all floaters past that site. Fishing activity was observed to be generally finished by 10am and anglers not in boats were not a subject of this study. The characteristics measured for floaters included the number of people in the floating group; the types of floating vessels; general age grouping and gender; and whether they had personal flotation devices, alcohol, paddles or oars, or fishing gear. Age grouping was estimated based on appearance and grouped into three classes: kids (1-11), youth (12-17), and adults (18+). Youth included those individuals who clearly appeared to be under 18 but

older than 11. As floaters passed the observer, she asked two questions: “Where did you start your float?” and “Where will you finish your float?”

### *Interviews*

We used interviews to gather in-depth information about where people float and why, as well as how people interacted with and felt about large wood in the river. Representatives of each float group that exited the river where an observer was stationed were asked to participate in a five to ten-minute interview. We 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 considered 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 observation sites were given priority in the sampling rotation on very hot days.

### Data analysis

The first stage in data analysis was to organize and clean the data. We began with data from the infrared counter to determine the highest use day, the percentage of groups floating outside the 11am-7pm observation day, and the potential of this tool to replace field-based observations. Because we found it difficult for the infrared counter to represent individuals, we were only able to determine number of groups from the counter. Based on calibration of the counter with visual confirmations, every count within four minutes of the last was considered one group.

Data from field observations were compiled into an excel spreadsheet for data cleaning, with each row representing a group that was assigned a unique identifier. To explore daily summaries, a separate spreadsheet was created included daily high temperature, average flow, day of week, date, field site observed, number of groups, number of people, and exact observation hours. The number of groups represented the observed count plus the percentage that would have floated outside the eight hour observation period, as determined by the infrared counter. A separate workbook was created for the interview data, with each row representing one interview and being linked to the observation data via the unique identifier assigned to each group. Access points described in observation and interview data were coded into 41 unique locations and each put-in and take-out was assigned its corresponding number.

Once data were organized, the observation spreadsheets were then imported into the Statistical Package for Social Sciences (SPSS) to create summary statistics, including the following:

- number of people
- number of groups
- percent males per group
- percent adults (appeared 18 and older), youth (appeared 12 to 17) and kids (appeared younger than 12) per group
  - percent of people wearing life vests by age grouping
  - percent of boats with paddles

- percent of groups with alcohol visible
  - percent of groups with coolers
- number of groups with fishing equipment
- percent and type of floating vessels per group
  - most popular access points.

These descriptive characteristics were correlated with each other to determine potential relationships. They were also compared across the seven locations using Kruskal-Wallis to determine potential differences in floater characteristics by location.

To estimate the total number of people who floated the Cedar River during the summer of 2010, we needed a statistical model that could predict floater numbers based on our observation data. We used stepwise linear regression models for each site that initially included temperature, flow, and whether the day of the week was a weekend or weekday. We added the estimates predicted by these models to determine the total number of users over the entire season and on the busiest day.

To confirm that interview respondents were a representative sample of floaters, we compared the frequency of their expressed favorite access points to the access points obtained from the field observations. Data from the open-ended interview questions were coded into succinct, descriptive categories to better present people’s answers. We coded and grouped the reasons why people chose their specific float route, what they like to do while floating, how they prepared for their trip, and how they feel about wood based on similarities in responses. The number and percentage of respondents were calculated for each of these categories.

To understand how interviewees generally rank potential hazards, we calculated the average rank and Smith’s salience for all hazards mentioned more than once. Smith’s salience is a 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 alone.

Finally, to create a visual representation of how many floaters used each access point, we created a new feature-class in ArcGIS to locate each of the 41 access points and applied a symbology based on number of people who used the location. To graphically present the density of use along the river, a raster of floater tracks was then created, assigning each a frequency value based on the number of groups observed on each track and the estimated number of users of each track. The observation database was linked to both the access points and floater tracks through the unique group identifier.

## **Findings**

### **Basic floater characteristics**

We visually observed over 1,900 floaters in 550 groups, with a median group size of three. In addition to people, nineteen dogs were observed. Sixty-four exit interviews were conducted. Sixty-five percent of floaters were male, 73% adults, 18% youth, and 9% kids. Eighty-four percent of vessels were inner tubes



or mattresses (Figure 3). Another 12% were rafts and a total of 5% were kayaks, canoes or pontoon boats. Eighty-three percent were repeat floaters who averaged about 19 trips over the past five years. While fishing gear was observed in some rafts, most fishermen would likely be off the river before the 11 am start time of this study, therefore this study does not reflect the attributes of that user group.

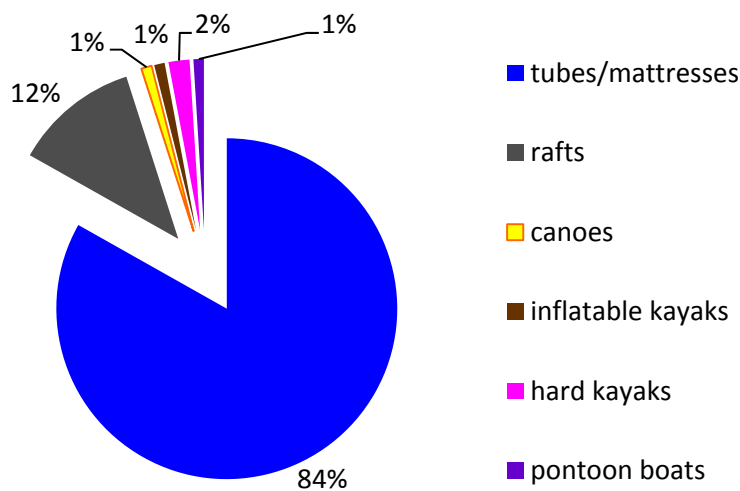


Figure 3. Floating vessels seen by type.

