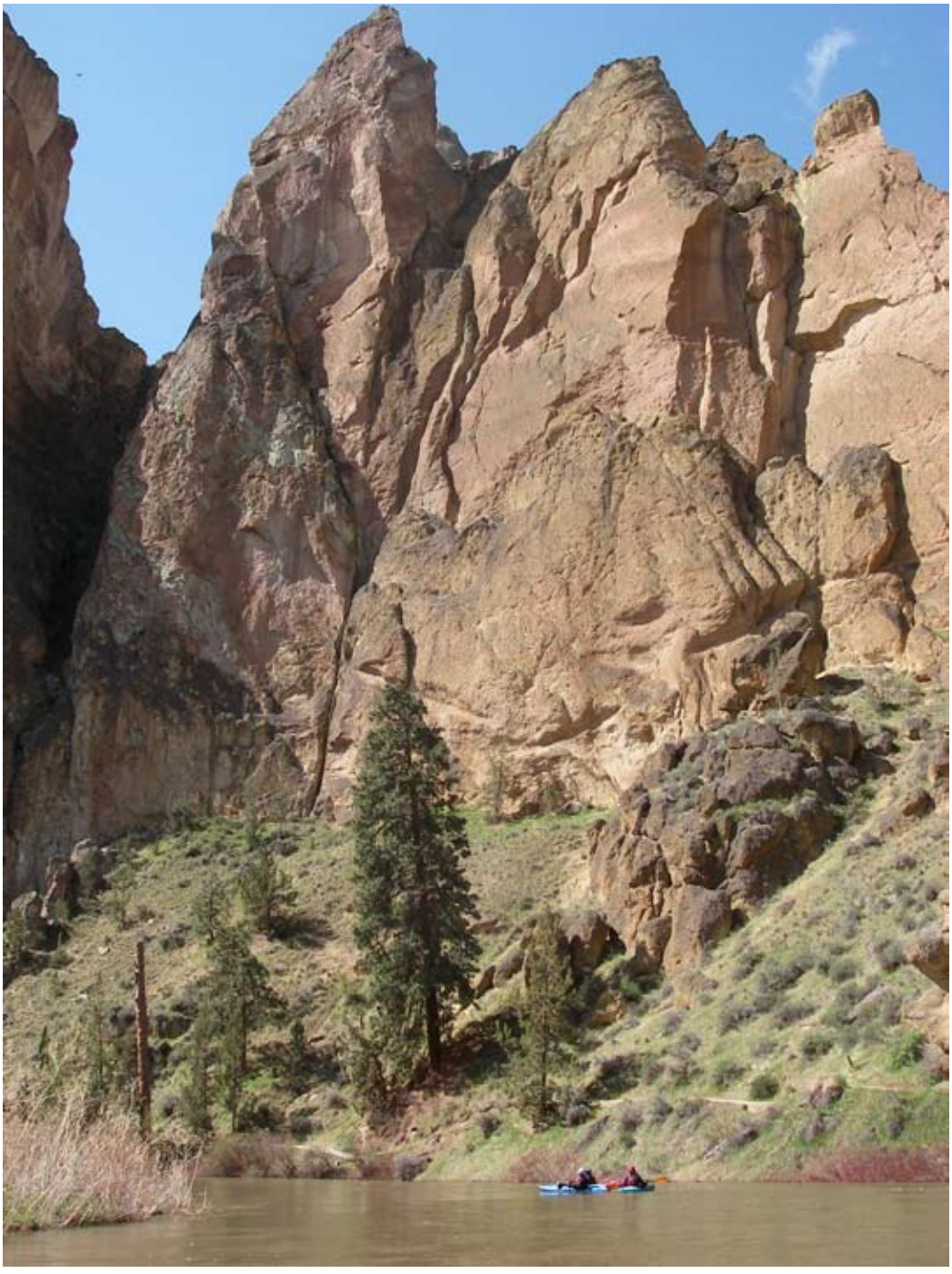
Crooked River

Internet Flow Study

May 2008



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Abstract

The Crooked River is a Wild and Scenic River in Central Oregon with a popular whitewater run below Prineville Reservoir. Adequate flows for whitewater recreation are rarely found on this stretch due to irrigation diversions and the impoundment of the main fork at Prineville and of Ochoco Creek, a major tributary below Prineville. There are two whitewater stretches of the Crooked: the class IV (V) Upper Crooked, from Lone Pine Bridge to Crooked River Ranch and the class III (IV) Lower Crooked, from Crooked River Ranch to Billy Chinook Reservoir. An internet flow study was conducted between the summer of 2006 and 2007 for both reaches of the Crooked. The structural norm approach, impact acceptability curves and the Potential for Conflict Index were used to examine the instream flow-recreation relationship for the river. Researchers found a minimum acceptable flow of 1,400 cfs for both reaches. The range of tolerable flows for both reaches was found to be between 1,400 and 4,600 cfs, while for the lower reach tolerable flows reached past 5,000 cfs, the high end of the flow spectrum measured. Optimum flows for the Crooked River were between 2,000 and 3,400 cfs. These flows received high acceptability ratings, and the Potential for Conflict index revealed exceptionally high consensus among respondents over the acceptability of these optimum flows. Over 30% of respondents identified the Crooked River as the top priority in the region, in reference to the designation of American Whitewater's time and resources.

Introduction

The Crooked River is a large volume tributary of the Deschutes River in Central Oregon. It makes a long journey through the heart of Oregon as it flows between the Ochoco Mountains to the north and the Maury Mountains to the south. It meanders through Post, Oregon, the geographical center of the state, before being impounded by Bowman Dam in Prineville Reservoir. Ochoco Creek, a major tributary of the Crooked near Prineville, is also impounded to create Ochoco Reservoir. During the summer months irrigation diversions remove most of the Crooked River's flow below Prineville. Natural springs supplement this flow and the river continues downstream to Billy Chinook Reservoir where it joins the Deschutes and Metolius Rivers.

In 1988, National Wild and Scenic River designation was assigned to the 8 mile segment of the Crooked River from Bowman Dam to Dry Creek as a recreational river and the 9.8 mile segment from the National Grassland boundary at river mile 17.8 (just downstream of the Highway 97 bridge) to River Mile 8 south of Opal Springs as a recreational river. A popular expert whitewater run begins between these two section, providing class IV/V kayaking and