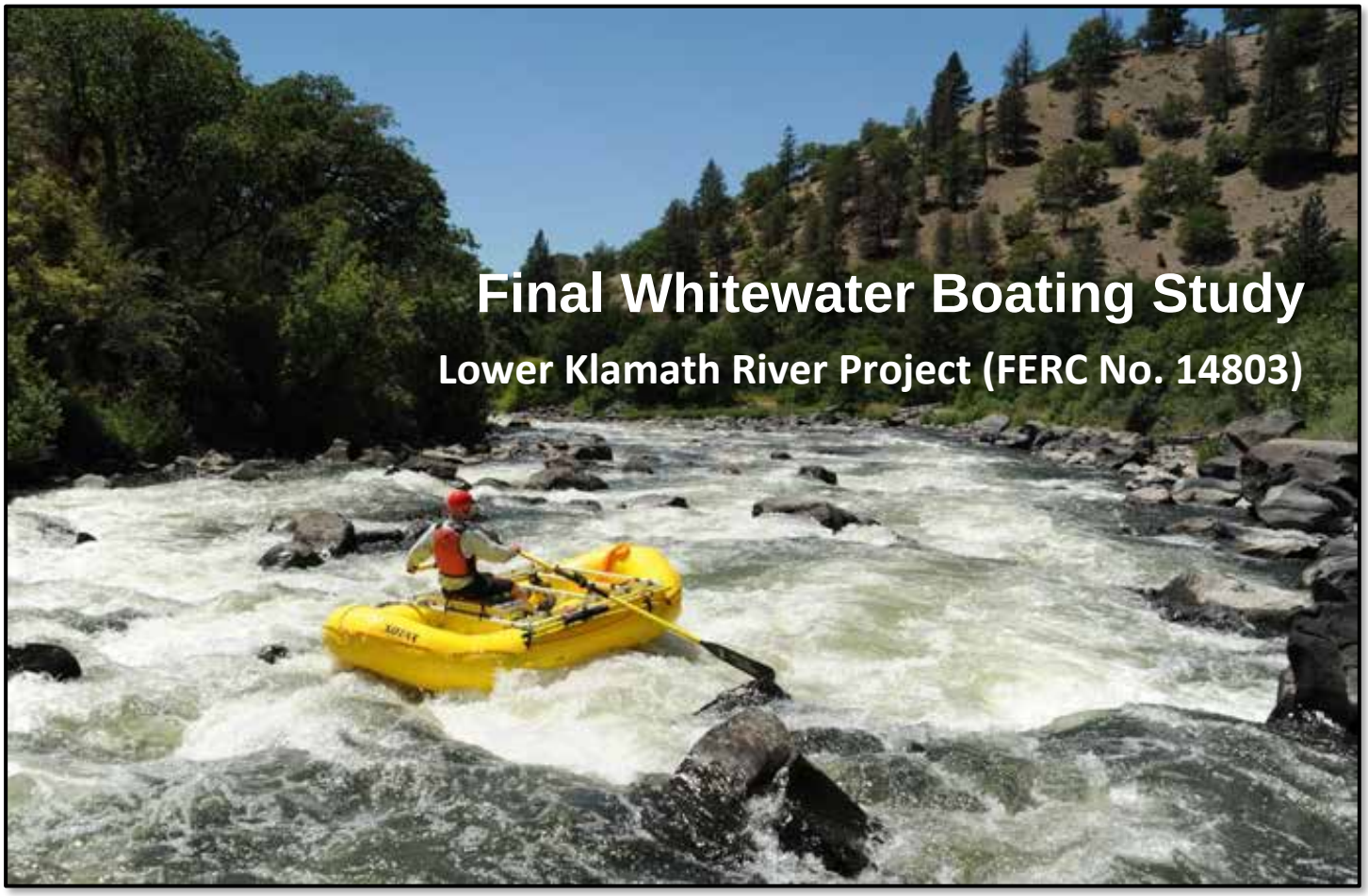

Final Whitewater Boating Study

Lower Klamath River Project (FERC No. 14803)

