Assessing Controlled Whitewater Flows On Washington State's Chelan River

An efficient and reliable study is key when deciding whether flows downstream of a hydro plant are feasible for whitewater boating. One such assessment — a controlled flow study — provides objective data about flow needs and safety risks. Chelan County Public Utility District commissioned such a study to assess boating feasibility downstream of its 48-MW Lake Chelan hydro plant.

By Bo Shelby, Doug Whittaker, and Rhonda Mazza

Controlled flow studies are an effective way to assess flows for whitewater recreation, particularly on river segments below dams. Yet, these studies can pose substantial methodological challenges, which are compounded on steep reaches with difficult whitewater and no previous boating use.

Such challenges were encountered during a study of the "boatability" of the Chelan River, a 4-mile reach with Class IV/V rapids downstream from the 48-MW Lake Chelan Hydroelectric Project in central Washington State. For the study, six kayakers conducted an on-river assessment. Results suggest flows around 225 to 250 cubic feet per second (cfs) are marginally "boatable," the optimal range for standard trips is 300 to 400 cfs, and standard trips transition into "big water" opportunities above 400 cfs.

Chelan County PUD used these findings as the basis for a proposal for a three-year whitewater flow monitoring plan for the river. The proposal is part of a comprehensive settlement agreement submitted to the Federal Energy Regulatory Commission (FERC) October 17, 2003. The plan is expected to be incorporated into the new FERC license (relicense) for the Lake Chelan hydroelectric project.

Studying whitewater flows

Owing to changes in policy and approaches by FERC and federal land management agencies, owners of FERC-licensed hydroelectric projects are reassessing flow regimes on affected downstream river segments. And, whitewater boaters are showing interest in flow releases on many of those segments.[1,2,3] Boater requests for whitewater flows can elicit licensee and agency reactions ranging from interest to skepticism to hostility. In any case, wise decisions about boating flows require efficient and reliable studies.

Considerable work on flow and recreation has occurred in the past dozen years, and a variety of methods and concepts have been developed.[4,5] Discussions at national workshops and conferences show increasing consensus about the utility of various approaches. In general, no one method is sufficient for all situations, and multiple methods can improve the defensibility of information.

Within this context, the controlled flow study has received attention as a quick, inexpensive, and useful method, particularly for segments downstream of dams.[1,6] The idea is to manipulate the independent variable (flow) by arranging for several increments in a short period, creating a quasi-experimental study design. At each flow, participants evaluate effects on recreation. After all flows have been observed, participants make overall evaluations using a "flow comparison" format.[5]

Controlled flow assessments provide outstanding study opportunities because exact flow levels are known, and observations occur in a short time frame. However, it is easy to underestimate logistical and methodological challenges. Controlled flow studies are most useful where river segments are short, flows can be definitively controlled, river access is easy, and users are readily available.[1]

Bypass reaches below dams featuring hydroelectric plants often fit this profile, and they often have steep gorge-like constrictions that create interesting whitewater. As FERC evaluates hydroelectric facilities for new licenses (relicenses), boater advocacy groups (e.g., American Whitewater) and agency interveners (e.g., National Park Service, Forest Service, and Bureau of Land Management) often request whitewater flow assessments, even on reaches never previously boated. In these cases, a controlled flow study may offer the best

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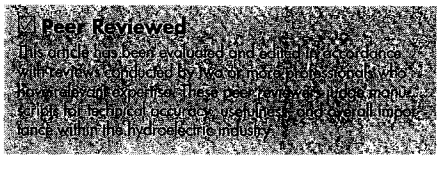