rafting while passing through one of the region's most sought after climbing destinations, Smith Rock State Park. Widely regarded as one of the finest whitewater runs in the country, the Crooked attracts visitors from the entire tri-state area of Washington, Oregon, and Idaho, even though the stretch is rarely runnable for more than a week, and in years of moderate to low snowpack, may not run at all. Significant releases from both Prineville and Ochoco Reservoir are required to provide sufficient flows for recreation and in years when water is scarce, releases might not occur.

There are two stretches of the Crooked River commonly run by whitewater enthusiasts. The Upper Crooked, a class IV (V) run, from Lone Pine Bridge to Crooked River Ranch and the Lower Crooked, a class III (IV) run, from Crooked River Ranch to Billy Chinook Reservoir. Between the summer of 2006 and 2007 an internet flow survey was implemented to attempt to quantify the instream flow-recreation relationship on the upper and lower sections of the Crooked.

Whitewater paddlers who responded to the internet survey found the Crooked River to be a whitewater gem in a region with hundreds, if not thousands, of other whitewater runs. Many expressed difficulty in predicting runnable flows for the Crooked and found that the best way to guarantee a run was to "drop everything and go," when adequate flows were present. Some respondents had never done the run due to the extremely short season when acceptable flows spilled from the dams. Respondents articulated a need to investigate the water quality, historical hydrologic pattern for the drainage and to strike a balance between ecological, agricultural and recreational interests. Results from impact acceptability curves suggested that a minimum acceptable flow for whitewater opportunities on the Crooked River is 1,400 cfs and that optimum flows were between 2,000-3,400 cfs.

Methods

Utilizing instream flow survey data and the structural norm approach, a technique used to graphically represent social norms, researchers have examined the acceptability of instream flows for nearly twenty years on river stretches across the United States (Whittaker & Shelby, 2002). The graphic representation, commonly referred to as an impact acceptability curve, is used to describe optimum flows, ranges of tolerable flows, norm intensity and level of norm agreement (Shelby, Vaske, &, Donnelly, 1996). The potential for conflict index (PCI) developed by Manfredo, Vaske, & Teel (2003) takes the graphic representation of social norms one step further by displaying information about their central tendency, dispersion and form (Vaske, Needham, Newman, Manfredo, & Petchenik, in press). In this study we combine these techniques to describe the instream flow-whitewater recreation relationship for the upper and lower sections of the Crooked River.