### How prepared are floaters?

When asked how they had prepared for their float trip, 38% 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 live nearby. Ninety-eight percent of floaters knew how to swim and 14% had access to a pfd either by wearing one or having one accessible, with 39% of kids 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.

Table 1. Measures of preparedness for river floaters.

<b>Percentage who know how to swim</b>	<b>98%</b>
<b>Percentage of people with access to pfd</b>	<b>14%</b>
<i>Kids wearing</i>	39%
<i>Adults wearing</i>	5%
<i>Youth wearing</i>	2%
<b>Percentage of dogs wearing pfd</b>	<b>21%</b>
<b>Percentage of boats with oars</b>	<b>13%</b>

<b>Percentage of groups with alcohol visible</b>	<b>26%</b>
<b>Additional percentage that might have had alcohol*</b>	<b>15%</b>
<b><i>*in coolers or other containers</i></b>	

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Some measures of preparedness varied by user type. Tubers generally did not wear pfd's, have oars or paddles, or float with kayaks, canoes or pontoon boats. Floaters in kayaks and canoes often wore pfd's and carried oars, and they were predominantly men. In addition to being the least likely to wear pfd's, youth were also not likely to have oars or paddles. Men were the least likely of adults to be wearing pfd's. Alcohol use, on the other hand, could not be attributed to any particular floater characteristic. It could be found in groups that were predominantly under the legal drinking age, with individuals that demonstrated otherwise safe river floating practices such as wearing pfd's and carrying oars, and with each type of floating vessel.

### What influences river use?

For six of the seven locations, temperature was sufficient to predict the number of floaters (Appendix A). Site 2 was not well predicted by temperature, 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. While day of the week was not a strong enough predictor to be part of the regression models, our numbers showed that weekends had slightly more use than weekdays for days of equal temperatures. Inner tubers were regularly seen on the river on days with temperatures higher than 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 predicted to be in the 80°F's. Most floaters were seen between 4pm-7pm, especially on weekdays.

### How many floaters on the Cedar?

Based on the regression models, we estimate that over **6,700** floaters went down the Cedar River between May and September 2010, with 640 of them on each of the busiest days. The busiest days were a Saturday and Sunday in mid-August that were 93°F.

### Where are they floating?

Floaters entered and exited the river at 41 unique access points, creating 135 floating routes that averaged five miles long (std=3.5miles) (Figure 4). The most commonly floated distance was three miles. Floaters tended to put in at many locations along the river, though most exited the river only in the

lower section between Ron Regis and Carco Parks. The most common put-in sites were Habenicht Park, Cedar Grove Road, the 76 station on Maple Valley Highway, and Cavanaugh Pond.

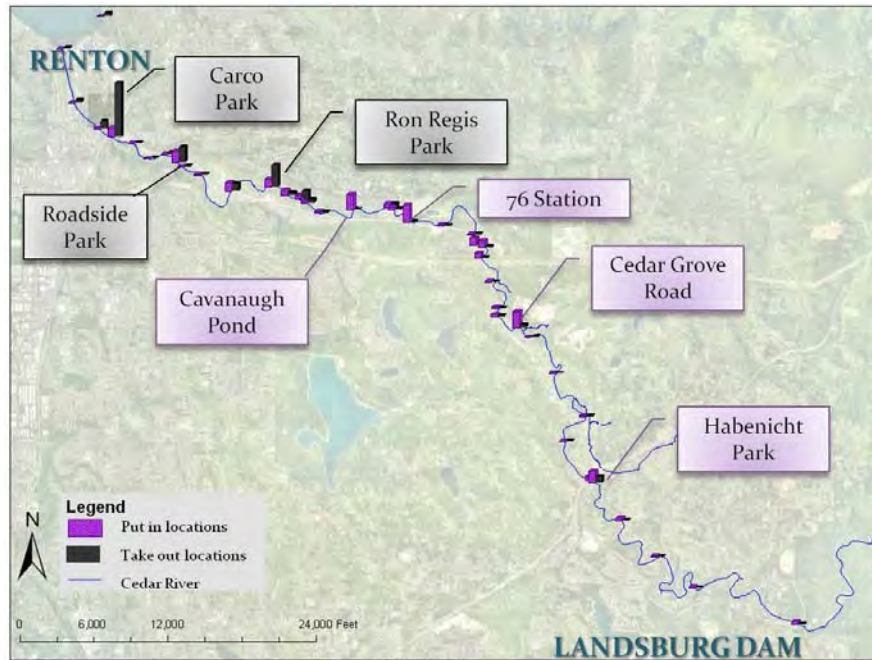


Figure 4. Relative use of put in and take out access points on the Cedar River.

Not all areas of the Cedar River were equally popular among floaters. Site-specific temperature-dependent regression equations were used to estimate recreation use for each river reach. Use was lowest at the upper reaches of the river near Landsburg Dam (Figure 5), with about 520 floaters estimated to have passed Habenicht Park over the season, and only 25 on the busiest day. Use gradually increased downstream with the highest overall use between the 76 gas station on Maple Valley Highway and Carco Park in Renton. Over 2,000 floaters passed these locations over the season, and almost 400 on the busiest day.