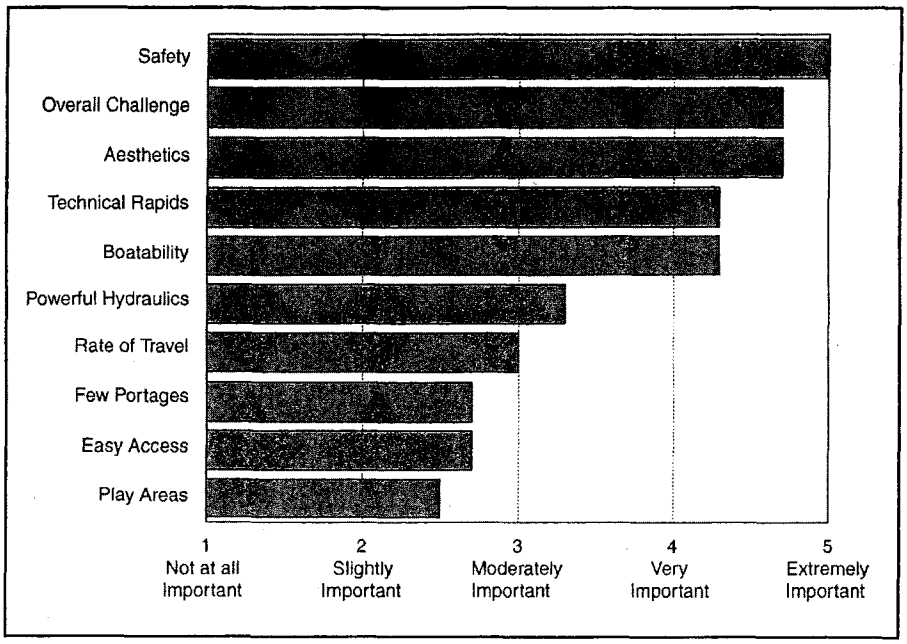


Figure 1: Six kayakers participating in a controlled flow study rated the importance of various attributes of whitewater boating downstream of the Lake Chelan hydro project.

opportunity to determine boating feasibility. However, difficult whitewater can make controlled flow studies complex. The Chelan River in Washington State offers a good example of a controlled whitewater study opportunity.

Issues involved in designing a controlled flow study

There are five categories of issues to consider when designing controlled flow studies for recreation: study output; sampling; flow control; effects on other resources; and study complexity.

Study output issues

Study output relates to the relative precision of qualitative and quantitative data. Flow-recreation studies can produce "flow evaluation curves" that show incremental flow-recreation relationships, or simply identify acceptable and optimal flows.[5] More precise curves or ranges come from quantitative surveys of participants, but they also can be developed by professional judgments.[4]

Providing whitewater flows in bypass reaches can be controversial. Bypass flows generally cannot be used for power generation, and may represent a financial loss for the licensee and its ratepayers and/or shareholders. Flow regimes that include higher whitewater flows also may have significant effects on biological resources or other recreation opportunities. This argues for more precise, quantitative data because stakeholders and resource agencies may be unconvinced by qualitative generalizations. Similarly, other researchers often generate specific incremental relationships between flows and their resources (e.g., Instream Flow Incremental Methodology studies), which argues for comparable precision from whitewater studies.

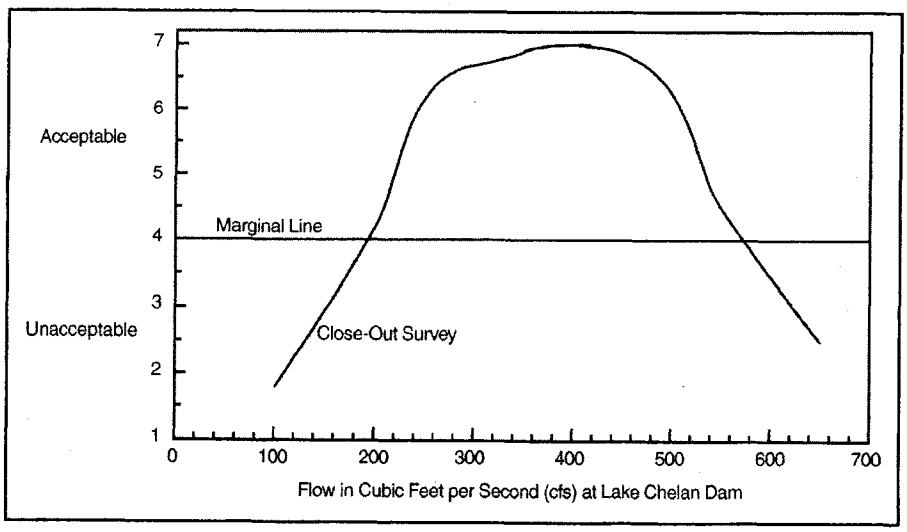


Figure 2: During a "close-out" survey in the Lake Chelan whitewater boating study, kayakers assessed a range of flows (from 100 to 650 cfs), determining the best single flow is 391 cfs.

Sample issues

Sample issues balance "representativeness" against potential cost or logistical trade-offs. Having more participants improves precision, but increases complexity and makes it difficult to maintain participation through a multi-day study. Thus, most studies use "purposive sampling," in which participants are invited based on their skill and safety record, proximity to the river, and ability to evaluate a diversity of whitewater opportunities.

Flow control issues

Flow control issues focus on whether flow levels can be precisely manipulated. This includes technical limitations of dams as well as administrative, political, and legal constraints. Technically, many dams are not equipped for variable releases, or gates provide flows in relatively coarse increments. This becomes more critical when small changes in flow substantially affect whitewater difficulty.