Instream Flows

Instream flow is the amount of water in a river at a given time, usually measured in cubic feet per second (cfs). Instream flow regimes have effects on fish habitat, fish food resources, fish populations and other ecological resources, influencing the entire riparian environment (Bovee, 1996; Covington & Hubert, 2003). Flow levels affect the channel features of river systems including beaches, pools, waves, riffles, banks, woody debris and rocks (Hill, Platts & Beschta, 1991). Channel features affect the riparian habitat and are also critical to specific types of river recreation (Whittaker & Shelby, 2002). Market and non-market benefits linked to river tourism are also strongly affected by instream flow (Douglas & Taylor, 1998).

Securing identifiably significant levels of instream flow on river reaches below hydrologic projects is one of the best ways to maintain the human, wildlife and intrinsic values associated with riparian corridors. Controlled dam releases and out-of-stream diversions are two ways that humans manipulate instream flows and therefore, on river stretches where manipulation is possible, flow management has become a central issue.

Instream flow can affect the recreation experience in a number of ways from determining whether a stretch is runnable or fishable, to whether a stretch will provide a technical low water trip or a high water, high challenge trip. Understanding the relationship between instream flows and natural resource values can aid in the creation of standards for recreation use (Whittaker & Shelby, 2002).

Structural Norm Approach and the Potential for Conflict Index

Impact acceptability curves take norms related to the acceptability of specific instream flows, measured at the individual level and then aggregates them to describe social norms by plotting the averages of individual's response evaluations (Shelby et al., 1996). The set of specific instream flows measured are displayed on the horizontal axis. Average evaluations are displayed on the vertical axis, with negative evaluations on the bottom, a neutral line in the middle, and positive evaluations on top (Whittaker & Shelby, 2002).

The highest point or peak of the curve represents the optimum flow. The range of flows with average evaluations above the neutral line represents the range of tolerable flows. The points where the curve intersects with the neutral line define the standards to be associated with too high and too low a flow. The relative distance of the curve in relationship to the neutral line defines the intensity of a norm. The variation among evaluations at each flow level constitutes the crystallization of the norm, but is typically not visually displayed on impact acceptability curves. In this study we use the Potential for Conflict Index and its associated PCI bubbles to describe crystallization graphically on the curve.

Surveys gathering data for use in the structural norm approach commonly measure variables using response scales with an equal number of response options surrounding a neutral center point. Numerical ratings are assigned in ordinal fashion with the neutral point being 0 (e.g. -1, -2, 0, 1, 2, where -2 = highly unacceptable, 0 = neutral, and 2 equals highly

acceptable.). The use of the potential for conflict index requires this common form of measurement. The PCI describes the ratio of scoring on either side of a rating scale's center point. The greatest possibility for conflict (PCI = 1) occurs when there is a bimodal distribution between the two extreme values of the response scale (e.g., 50% strongly support, 50% strongly oppose, 0% neutral). A distribution with 100% at any one point yields a PCI of 0 (i.e., no conflict).

Following computation of the index, the results are displayed as bubble graphs. The size of the bubble depicts the PCI value and indicates the degree of dispersion (e.g., the degree of potential conflict over the acceptability of a flow level). Small bubbles indicate more potential agreement over the acceptability of a specific flow; larger bubbles reflect less potential agreement. The center of the bubble, which is plotted on the Y-axis, represents the mean score (central tendency) for the variable. With the neutral point of the rating scale highlighted on the Y-axis, it is apparent that respondents' average evaluations lie above or below the neutral point (i.e., the flow, on average, is acceptable or unacceptable).

Internet Survey

An internet-specific instream flow survey for the Upper and Lower Crooked was conducted between the summers of 2006 and 2007. The survey was advertised on the American Whitewater website through a number of articles. Individuals interested in the management of the Wild and Scenic stretch of the Crooked River, and specifically those who had run the river in the spring of 2006, when the river uncharacteristically ran for nearly a month, were invited to take part in the survey.

Evaluating respondents flow preferences for the upper and lower stretches of the Crooked River was the main impetus for the study, however the survey measured a wide range of variables related to the management of the Crooked River. Respondents evaluated the acceptability of 22 specific flows for the Upper Crooked based on the US Bureau of Reclamation Crooked River near Terrebonne gauge and 17 specific flows for the Lower Crooked based on the USGS Crooked River below Opal Springs gauge. Flows evaluated for the Upper Crooked ranged from 50 cfs to 5,000 cfs. Flows evaluated for the Lower Crooked ranged from 600 cfs to 5,000 cfs (see Tables 1 and 2 for a complete listing of flow levels measured). Respondents evaluated flows that they may not have directly experienced including flows above the range likely to be seen in this regulated river. Each flow was evaluated on a 7-point scale totally unacceptable (-3), moderately unacceptable (-2), slightly unacceptable (-1), neutral (0), slightly acceptable (1), marginally acceptable (2) and totally acceptable (3). Acceptable flows, optimal flows, and norm crystallization were determined for all respondents.