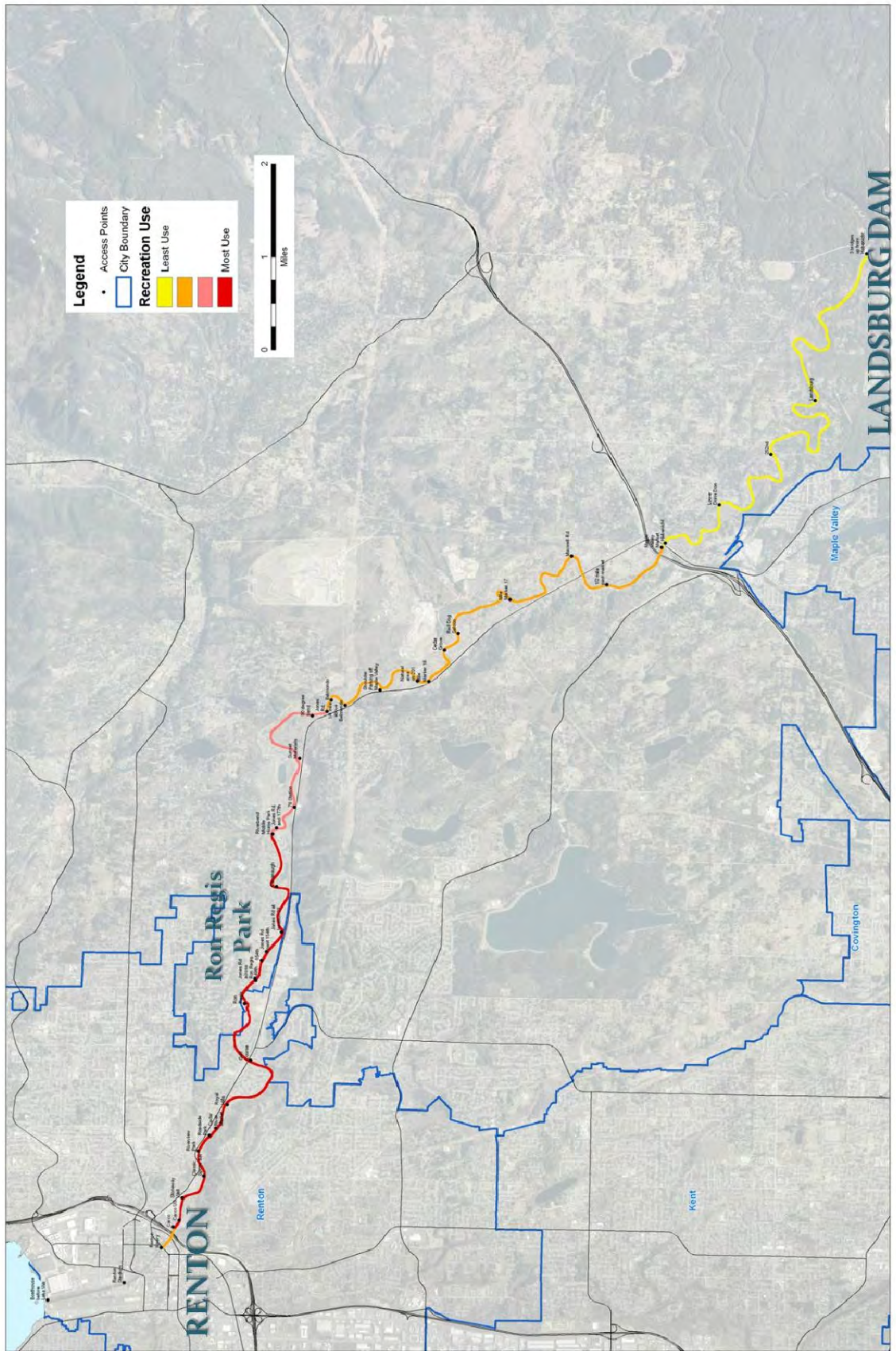


Figure 5. Proportional recreation use along the Cedar River.

## Why float there?

When asked why they chose to float a specific section of the river, 48% of floaters said it was close to home or a friend’s house (Table 2). Another 20% chose their floating route because they perceived it was calm and easy. A notable 19% chose the route because there was less debris or it was considered safer. Eighteen percent said it was what they know and 15% said it had easy access and parking. Only 5% chose their specific route because of aesthetics.

Table 2. Reasons for floating their chosen route.

Reason	% respondents
Close to home or a friend’s	48%
Calm, chill area, easy	20%
Less debris/below log jam/safer	19%
What I know	18%
Easy access/parking	15%
Fun places to hang out (rapids, currents, beaches, swimming pools)	10%
Aesthetic/wilderness	5%
Recommendation	3%
New part of river, Less drunks than other rivers, Appropriate distance	2% each

## What do they think of large wood?

Of the 64 people interviewed, eighty-eight percent had noticed or run into large wood in the river. 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 person each said they had to rescue others, they snagged their bathing suit, they went under a log, or they had to duck under branches. Various respondents offered a positive perspective to the wood, saying it provided preferred swimming holes and salmon habitat. Most respondents considered large wood to be any piece of wood that was in and sometimes hanging over the water. This included large diameter logs that had fallen or been placed in the river. It also included smaller diameter branches that stuck out from the water and branches that hung over the river.

Ninety-one percent of respondents believed the wood got there naturally and 7% didn’t know how the wood got into the river. This data corresponds to unpublished data from the Cedar River Large Wood Study that indicates most large wood on the river is of natural origin. Survey respondents provided a variety of answers to the question, “How do you feel about large wood in the river?” Answers were coded and grouped into a spectrum of acceptance (Figure 6): 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 by it; 21% felt it was generally not a problem but that the pieces that spanned the river and stuck out could be removed; 3% had no feelings but didn’t believe it should be removed; 16% didn’t like it but saw the benefit; 14% were not bothered by it at all; and 17% thought it was natural and therefore appropriate to be there.