Lack of upstream storage also may constrain flow control. During dry periods, there may be insufficient stored water for consecutive days of flows; during wet periods, there may be insufficient storage capacity to mediate potential rain or melt-off spills. Many studies require careful timing and contingency plans, which often have administrative, political, or legal constraints.

Effects on other resources

Effects on other resources are another concern. Bypass flow regimes usually are different from "natural regimes," but they often have been in place a long time, and both people and biota may be accustomed to them. Study releases different from the status quo are generally higher than dewatered "base" levels, requiring consultation with, and approval from, resource agencies and other stakeholders. For example, concern about potential effects on fisheries, wildlife, and amphibians have delayed or altered

several whitewater studies.

Negative effects, however, are not a foregone conclusion. Some bypass reaches are in headwater areas, where relatively low flows can provide optimal boating. In addition, whitewater "spike flows" can mimic high flows that provide biophysical benefits, such as building beaches, cleaning spawning beds, introducing woody debris, or removing encroaching vegetation.[7] Research on the biophysical effects of scheduled spike flows for boating has been integrated into several relicensing studies.

Study complexity issues

Study complexity focuses on the number of study flows, the number of participants involved, and the type of information collected. The rugged terrain associated with many challenging rivers may increase the logistical challenges and safety/liability risks. Safety concerns also may dictate use of small teams of boaters, which may influence sample needs and statistical analyses. The safety priority also may preclude examination of flows near the high or low ends of acceptable ranges because they might be unsafe. Similarly, study complexity and costs increase if additional emergency equipment or law enforcement is needed.

A look at the study on the Chelan River

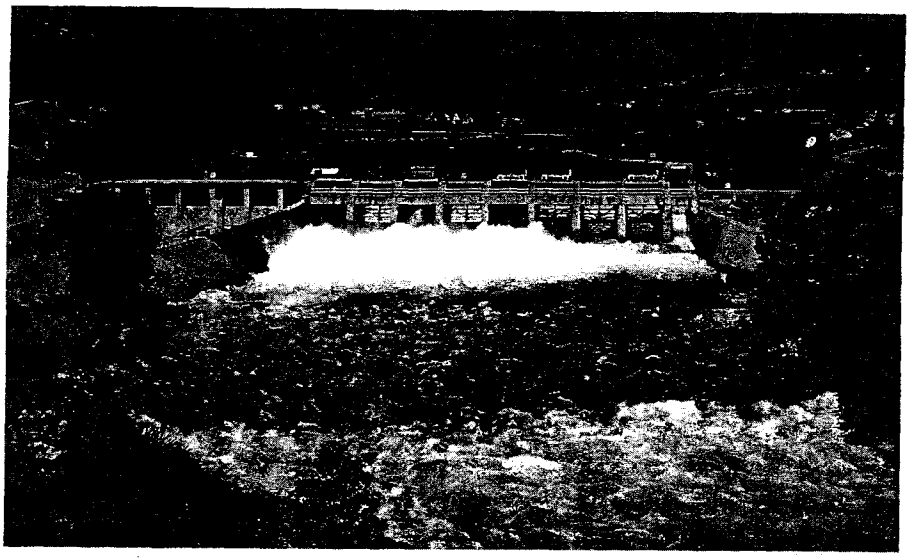
Chelan County Public Utility District (Chelan PUD) operates the Lake Chelan Hydroelectric Project (FERC project number 637) on the Chelan River in north central Washington. The river flows approximately 4 miles from Lake Chelan into the Columbia River; about 3.5 miles of braided channel with the rest in the steep Chelan Gorge. Water diverted to a powerhouse bypasses this river section, and, for most of the year, only incidental flows (less than 5 cfs) are provided. However, Lake Chelan is, on average, full from July through September, so summer run-off in excess of powerhouse capacity must be spilled into the river for two or more months. These spills commonly exceed 2,000 cfs even when the project is generating at full capacity.

As part of Chelan PUD's relicensing process, whitewater kayakers expressed interest in flows through Chelan Gorge. The gorge drops 480 feet per mile, and has falls 5 to 20 feet high, bedrock chutes, large boulders, and deep pools. Although mid-summer spills are too high for boating, Chelan PUD agreed to assess whether lower flows could provide boating opportunities.