Respondents were asked to identify their primary preferred craft type for running the Crooked River and their skill level in terms of the highest difficulty of whitewater they confidently paddled in their preferred craft type. Respondents were also asked to identify the number of times they had run each stretch, the dates and the flow levels of their previous runs. A set of open ended flow questions were asked for both the lower and upper stretches including respondent's minimum, standard, technical, high challenge, preferred and highest safe flow for their craft type.

Results

Overall Evaluations

In total, 63 paddlers responded to the survey. Nearly 1/3 (30%) of all respondents rated the Crooked River, in terms of the time and resources American Whitewater should invest in this project, the top priority in the region. Another 1/3 (35%) of respondents rated the Crooked as a good project, and slightly more important than others in the region. The ability to find adequate flows for sustained periods of time and on weekends was of concern to many respondents. Concerns about the water quality and the difficulty of access for larger crafts, such as rafts and catarafts, were also noted by multiple respondents. Respondents reported that the times adequate flows were available occurred between the dates of March 15th and May 7th 98% of the time.

Of all respondents, over 97% had paddled at least one section of the Crooked and, of those, over 40% had paddled a section of the river 2 to 5 times. Nearly all respondents (96%) reported putting into the river at either the Lone Pine Bridge or the aqueduct upstream of Smith Rock Park, the two regular put-ins for the Upper Crooked. Nearly half of the respondents (41%) also reported continuing on into what is considered the Lower Crooked and taking out at either Opal Springs or Billy Chinook Reservoir. Hard shell kayaks were the craft of choice, with 68% of respondents paddling them, while 18% paddled oar rafts or catarafts, 6% ran paddle rafts, 6% paddled inflatable kayaks and 2% paddled open canoes. Almost all Crooked River users surveyed were advanced whitewater paddlers, with over 97% of respondents reporting confidence in class IV whitewater or greater.

In a comparative analysis of impact acceptability curves for both the Upper and Lower Crooked (Figure 1), flows less than 1,400 cfs were determined to be unacceptable. Optimal flows for both runs were between 2,000 and 3,400 cfs. On average, flows up to 4,600 cfs were considered acceptable for the Upper Crooked, while respondents found flows up to 5,000 cfs and beyond acceptable for the Lower run.

Upper Crooked

For the Upper Crooked, under the structural norm approach, flows between 50 cfs and 1200 cfs were, on average, unacceptable. Flows of 1,400 to 4,600 cfs were within the range of acceptable flow conditions. Flows between 2,200 and 3,000 cfs were considered optimal. Flows of 5,000 cfs were, on average, considered unacceptable (Figure 2). Flows greater than 5,000 cfs were not measured.

The Potential for Conflict Index ranges from 0 (no conflict, high consensus) to 1 (high conflict, low consensus). PCI scores for the acceptability of specific flows ranged from .00 (50 to 600 cfs and 2,200 to 3,000 cfs), to .75 (5,000 cfs). Using the traditional norm acceptability curve (Figure 2), the average flow evaluation for 5,000 cfs was just under the neutral line, suggesting that a flow of 5,000 cfs was an unacceptable level of flow for whitewater recreation. When the curve is displayed with PCI bubbles (Figure 3), it is apparent that nearly as many paddlers evaluated a flow of 5,000 cfs as acceptable, as evaluated it as unacceptable. The bubble straddles the neutral line and the PCI value is the largest measured for any of the specific flow evaluations (.75).