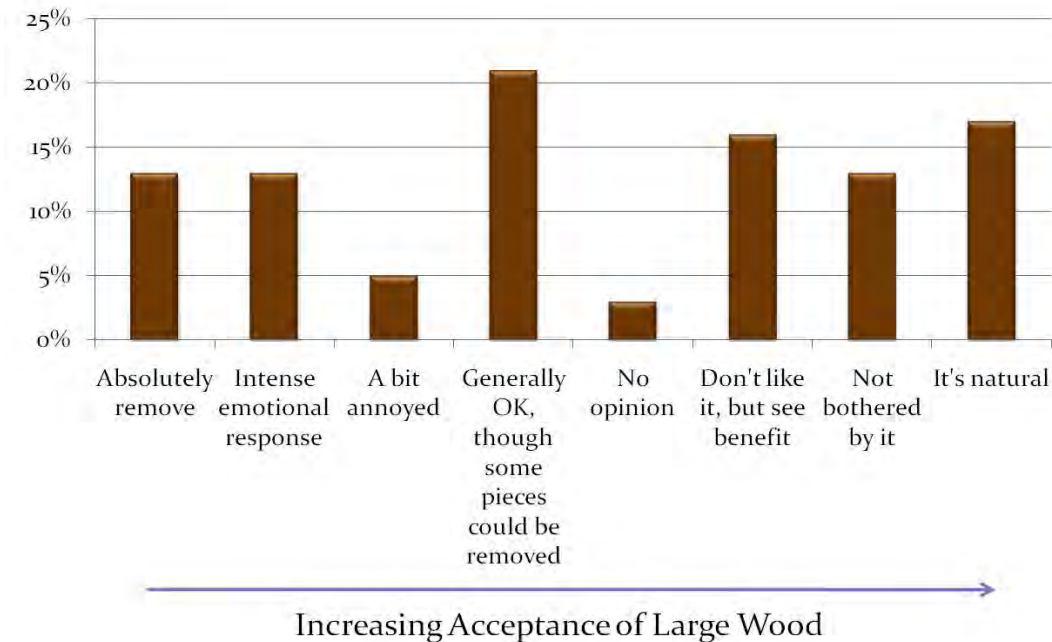


Figure 6. Coded responses of how Cedar River floaters felt about large wood.

### What is good about large wood?

When asked why large wood is good for the river, 38% of floaters said that it provides salmon habitat. Another 17% said it supported other natural functions, including general wildlife habitat and erosion control. Five percent said it was good for tubing. Four percent did not know why it was good and only 2% said there was nothing good about wood in the river.

### How does wood relate to other hazards?

Floaters were asked to rank seven potential hazards as they related to each other. Of the seven, large wood and rocks were considered the most hazardous, with mean rankings of 1.5 and 2.2 out of seven respectively, followed by fast water (3.5), and cold water (4.5) (Table 3). Large wood and rocks, which are naturally in the river but also are sometimes placed or maintained by river management agencies, rise to the top of perceived hazards. Access points, deep pools, other users, trash, and beer were other hazards mentioned. It is important to note that interviewees were asked to rank these seven specific hazards and did not come up with them on their own. As such, 95% of people choosing to rank large wood as a hazard does not imply that 95% of people think that floating the river *is* hazardous or that this is because of large wood. Rather, these numbers represent the relative importance of each of these seven hazards to the users who were interviewed.

Table 3. Floater perception of river recreation hazards.

<b>Predicted Hazards</b>	<b>% people who responded</b>	<b>Average Rank</b>	<b>Salience*</b>
Large Wood	95	1.5	0.9
Rocks	92	2.2	0.7
Fast Water	74	3.5	0.4
Cold Water	66	4.5	0.3
Access Points	58	4.7	0.2
Deep Pools	58	4.8	0.3
Other Users	53	5.5	0.2
<b>Additional Hazards</b>			
Trash	3	2.5	0.0
Concrete	3	2.0	0.0
Beer	2	1.0	0.0

\*Salience is a statistic that incorporates the number of respondents with average rank. In this case it is an indication of the relative importance of each hazard to river users in the context of the seven hazards they were asked to rank. Salience is interpreted on a scale of 0 to 1. A number closer to 1 indicates a higher perception of hazard to the river user among the hazards listed.

### Predicting high risk areas and seasons

This study substantiates the commonly held notion that summer recreation is largely determined by high temperatures. When temperatures are above 70°F, there are likely to be floaters on the river. When the temperature reaches 80°F or more, recreation use increases dramatically. For a management agency, this information can help determine when recreation concerns need to be most taken into consideration.

Figure 7 shows the number of days over 80°F for the months May through September from 1995-2010. We can see that the majority of hot days occur in July and August, but it is not unprecedented to have 80°F days in May, June and September. Of these months, May is the most concerning to river management staff because flows are typically higher in late May and early June than later in the recreational use season. This was the case in 2010 (Figure 2). This combination of high flow and warm days can create a particularly dangerous situation for river recreationists. The warm weather increases the likelihood of floaters. The high flow increases floating danger by decreasing reaction time and concealing potential hazards such as rocks and logs. Water temperatures are also colder in the spring versus summer months, increasing the risk of hypothermia, though this is a safety issue for many King County Rivers year-round.