Methodology used to assess whitewater

The authors of this article conducted a boating assessment in two stages. The first was on land in June 1999; the second involved boating on the river in July 2000. Both were controlled flow investigations, where known flows were released and evaluated for whitewater kayaking. The initial assessment on land examined three flows from 250 to 500 cfs (actual flows were 250 cfs, 368 cfs, and 490 cfs). Results of the assessment suggested the reach had boating opportunities for highly skilled Class V paddlers (even though specific rapids might be un-runnable). As a result, the recommendation was an on-river assessment between about 300 and 500 cfs.

The on-river assessment involved a team of six kayakers boating different



The Chelan River downstream from the 48-MW Lake Chelan Hydroelectric Project was the site of a controlled flow whitewater boating study.

flows on three consecutive days. The objectives: to determine if boating on the river was feasible, and to evaluate different flow levels for different whitewater opportunities. The initial flow of 273 cfs helped identify the minimum "boatable" flow and offered good scouting and portaging options at the difficult rapids. On subsequent days, boaters ran flows of 391 cfs and 475 cfs.

Following each run, boaters completed "post-run" surveys; after the final run, boaters completed a "close-out" survey and participated in focus group discussions. Information was designed to produce flow evaluation curves describing the relationship between flows and perceptions of boating quality.[5] Quantitative information also assessed "boatability," challenge, play boating quality, safety, and aesthetics.

Safety and liability were key concerns throughout the study. Boaters carried first aid and swift water rescue equipment, and public access during the study was limited to minimize rock fall in the Gorge. Chelan PUD and other agencies participated by coordinating logistics, managing and measuring flows, and/or providing safety and rescue support.

Whitewater Rating System

Class I: Easy. Includes fast moving water with small waves and few obstructions. Little training required. Risk to swimmers is slight; self-rescue is easy.

Class II: Novice. Includes straightforward rapids with wide, clear channels that are obvious. Swimmers are seldom injured.

Class III: Intermediate. Includes rapids with moderate, irregular waves that may be difficult to avoid. Complex maneuvers in fast current and good boat control in tight passages are often required. Strong eddies and powerful current effects can be found. Injuries to swimmers are rare; self-rescue is usually easy but group assistance may be required to avoid long swims.

Class IV: Advanced. Includes powerful but predictable rapids requiring precise boat handling in turbulent water. It may feature large, unavoidable waves and holes or constricted passages demanding fast maneuvers under pressure. Risk of injury to swimmers is moderate to high, and water conditions may make self-rescue difficult. Group assistance for rescue is often essential but requires practiced skills. A strong eskimo roll is highly recommended.

Class V: Expert. Includes extremely long, obstructed, or very violent rapids which expose a paddler to added risk. Drops may contain large, unavoidable waves and holes or steep, congested chutes with complex, demanding routes. Rapids may continue for long distances between pools, demanding a high level of fitness. Swims are dangerous, and rescue is often difficult even for experts. A very reliable eskimo roll, proper equipment, extensive experience, and practiced rescue skills are essential.

Results from the controlled flow study

After each run, boaters were asked to evaluate flows and trip attributes on a seven-point scale from "totally unacceptable" to "totally acceptable." For the upper river, overall ratings were similar to "boatability" evaluations, with the highest flow rated best. In the gorge, overall ratings were relatively high for all three flows, but were lower at the 273-cfs level. Focus group discussion indicated the higher flows had softer, more aerated water below the waterfalls, cleaner boating lines, and better route options. Overall ratings for the entire river were in line with the ratings from the gorge segment, consistent with group consensus that the gorge rapids were the most important part of the trip.

On the close-out survey, the kayakers assessed the relative effect of different attributes. Results, shown in Figure 1, suggest that safety, overall challenge, and aesthetics were most important, followed closely by the availability of technical rapids and "boatability." Powerful hydraulics, rate of travel, few portages, easy access, and the quality of rodeo-type "play boating" areas were relatively less important.

As part of the close-out survey, boaters were asked to reassess flows, and rate a greater range of flows (100 to 650 cfs) based on observations of the three study flows. All three were within an "optimal range," with 391 cfs being the single best flow (see Figure 2).

Taken together, results suggest kayakers can navigate the river at flows about 225 cfs, but these are marginal. As flows approach the lowest study flow (273 cfs), conditions improved enough to offer an acceptable quality "standard trip." Rapids in the gorge were rocky but well defined, with less forceful hydraulics and larger eddies and pools.

Based on survey results, the optimal range is from 300 to 400 cfs. The 391-cfs study flow improved upper river "boatability" and challenge in the gorge with more route options, but without too much power in hydraulics. Around 400 cfs, standard trips transitioned into "big water trips" with larger and more powerful hydraulics. The 475-cfs study flow improved upper river "boatability," but hydraulic power in the gorge was noticeably greater, eddies and pools were

smaller and less stable, and the margin for error was smaller.