Figure 1

Upper and Lower Crooked River Impact Acceptability Curves

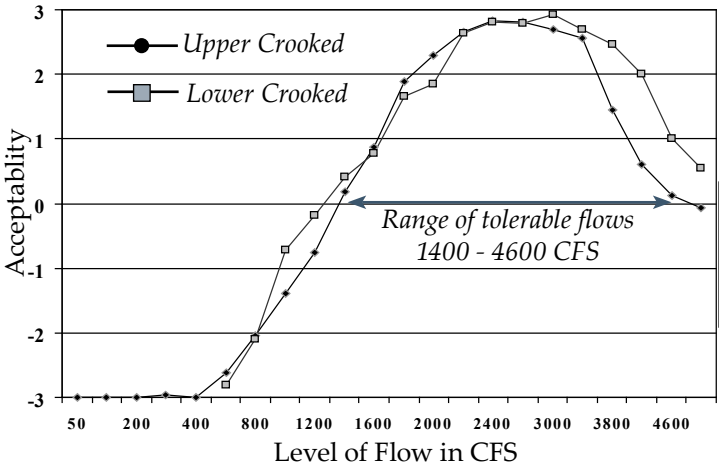


Figure 2

Upper Crooked River Impact Acceptability Curve

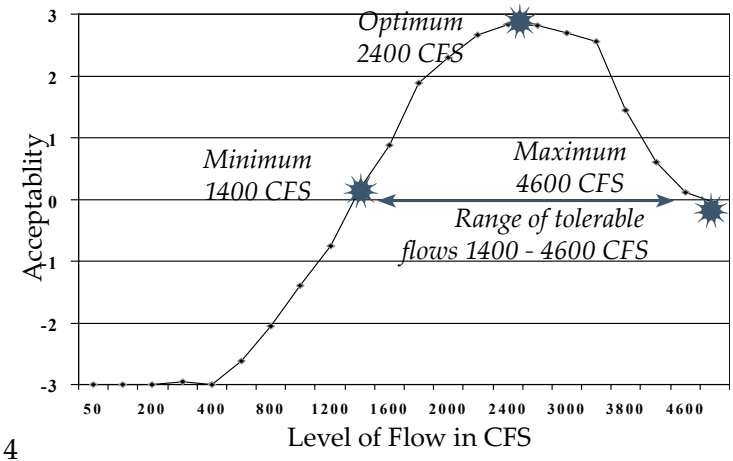
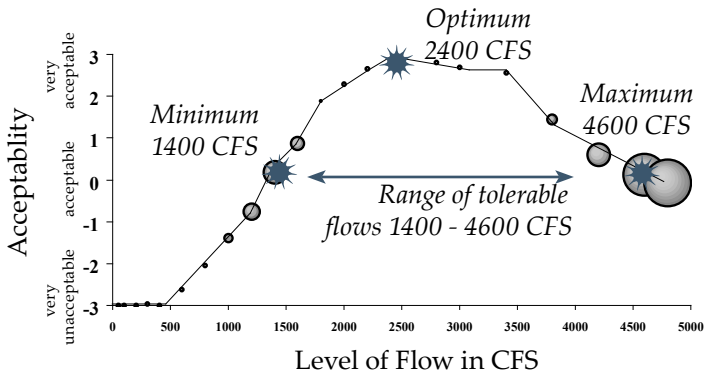


Figure 3

Upper Crooked River Potential for Conflict Index Curve



PCI scores at the most optimal flows of 2,200, 2,400, 2,800 and 3,000 cfs were all 0. These extremely low PCI values (smallest bubbles in the PCI range, Figure 3) suggest that across all boaters there was consensus regarding the acceptability of these optimum flow levels. PCI values, as well as mean evaluations and standard deviations, for the flows evaluated under the impact acceptability curve for the Upper Crooked are displayed in Table 1.

Under the set of open ended flow response questions, 1,577 cfs was considered, on average, to be the minimum flow, with responses ranging from 800 to 2,500 cfs. The flow reported for a standard whitewater experience was 2,220 cfs on average, with a response range of 1,000 to 3,500 cfs. The average flow level reported for a technical whitewater trip was 1,526, with a response range of 700 to 3,500. A flow of 3,498 cfs was the average flow for an increased challenge trip, with a range of 1,300 to 5,000 cfs. The average highest safe flow was 4,678 cfs, with a range of 2,500 to 30,000 cfs and the preferred flow for respondents was 2,849 cfs, with a range of 1,500 to 5,000 cfs.

Table 1

Mean acceptability rating, Standard Deviation and Potential for Conflict Index value for flows at the Terrebonne gauge on the Upper Crooked, Oregon, USA