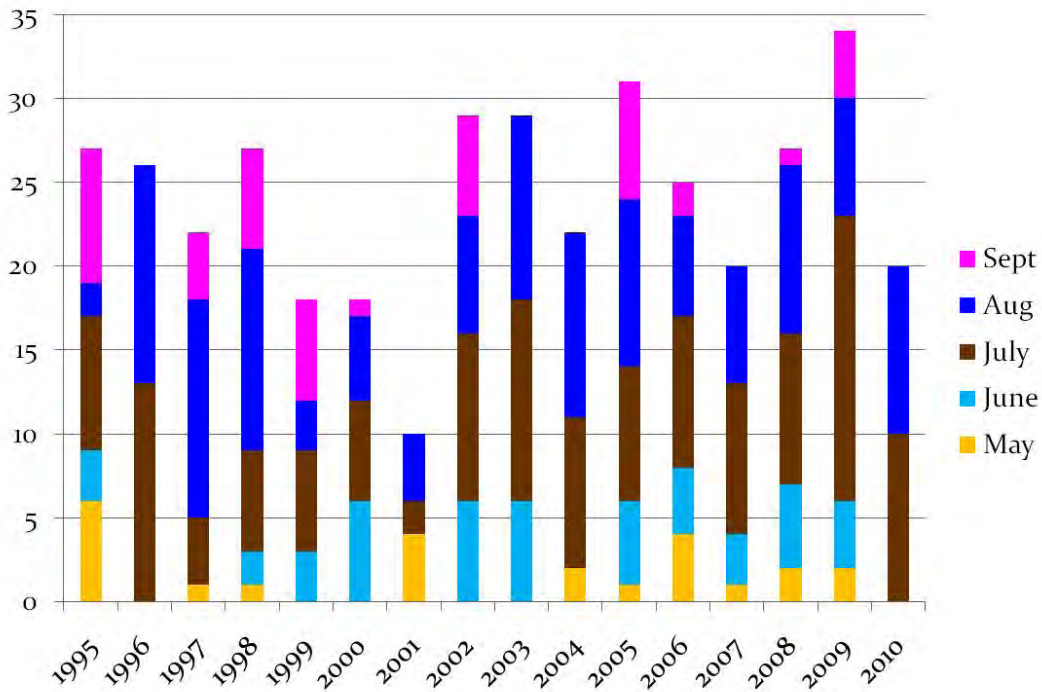


Figure 7. Number of days over 80°F for the months May-September from 1995-2010.

## Conclusions

Recreation users are prevalent on the Cedar River. The level of use is strongly correlated with forecast and actual air temperatures, with use beginning to increase substantially when temperatures are over 80° F. Most floaters are adults who use inner-tubes and mattresses. Many make decisions that increase their risk for injury, such as drinking alcohol, not wearing life jackets, not carrying oars or paddles, and not checking river conditions. Among seven possible river hazards, floaters ranked large wood and rocks as the greatest dangers to their float trip. It is important to note that in the 2010 season of over 6,700 floaters, there were very few river rescues, primarily in the high flows of June, and no recorded fatalities due to floating on the Cedar River. River managers should therefore consider periods of high flow and high air temperature in areas where there are objective physical hazards as the most hazardous conditions for recreation users, and manage their outreach, patrol, and response efforts accordingly.

## Recommendations

### Managing the Cedar River

Data provided in this study can be used for managing large wood and designing projects along the Cedar River. The study demonstrated that casual river floating by inexperienced and underprepared users is

for the most part limited to the summer season, typically corresponding to low flow periods. This information can be used to target a range of recreation flows for a site and corresponding surface water elevations for project safety features. Recreation access to the river was widely scattered, therefore any efforts to distribute information about safe recreation use, new hazards, or project information will need to have a broad-reaching outreach effort. When selecting an appropriate use of wood in project designs or determining whether to relocate potentially hazardous naturally recruited large wood, river managers can refer to the recreation use maps and corresponding data to determine how many recreation users may pass that location. Similarly, river managers can consult the data to learn where the most common access points are in reference to a project site or large log. Information boards may be placed at these access points and points upstream to warn river users of potential hazards, or access points may be closed with indications of safer or more appropriate places to enter the river.

## Recreation management plans

King County currently offers river recreation safety guidance through brochures and news releases but does not have a formal approach to recreation management. Based on our findings about alcohol use, the lack of PFDs, and a distinct floating season it may be worth considering a recreation safety plan for the Cedar River. This plan could include seasons, reaches, and rules and regulations that are enforceable by the King County Sheriff's Office. Assuming that some or all of these findings may apply to other County rivers as well, such a plan might be appropriate Countywide.

It is interesting to note that other public agencies have developed recreation management plans for river use. While these regulations are not in response to conflicts with large wood, they provide examples of recreation guidelines. The city of New Braunfels, Texas, for example, has prohibited the use of glass, Styrofoam, and containers less than five ounces on rivers within city limits ([www.nbtexas.org](http://www.nbtexas.org)). They also restrict river use based on flow. At flows over 500 cfs, all children under eight must wear PFDs; over 750cfs everyone must do so. At flows over 1000 cfs, nobody is allowed to float the river. The city has size limits for coolers and prohibits jumping off cliffs and bridges at flows over 1000 cfs. In Utah, all children under twelve years old must wear PFDs ([www.discovermoab.com/pdf/riverrec.pdf](http://www.discovermoab.com/pdf/riverrec.pdf)). On certain sections of the Chattahoochee River in Georgia, the National Park Service requires pfd use by everyone ([www.nps.gov/chat](http://www.nps.gov/chat)). In addition to creating restrictions, public agencies have also looked for ways to support recreation through education and scheduled dam releases. In Tennessee, for example, the Tennessee Valley Authority posts a schedule of dam releases for the benefit of recreation users ([www.tva.gov/river/recreation/schedules.htm](http://www.tva.gov/river/recreation/schedules.htm)).