Challenging methodological issues

Conducting a successful boating flow study on a difficult whitewater river, like the Chelan River, poses several challenges. The following paragraphs describe how the five categories of issues involved in controlled flow studies (outlined in general earlier in this article) were dealt with in this particular study.

Study output was primarily quantitative, anticipating potential controversy about providing flows for an activity that had not occurred in the past. Qualitative data from focus groups provided more detail.

The small purposive sample was required due to safety issues. Participants were chosen for having skills to cope with the challenging whitewater and technical rock climbing associated with scouting, running, or portaging previously un-run rapids. At the same time, the sample included boaters who could represent other potential users. Several had teaching or trip-leading experience with less skilled boaters, and most were comfortable making assessments for those types of boaters.

Flow control was a relatively small issue during the study because during average water years, water is plentiful in Lake Chelan during the early summer snow-melt. To keep lake levels constant, water was actually held back during the study (with supplemental releases at night). The dam structure was capable of releasing discrete amounts of water close to requested amounts.

Concerns about biophysical effects were not a substantial issue. Flow requests were well below flows typically released in summer from the dam, but they were higher than base flows. Biologists also used the study flows to collect data about aquatic habitat conditions, providing better information about how boating flows might affect fish.

There was considerable complexity associated with the study. Both on-land and on-river assessments were necessary because this river segment had never been boated before. The on-land portion helped determine the range of flows to be released, and offered opportunities for pre-study reconnaissance, improving logistical coordination, and increasing margins for safety.

Chelan Gorge is a steep, rugged canyon without an access road along the water. This increased logistical challenges for photography and possible emergencies. However, the short 4-mile length of the reach was an asset. Flows stabilized within 1.5 hours of initial releases, and, despite challenging whitewater, were relatively easy to run in a day. This allowed evaluations of different flows on consecutive days, making it easier to maintain participants for the entire study.

While primary data generally came from boater evaluations, photographs or video footage complemented word descriptions or numerical ratings. On the Chelan River, professional photographers shot extensive footage from difficult-to-reach vantage points in the gorge, providing high quality photos for the report and a documentary video.

Management implications

The results from the Chelan River whitewater study showed that a single flow of

River segments downstream from dams can offer challenging whitewater to skilled boaters.

about 375 cfs would provide an optimal boating opportunity, but two flows (300 cfs and 450 cfs) at different times would provide different types of boating and thus more diversity. The study also suggested that flow recommendations might need adjusting over the 30- to 50-year term of the license. In the past decade, for example, there has been a revolution in kayaking equipment and skill levels, with many boaters tackling steeper, more technical rivers. The principles of "adaptive management" could apply here; as skills, equipment, or preferences change, flow evaluations and requirements might change as well.

While Chelan PUD generally opposed whitewater releases for liability reasons, the licensee responded to study results and whitewater advocates with a three-year monitoring program that includes whitewater releases. The program provides flows on two weekends in July, each offering a day of "standard" (350 cfs) and "big water" (425 cfs) flows. Chelan PUD and American Whitewater are cooperating to resolve issues associated with providing whitewater flows.

Advantages of the study

Controlled flow studies, such as the one conducted at the Lake Chelan project, provide several benefits. First, such a study demonstrates whether boating is feasible in challenging bypass reaches and reduces speculation about safety risks. Before the Lake Chelan study was conducted, local newspaper editorials voiced fear of boater injuries and doubted

the need for the study. Following the systematic evaluations showing boating was feasible, local papers reported its success with front-page color photos.

Second, studies provide objective data about flow needs for whitewater boating; offering decision-makers useful recreational information that they can integrate and balance with issues concerning liability, hydrology, power generation, and effects on other aquatic resources. On the Chelan River, an "elegant solution" allows whitewater flows during normal summer runoff with minimal lost power generation or effects on biota. These solutions may not always be available, but they are impossible to develop without precise information about flow needs for all resources, including recreation.

Finally, the study itself helps licensees, land management agencies, and local populations to better understand whitewater boating and why boaters are interested in flows. Participants in flow studies become de facto "ambassadors" for whitewater boating, and their conduct may modify how various stakeholders in the relicensing process view whitewater recreation. While the study was being planned, community sentiment toward boating in the Chelan Gorge was tepid at best and sometimes hostile. By the end of the study period, many community members supported the concept.[8] ■

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Notes

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