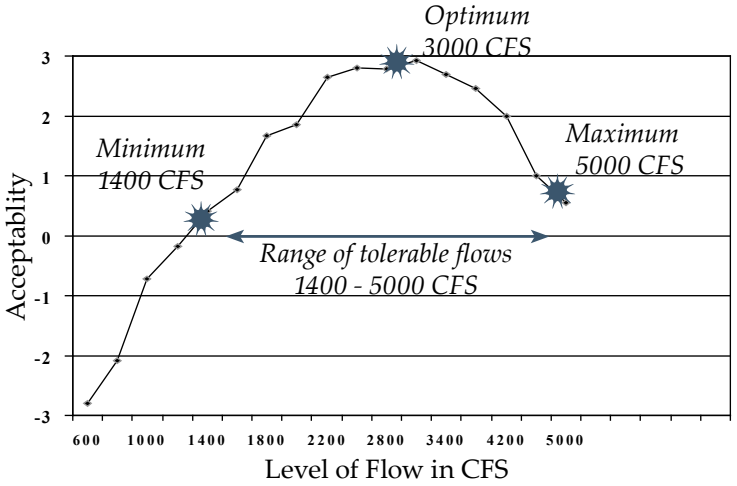
Specific Flow CFS	Mean Acceptability	Standard Deviation	PCI
50	-3.00	0.00	0.00
100	-3.00	0.00	0.00
200	-3.00	0.00	0.00
300	-2.96	0.20	0.00
400	-3.00	0.00	0.00
600	-2.62	0.82	0.00
800	-2.05	1.28	0.06
1000	-1.39	1.73	0.14
1200	-0.76	1.76	0.25
1400	0.18	1.59	0.36
1600	0.88	1.56	0.21
1800	1.89	1.20	0.05
2000	2.30	1.36	0.06
2200	2.66	0.73	0.00
2400	2.83	0.38	0.00
2800	2.81	0.59	0.00
3000	2.70	0.81	0.00
3400	2.56	1.02	0.02
3800	1.44	1.69	0.16
4200	0.61	2.09	0.37
4600	0.12	2.42	0.67
5000	-0.06	2.54	0.75

Lower Crooked

Over half (56%) of respondents had not run the lower section of the Crooked and under 20% of all respondents had run the lower section more than once. Of the respondents who had run the lower section 78% put-in at the Lone Pine Bridge to paddle both the upper and lower sections of the Crooked. The impact acceptability curve suggests a minimum flow of 1,400 cfs, equal to the minimum flow for the upper section. Flows between 600 cfs and 1,200 cfs were, on average, unacceptable. Flows of 1,400 to 5,000 cfs were within the range of acceptable flow conditions. Flows between 2,200 and 3,400 cfs were considered optimal. Flows of 5,000 cfs were, on average, considered acceptable (Figure 4). Flows greater than 5,000 cfs were not measured.

Figure 4

Lower Crooked River Impact Acceptability Curve



PCI scores for the acceptability of specific flows ranged from .00 (600 cfs and 2,200 to 3,400 cfs), to .67 (1,200 cfs). Using the traditional norm acceptability curve (Figure 4), the average flow evaluation for 1,200 cfs was just under the neutral line, suggesting that a flow of 1,200 cfs was an unacceptable level of flow for whitewater recreation. The PCI bubble however is the largest measured for the Lower Crooked and it straddles the neutral line (Figure 5), suggesting that nearly as many paddlers evaluated a flow of 1,200 cfs as acceptable, as evaluated it as unacceptable. PCI scores at the optimal flows of 2,200, 2,400, 2,800, 3,000 and 3,400 cfs were all 0. As with the Upper Crooked, these extremely low PCI values suggest that there is considerable consensus regarding the acceptability of these optimum flows. PCI values, as well as mean evaluations and standard deviations, for the flows evaluated under the impact acceptability curve for the Lower Crooked are displayed in Table 2.

Under the set of open ended flow response questions 1,540 cfs was considered, on average, to be the minimum flow, with responses ranging from 800 to 2,500 cfs. The flow reported for a standard whitewater experience was 2,344 cfs on average, with a response range of 1,200 to 3,000 cfs. The average flow level reported for a technical whitewater trip was 1,483 cfs, with a response range of 600 to 2,000 cfs. A flow of 5,357 cfs was the average flow for an increased challenge trip, with a range of 1,400 to 30,000 cfs. The average highest safe flow was 5,943 cfs, with a range of 2,500 to 30,000 cfs and the preferred flow was 3,222 cfs, with a range of 1,100 to 10,000 cfs.

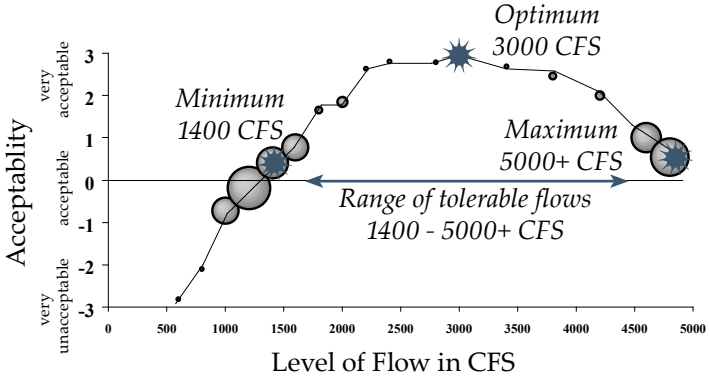
Table 2

Mean acceptability rating, Standard Deviation and Potential for Conflict Index value for flows at the Opal Springs gauge on the Lower Crooked, Oregon, USA