KLAMATH RIVER RENEWAL CORPORATION

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Executive Summary

PacifiCorp's Klamath Hydroelectric Project license expired in 2006. Relicensing studies, a license application, and discussions led to an initial 2010 Klamath Hydroelectric Settlement Agreement (KHSA) to remove four dams (J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate) rather than relicense the renamed Lower Klamath Project (FERC No. 14803). This settlement has been amended twice, most recently in 2016, and the Klamath River Renewal Corporation was created to execute dam removal, hereafter called the Proposed Action. A 2020 Memorandum of Agreement describes how relevant parties will implement the amended KHSA. The dam removal is scheduled to begin in 2023 pending issuance of a FERC Surrender Order.

Whitewater recreation will be substantially affected by the Proposed Action. Inundated segments will be uncovered, bypassed segments will have increased flows, segments with power generation will have fluctuations leveled-out, and there will be new connections among segments. De-construction, restoration, and access changes may further affect the types, amount, or timing of whitewater boating.

The Renewal Corporation contracted a Whitewater Boating Study of four river segments (Keno, Big Bend, Hell's Corner, and Ward's Canyon). The 2020 study includes information about the Proposed Action flow regime; how seasonal flow shifts affect boating opportunities on the four segments or their connections through restored segments; boating-related access issues during deconstruction and over the long-term; and in-channel/riparian vegetation issues resulting from dam removal, particularly in Ward's Canyon. Field work focused on summer low flows that were not well-documented during 2004 relicensing studies, given modern equipment and practices. The study used controlled flow releases in Big Bend, Hell's Corner, and Ward's Canyon, and existing flows in the Keno Segment. Methods are in the report and a more detailed Study Plan.

Hydrology information illustrates the more natural Proposed Action flow regime. An annual hydrograph shows how spring run-off flows will be higher and more varied, often exceeding 1,500 cfs downstream of the springs below J.C. Boyle Dam (in Big Bend, Hell's Corner, and Ward's Canyon). A mid- to late-summer hydrograph shows relatively stable lower flows typically ranging from 800 to 1,100 cfs from July through September. Overall, the Proposed Action shifts higher flows (currently occurring during summer months due to peaking) to spring months (when they will occur less predictably and on fewer days, due to variable inputs and decreased storage).

A summary of 2020 fieldwork is provided in the table below. Results included flow evaluation curves for rafts and kayaks for each segment, and specified flows for different types of whitewater trips. Conclusions and implications include the following.

- ***Keno*** will continue to provide a scenic Class II/III trip with fishing and bird-watching bigger attractions than whitewater. Proposed Action summer flows of 600 to 800 cfs will be boatable, but the segment is not a substitute for better whitewater downstream. Keno will continue to support limited guided fishing along with local boating and fishing. Improved access could handle problems from existing use or facilitate additional use.
- ***Big Bend*** will provide a new boating trip in a scenic canyon during higher spring flows. Proposed Action summer flows will be higher than bypassed flows, but too low for standard whitewater boating with guided passenger loads. Big Bend requires few access improvements aside from

parking organization and a boat slide/trail at the put-in. The non-natural constriction at Sidecast Slide also needs work (beyond already-completed fish passage modifications) to provide a boatable channel at summer flows.

- ***Hell's Corner*** will provide high quality standard whitewater boating during the spring season, available from March through May in most years and into June in wet years. Summer low flows will provide acceptable technical whitewater for kayaks and small rafts, but will be sub-marginal for standard kayaking and rafting, probably requiring smaller boat/passenger configurations that would affect commercial viability. Hell's Corner accesses are well-located and require few improvements.
- Previously unboatable due low bypass flows, ***Ward's Canyon*** will provide an exciting new whitewater boating opportunity. Summer flows will provide optimal technical boating and acceptable standard boating that will attract guided and unguided use. The segment will need attention to access; it currently lacks an appropriate put-in, and the take-out at Fall Creek is well-located but needs organization and development. Ward's Canyon also has hundreds of trees that have grown in the channel and riparian area during a century of very low bypass flows. Before restoration of Proposed Action flows, vegetation should be cleared.
- A restored Klamath River will provide several options for extending boating trips through ***multiple segments.*** The most likely combination due to similar whitewater difficulty is a day trip in Big Bend and Hell's Corner, but trips with Keno and/or Ward's Canyon are possible, depending on what rapids emerge after reservoir drawdowns. For most craft and loads, multi-day trips will require higher flows that will occur from March thru May.