## Recreation monitoring

We also recommend continual monitoring of recreation use. This may include field observations at river management project sites and collaborations with the King County Sheriff's Office Marine Unit and volunteer and professional swift water rescue teams. King County river management projects often include design elements intended to reduce risk to recreation users, such as bumper logs to divert floaters away from the bank. An easy way to ensure this design technique serves its purpose is to

require a field observation day on a hot summer weekend to take notes on how recreationists interact with the facility. A similar monitoring plan could be used to test hypotheses about whether large wood in rivers helps or hinders recreation users and under what conditions (i.e., based on flow, based on position of wood to the bank, etc.).

King County river managers should collaborate with the King County Sheriff's Office and swift water rescue teams to gather further data about the number of recreation accidents. For this study and a previous overview of recreation accidents, Water and Land Resources staff contacted the sheriff's office and surrounding fire departments to obtain information about river rescues. In both cases it appeared that the information was difficult to access and that some incident reports had little information about the accident. Working with these agencies, it may be possible to improve the information and access to incident reports to get a better idea of when and how river recreation accidents occur.

### **Future study methods**

While this study characterized the amount and type of recreation uses on the Cedar River in 2010, we recommend continued studies on this and other rivers to maintain an understanding of how river recreation use and river management practices affect perceptions of recreation safety over time. Though direct field observations on purposively sampled days worked well for this study, other studies may not have the necessary personnel to fully replicate this approach. An infrared counter, previously unpublished as a method for river recreation studies, was used to count river users as a potential alternative to field-based observations. This method proved to work well for counting groups. When installing infrared counters, however, workers must properly camouflage the equipment and ensure that it cannot be easily removed. Interviews with floaters as they exit the river were also a new way to understand the public's opinion about large wood in river management. Previous studies have primarily focused on college student reactions to photographs of rivers with and without wood. We found the interviews with actual river users to be particularly insightful and possibly more valid for making management decisions than methods that rely on non-recreationists for input. Further suggestions are provided in Appendix B.

### **Limits of this study**

Readers should be aware that these study results do not easily apply to other contexts. First, the regression models used to estimate river use at the seven observation sites are not valid to predict use on other rivers or in other years. Other rivers will have different factors influencing recreation. Also, because many floaters explained that they chose the hottest day of the week for their float trip, we cannot say with confidence that the use trends we found correlating to specific temperatures would be the same in other years with different climate patterns. Considering that 2010 was a fairly mild summer, however, we can hypothesize that our estimates are low estimates for other years on the Cedar River.



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Appendix A: Regression model statistics using temperature to predict the number of floaters

Model	R (SE)	Overall Fit	Coefficient (SE)	t (sig.)
		F (sig.)		
Site 1	0.71 (0.57)	7.24 (0.03)	0.04 (0.15)	2.69 (0.03)
Site 2	0.42 (0.52)	1.28 (0.30)	0.02 (0.02)	1.13 (0.30)
Site 3	0.87 (0.45)	18.39 (0.00)	0.06 (0.01)	4.29 (0.00)
Site 4	0.88 (0.40)	25.00 (0.00)	0.09 (0.02)	5.00 (0.00)
Site 5	0.83 (0.50)	13.48 (0.01)	0.08 (0.02)	3.67 (0.01)
Site 6	0.87 (0.45)	22.59 (0.00)	0.06 (0.01)	4.75 (0.00)
Site 7	0.68 (0.61)	6.12 (0.04)	0.05 (0.02)	2.47 (0.04)

## Appendix B. Expense report

<b>Materials</b>	<b>Item</b>	<b>Total KC Cost</b>
	Camouflage rock	83.00
	Trailmaster IR counter and data collector	675.00
	Inner tubes	53.42
	Coroplast	32.85
	Sign posting materials (wood posts and wire)	12.00
	Spray Paint (3 cans)	20.00
	Loppers	20.00
	8 C Batteries	10.00
	Stencils, markers, pens, pencils, clipboards	10.00
	Write in the rain paper (2 boxes, 1.25 used)	57.90
	Camouflage duct tape	7.00
	Information Card	74.68
	<b>TOTAL MATERIALS*</b>	<b>1,055.85</b>
<b>Personnel</b>	<b>Hourly Distribution</b>	
	Original study Designer	5,000.00
	Total Project Coordinator (54.90/hr**)	37551.60
	<i>Study design and preparation (124 hours)</i>	<i>6807.60</i>
	<i>Data collection (280 hours)</i>	<i>15372.00</i>
	<i>Administration (20hours)</i>	<i>1098.00</i>
	<i>Data analysis (160 hours)</i>	<i>8784.00</i>
	<i>Report preparation and presentations (100)</i>	<i>5490.00</i>
	Assistant (20.00/hr)	
	<i>Data collection (200 hours)</i>	4000.00
	<b>TOTAL Personnel</b>	<b>46,552.00</b>
<b>Travel</b>		
	Field Assistant personal miles (1852)	926.00
	Project Coordinator personal miles (350)	175.00
	Project Coordinator King County rental (196 hours)	723.35
	<b>Total Travel</b>	<b>1824.35</b>
<b>Total</b>	<b>Project Costs for 1 season</b>	<b>49,431.80</b>

\*Purchased but Didn't Use: White foam board, table

\*\*includes KC overhead expenses, hourly wage of \$30/hr



## Appendix C. Suggestions for future research

If the County wishes to gather similar information on other rivers or confirm and update information on the Cedar River in the future, there are a few options. First, the infrared counter was effective for counting groups of people, but only after seven eight-hour days of calibrating the counter to field observations. The field observations were also critical to understand the site and recognize that certain recordings were attributed to other uses on the site (i.e., flyfishermen, dogs and owners playing fetch, swimmers, etc.). If future studies were to rely on infrared counters for data collection along the river, it would be critical to spend at least two full days at each site at different times of the season to understand common uses. Alternatively, attaching a video or still camera to the counter would remove the need to calibrate field observations to the counter recordings. Though this method would still require weekly trips to download data from each of the counters, it would likely result in a cheaper method for capturing recreation use data. It should also be noted that each river will require different numbers of counters depending on predicted access sites. The primary drawback to relying on infrared counters is that continuous spatial data on river use will not be available. Instead, one would learn the relative use rates among the countering sites without exact information about put in and take out locations. The risk to relying on counters is vandalism.