Specific Flow CFS	Mean Acceptability	Standard Deviation	PCI
600	-2.80	0.63	0.00
800	-2.09	1.38	0.06
1000	-0.73	2.15	0.42
1200	-0.18	2.52	0.67
1400	0.42	2.43	0.50
1600	0.77	2.31	0.41
1800	1.67	1.21	0.11
2000	1.85	1.77	0.15
2200	2.64	0.63	0.00
2400	2.80	0.41	0.00
2800	2.79	0.80	0.00
3000	2.92	0.28	0.00
3400	2.69	0.85	0.00
3800	2.46	1.39	0.10
4200	2.00	1.63	0.13
4600	1.00	2.49	0.47
5000	0.56	2.60	0.59

Figure 5

Lower Crooked River Potential for Conflict Index Curve



Discussion

All (100%) of respondents identified determining the flow preferences and other recreation attributes for the Crooked River as an important project, worthy of at least some of American Whitewater's time and resources. These results imply that the Crooked River is a very important recreation resource to many whitewater paddlers in the region. Agencies tasked with managing river recreation on public lands are currently required, through planning frameworks and federal regulations, to specify standards for the conditions they aim to provide. If the goal is to provide quality recreation opportunities, managers should consider using the information provided in this report through the structural norm approach for developing these standards. They must also consider alternative sources of information including legal and administrative mandates, agency policy, historical precedents, interest group politics and user information (Vaske, Donnelly, & Shelby 1993).

Over 85% of respondents put-in at the Lone Pine Bridge (Upper Crooked) and only 7% of respondents ran the lower section as a run unto itself. Controlling flows for the upper and lower sections separately would only be marginally feasible and the flow preferences for the runs are remarkably similar (Figure 1). While the difficulty of the sections are not consistent, it appears that the large volume characteristics of the riverbed are similar enough that defining the flow-recreation relationship for the Crooked River in general, rather than for the separate upper and lower sections, is the most beneficial approach.

For whitewater river running, a certain minimum flow is necessary just to navigate a stretch without scraping over or becoming hung up on rocks in the riverbed. In general, once that minimum flow level is surpassed, the stretch becomes runnable up to a certain, much higher, level of flow. These low and high ends of the flow spectrum, or range of runnable flows, can be dictated by a number of variables, including skill level, experience and craft type. For the Crooked River, the majority of river users found the low end of the flow spectrum to begin at approximately 1,400 cfs.

The Potential for Conflict Index (PCI) helps to identify the agreement between respondents at each individual flow level. Tables 1 and 2, and Figures 3 and 5 reveal a PCI score trend that is similar to previous studies (Stafford and O'Keefe, 2007; Vaske, Stafford, Shelby & Whittaker, in review). Users are in the most agreement at flow levels which are highly unacceptable and highly acceptable. Users are in the least agreement when average response evaluations are at or near the neutral line representing the transitions between acceptable and unacceptable flows. According to the PCI, there was a lack of consensus regarding the low end of the spectrum for the Lower Crooked. The highest PCI score for the Lower Crooked (.67) was recorded for the specific flow of 1,200 cfs, while it only recorded a slightly negative acceptability rating (-.18). Paddlers interested in only running the Lower Crooked may find flows under the 1,400 cfs minimum acceptable, especially if they are in smaller craft types

such as hardshell kayaks or open canoes. However, an open ended average minimum flow for the Lower Crooked of 1,540 cfs provides evidence that very few users would find flows below the suggested minimum of 1,400 cfs acceptable and there is little other evidence to suggest that parties are willing to travel to run the Crooked River at these low flows. Only one respondent reported running either section of the Crooked at any level below 1,400 cfs.

The Potential for Conflict Index shows strong consensus at the optimal flow levels for both stretches. There was essentially no disagreement (PCI values at or near 0) that the flows of 2,000 to 3,400 cfs were totally acceptable for all types of skill level and craft types measured. These results, coupled with the average open ended responses for preferred flows of 2,849 cfs and 3,222 cfs for the upper and lower sections respectively, strongly suggests that flows in this range would satisfy the greatest number of river users. Average open ended responses for a standard whitewater experience also support these optimal flows with 2,220 cfs and 2,344 cfs for the upper and lower sections respectively.