An alternative to the infrared counter paired with a still camera is the use of traffic counters connected to some power source (a citizen's home, batteries with solar panels, or batteries that are replaced every couple days). Live-feed video can be sent via cellular technology to a web location where data can be downloaded and analyzed from the office. This method has the same drawbacks and risks as the infrared counter with still camera and would cost either more or less depending on employee rate (the counter is more employee dependent while the traffic camera is more equipment dependent).

A third option could be implemented if the county wants to get a rough idea of use on the hottest day of any river. Selecting a particularly hot day with expected high use for the season (i.e., on a holiday weekend or on Cedar River Days for the Cedar River), the county could use helicopter flyovers or send various survey workers out on the same day. Helicopter flyovers could go over the river three times to account for different users during the day, every two to three hours along the stretch of the river, counting the number of users and recording their location with a GPS tracker connected to a time keeping device. Additional data could be collected with the use of a video camera that could be later coded. An alternative to the flyovers would be to station various survey workers along sections of the river for the entire day to gather typical observation data, including put in and take out locations.

## Appendix D. Draft budgets for potential future studies

Based on measuring use on the Cedar River	Cost	Notes
<b>Option I: repeat on different year</b>		
A. Same Method, same payscale	<b>38,400</b>	allows for in-site interviews as well as observations eliminates some materials and study design aspects of original study
B. Same Method, KC perm employee payscale (\$100/hr) with assistant (\$20/hr)	<b>70,000</b>	
<b>Option II: Flyover to determine use on a hot day</b>		
Helicopter rental (\$269/hr with 2 flyovers per day at 2 hours each)	1,076	would want to sample at early and late end of float day (12pm-2pm and 4pm-6pm)
Personnel time (20 hours per sampling day at \$100/hr)	2,000	
<b>TOTAL</b>	<b>3,076</b>	
<b>Option III: Infrared counters with still camera (7 sites)</b>		
Trailmaster 1550 Infrared Counter (260*6 - one already purchased)	1,560	includes set-up, weekly downloads, project management, data analysis and write-up includes set-up, weekly downloads, project management, data analysis and write-up
Camouflage materials	200	
1 TM35-D still camera with cable and mounting pod	500	
A. Personnel time- 500 hours (Temp at \$55/hour)	27,500	
B. Personnel time - 500 hours (KC perm employee at \$100/hour)	50,000	
Travel costs (200 hours at \$3.70/hr for KC Fleet)	740	
<b>Total for Temp to coordinate (A)</b>	<b>30,500</b>	
<b>Total for KC employee (B)</b>	<b>53,000</b>	
<b>Option IV: Traffic Video cameras</b>		
Traffic camera plus lens, housing (300/camera * 7 sites)	2,100	omit the TM technology and use traffic cameras as has been done with DOT support
Video encoder (*7)	4,900	
Router and 3G card (\$400 per camera *7)	2,800	middle option - could be cheaper or more expensive
Personnel (@ \$100/hour)	25,000	
Power supply (electric - \$6/site; batteries-\$1200/site; solar- \$3000/site)	8,400	
<b>TOTAL</b>	<b>43,200</b>	
<b>Option V: Knowing the highest use sites along the river, KC could place 1 or 2 counters rather than 7 if they're interested only in one location or the highest use</b>	<b>4,500-15,000</b>	

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## Appendix E. Observation Site Descriptions

### **Site 1: Habenicht Park**

This was the furthest upstream site, about six miles from the Landsburg Dam. It is popular with dog owners for playing fetch in the river and a number of transients hang out during the day. Some people come down from Cedar River Trail to relax. Others come to swim and picnic as well. On cooler days, there are often a couple fly fishermen, particularly earlier in the day. Habenicht Park is more popular as a put-in than take-out site. Those who take out generally come from Lower Dorre Don Rd. or are launching kayaks or pontoon boats from Landsburg. There are three main access points here: one at the end of each trail from the parking lot, and one across the river at a restaurant/apartment building below the Hwy 169 Bridge. The parking lot is large and regularly full and there is a portable toilet near the parking area.

### **Site 2: Cedar Grove Road**

There are several access points around the Cedar Grove Bridge. One can access the river via a trail through the natural area which has space for about half dozen or so cars to park on Cedar Grove Rd. Access is also at a variety of vacant lots purchased by the county. This site is also used more a put-in than take-out location. This is not a generally popular location for people to hang out, although dog owners seem attracted to the isolation and relatively slow and deep river for playing fetch. There are no facilities nearby and the trails that lead to the river are somewhat overgrown.

### **Site 3: Belmondo Natural Area**

This site is a popular BBQ hang out for families or groups of young adults. People love swimming in the deeper ends and there's a rock/concrete slab that people jump off of into a deeper pool. Dogs are common playing fetch in the water and running around the beach. Fishermen tend to use the site at early hours on cooler days when there are fewer people. Apparently the deep pools and trees are home to lots of large fish. Visitors seem to be regulars; several groups were seen multiple times and they all seem to know each other. The parking lot is small and can hold only 4-6 cars. There seem to be issues with people blocking the driveway of neighbors. People also park along Maple Valley Hwy across the street where there is a wide shoulder.

### **Site 4: Cavanaugh Pond Natural Area**

This is a popular location particularly for residents of the trailer park. There is a large beach for hanging out. It is not necessarily a common access point because of the quarter-mile hike required to get to the beach from the parking area, but it is definitely a popular stop-over point for picnicking, drinking and sunbathing. Many people come to play fetch with their dogs, flyfish, and picnic and swim with family. It's a 10 minute walk to the beach from the gate to the park. About a dozen cars can park at the gate. No restrooms or facilities.

### **Site 5: 149<sup>th</sup> Ave.**

This site is just south of Ron Regis Park at the end of a dead end road at the old Jones Rd. Bridge footings. It is surrounded by private homes and King County property. Some people come to the very small beach to smoke and hang out, but it is more popular as a fly fishing location. Compared to other observation sites, this is a fairly calm area. Locals and experienced tubers seem to know this as an access

point. They use it as an early take-out before Ron Regis to avoid the log jam below. There is space for only 2-4 cars to park at the road, but an easy 5 minute walk to the large Ron Regis parking area.

#### **Site 6: Roadside Park**

This is a city park off Maple Valley Hwy that has a parking lot for a couple dozen cars or so. It is a very popular access point for both put in and take outs. It is also a popular stop for those on the Cedar River Trail that are biking, dog walking and running. There are lots of dogs playing fetch and families picnicking, making sand castles, swimming, and jumping from rocks. On at least three occasions, young men were seen jumping off the trestle. The beach is fairly small so it is often crowded and there are no toilets, though Riverside Park is just down the trail and has full facilities. On cooler days, there are also a couple flyfishermen.

#### **Site 7: Carco Park**

This was the furthest downstream site and by far the most popular location for a variety of users. The beach is fairly large and the grassy park is huge. People come from the Cedar River Trail on bikes, running, and with dogs. Families come to picnic on the beach and the grass – sometimes bringing large tents and setting up BBQs. On hot weekend days, the entire grass park is packed. It is also very popular for swimming, even though no swimming or pets are technically allowed in the beach area. The water park, community center and theater are share the same hug parking area and there is a skate park across the street. There are full facilities for restrooms and drinking water. There are at least five places people can put in and take out tubes in this area; it is the most popular spot on the river for taking out tubes. Many people also tube within the park area, from upstream to downstream– about a 5-10 minute ride.

#### **Ron Regis Park**

This was not an official observation site, but one day was dedicated to watching how users interacted with the log jam. On an 83°F August weekday, about three dozen people used the beach for walking, playing fetch with their dogs, socializing, drinking, and swimming. Over a dozen people used a spanning log to cross from the riverbank to an island that is popular for hanging out. Others used pools created by logs for swimming or sat on logs while socializing.

Appendices F and G. Interview and observation guides.



## Cedar River Exit Interview Guide

Location: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_ Survey Worker: \_\_\_\_\_

Put In: \_\_\_\_\_ Take Out: \_\_\_\_\_

1. How many times have you floated the Cedar River this year? \_\_\_\_\_ In the past 5 years? \_\_\_\_\_

2. Where do you usually put in and take out?

Put in:

Take out:

3. How did you prepare for this trip?

(What did you bring with you? Did you check conditions?)

4. Why did you come to this specific part of the river to float?

5. What activities do you like to do along your float route?

6. What are the primary hazards to your river float?

Rank the following hazards:

Fast Water \_\_\_\_\_

Cold Water \_\_\_\_\_

Rocks \_\_\_\_\_

Deep Pools \_\_\_\_\_

Large Wood \_\_\_\_\_

Access Points \_\_\_\_\_

Other Users \_\_\_\_\_

Other \_\_\_\_\_

7. Have you noticed large wood in the river this year? Prior years?

8. How do you feel about large wood in the river?

9. What do you know about large wood in the river? (How does it get there? What's good about it? What's bad?)

10. How many people in your party know how to swim? \_\_\_\_\_

11. Your age range:

- 15-18 years old
- 18-22 years old
- 23-30 years old
- 31-40 years old
- 41-50 years old
- 51+ years old

# Youth \_\_\_\_\_ Adults \_\_\_\_\_; # and type boats \_\_\_\_\_

Lifeguards \_\_\_\_\_ Coolers \_\_\_\_\_ Fishing \_\_\_\_\_

High Temp: \_\_\_\_\_ Sunny / Partly Cloudy / Cloudy

River Flow: Landsburg: \_\_\_\_\_; \_\_\_\_\_; \_\_\_\_\_ Renton: \_\_\_\_\_; \_\_\_\_\_; \_\_\_\_\_ High Temp: \_\_\_\_\_ Sunny/ Partly Sunny /Cloudy  
 Location \_\_\_\_\_ Date \_\_\_\_\_ Survey worker \_\_\_\_\_ In: \_\_\_\_\_ Out: \_\_\_\_\_  
 Time \_\_\_\_\_

Time	# people (kids/adults)	# with vests (kids/adults)	# unworn vests	# Tubes /air mattresses	# rafts	# canoes	# kayaks	# other vessels & type	# vessels w/ oar/paddle	Fishing gear (Y/N)	Alcohol (Y/N)	Put in	Take out	Notes*