Creating standards for the high end of the flow spectrum has created a unique challenge for managers on rivers across the country (Vaske, Stafford, Shelby & Whittaker, in review). High flows can sometimes present greater dangers to paddlers, but they can also create increased challenges and rewards for skilled river runners. For the Crooked River it appears that flows rarely reach the upper range of the flow spectrum, but when they do, respondents were divided over the acceptability of the highest flows in the range. There was much more disagreement over the extreme high end of the flow spectrum for the Upper Crooked than there was for the Lower Crooked. For the Lower Crooked 5,000 cfs was considered on average to be within the acceptable range flows and under the open ended response format an average highest safe flow of 5,943 cfs was recorded. For the Upper Crooked, the average highest safe flow recorded was 4,678 cfs and 5,000 cfs was considered, on average, to be unacceptable.

The PCI score, again, can help to further analyze the agreement surrounding these acceptability ratings. For the Upper Crooked, at the specific flow of 5,000 cfs, we see the highest recorded PCI score of the study (.75) and a barely negative acceptability rating (-.06). This lack of consensus suggests that there are a fair number of respondents who found 5,000 cfs to be a completely acceptable level of flow while many other respondents found this flow to be too high. The lack of consensus on the Upper Crooked as compared to the Lower Crooked can likely be accounted for by the differences in difficulty levels represented by the separate stretches of river. The Upper Crooked is a much more difficult run by whitewater standards and therefore, at a certain level of flow, which appears to be 4,000 to 5,000 cfs, the difficulty increases. For paddlers who are not looking for an increased challenge trip, the flow becomes unacceptable. However, for another set of paddlers, looking for an increased challenge these levels are totally acceptable drawing these highly skilled paddlers to the run. On the Lower Crooked, higher flows also would represent an increased challenge trip, although it appears that the difficulty does not change enough at flows up to and beyond 5,000 cfs to warrant a negative average acceptability rating.

This flow study of the Crooked River has a number of limitations. Internet studies, because they only allow for respondents who have internet access, are by nature a biased medium for conducting research. In general, only experienced river users are surveyed for instream flow studies, because prior research suggests that experienced boaters are more knowledgeable about how flows affect recreation attributes and are most capable of evaluating specific flows (Shelby, Brown, & Baumgartner, 1992). In an internet study it is nearly impossible to control the type of respondents. Reaching out to experienced users through internet

surveys is a very real possibility. In this study only 3% of respondents classified themselves as less than class IV paddlers, meaning that in terms of skill level, the great majority of respondents were experienced boaters. There is no way to determine these respondents true experience level or capability of estimating and determining the difference between specific flow levels and this lack of control should also be considered a limitation.

Asking participants to recall flows from memory and to conjecture on the acceptability of flows that they may not have experienced might be a difficult task for some respondents. Recalling flows from memory and forecasting the acceptability of flows has, however, proven to be an accurate way for highly experienced river users to determine the flow-recreation relationship (Whittaker & Shelby, 2002). The survey used in this study is the most common type of instream flow study and is referred to as a "flow comparison survey," referring to a survey type that asks boaters to evaluate a variety of flows from memory or conjecture. A more accurate assessment may be reached using a different type of flow survey, referred to as a "controlled flow assessment," conducted with a group of boaters evaluating several manipulated flows over a short period of time. Controlled flow assessments require a much greater commitment from the boating community, management community and water resource community and are, therefore, sometimes unfeasible.

This study provides a firm outline for the instream flow-whitewater recreation relationship on the Crooked River. The following summation is a good start towards creating a set of standards that could aid in the management of recreation on this Wild and Scenic stretch of river. Overall, there is strong support that flows within the range of 1,400 cfs to 4,600 cfs are acceptable to a large majority of whitewater river users on the Crooked River. River runners looking for different experiences might find certain levels of flow within this range to be more or less acceptable. Paddlers looking for a more technical whitewater experience will want to find flows at the lower end of the flow spectrum, between 1,400 and 2,000 cfs. Paddlers looking for a standard whitewater experience, or the perfect combination of covered rocks and defined river features, will want to find flows in the middle of the spectrum, ranging from around 2,000 cfs to 3,400 cfs. Highly skilled paddlers looking for an increased challenge whitewater experience, will want to shoot for flows above 3,400 cfs to as high as they judge safe for their skill level. For many users, any of these experiences will do, as long as they can find adequate flows to get on the river, and, therefore, they will find the entire range of flows to be acceptable.

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