Summary of 2020 whitewater boating assessments.

Segment	Flows Assessed	Participants / Craft	Comments about Flows / Findings
Keno	800 cfs	11 boaters in 6 kayaks, 2 catarafts, an inflatable kayak, and a raft.	Low end of boatable range; technical flow for kayaking and rafting; marginal for commercial rafting with six-passengers; challenging inflatable kayaking.
Big Bend	1,100 cfs (dropping to 950 cfs)	9 boaters in 4 kayaks, 4 rafts, and a cataraft.	Technical flow for kayaking and rafting; low end of acceptable range for rafts even with light loads; several pinning and wrapping hazards. Small decrease in flows at end of study flow more technical. Kayaks ran Sidecast Slide, most rafts portaged.
Hell's Corner	830 cfs	7 boaters in 2 kayaks, 4 rafts, and a cataraft.	Technical flow for kayaking and rafting; low end of acceptable range for rafts even with lighter loads. More limited route options and more wrapping/pinning hazards than 1,100 cfs.
	1,100 cfs	9 boaters in 4 kayaks, 4 rafts, and a cataraft.	Technical flow for kayaking and rafting; low end of acceptable range for rafts even with lighter loads. Noticeably stronger hydraulics than 830 cfs, increased challenge and risks.
Ward's Canyon	800 cfs	10 boaters in 3 kayaks, 3 rafts, and a cataraft.	Acceptable standard boating for kayaks and rafts, even with moderate commercial passenger loads (four pack). In-channel vegetation hazards.
	700 cfs	9 boaters in 3 kayaks, 2 rafts, and a cataraft.	Transition flow between technical and standard trips for kayaks and rafts. Shallower rapids, constrained route options compared to 800 cfs, vegetation hazards remain.

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1 Introduction

PacifiCorp's Klamath Hydroelectric Project (KHP, FERC No. 2082) was constructed between 1911 and 1962. The KHP includes eight developments (East Side, West Side, Keno (non-generating), J.C. Boyle, Copco No. 1, Copco No. 2, Fall Creek, and Iron Gate), and it has been operating on annual FERC licenses since the 50-year license expired in 2006.

Relicensing studies and a license application occurred from 2000 to 2004, followed by a trial-type hearing (2006-2007) and subsequent settlement discussions (2006-2016) among the utility, Tribes, federal and state agencies, and several non-governmental stakeholders. The Klamath Hydroelectric Settlement Agreement (KHSA, originally 2010 but amended twice and finalized in 2016) plans to remove four dams (J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate; labeled the Lower Klamath Project) rather than relicense the entire KHP. This complex decision process considered tradeoffs among multiple resource values, concluding that a restored river will provide the greatest benefits in the long run.

Pursuant to the amended KHSA, Klamath River Renewal Corporation (Renewal Corporation) is an independent nonprofit organization created to execute decommissioning and removal of the Lower Klamath River Project (FERC No. 14803), hereafter called the Proposed Action. A November 2020 Memorandum of Agreement including the states of California and Oregon, the Yurok and Karuk Tribes, PacifiCorp, and Renewal Corporation describes how the parties will implement the amended KHSA with regard to the requested FERC License Transfer Order. On November 17, 2020, the Renewal Corporation filed the Amended Surrender Application with FERC, including Exhibit A-1 (Definite Decommissioning Plan) and Exhibit E (Environmental Conditions report). The Whitewater Boating Study is intended to further supplement the Amended Surrender Application, with results incorporated into the Recreation Facilities Plan initially submitted to FERC in February 2021. This final study report and photo summary will be filed with other finalized recreation facilities and access documents in fall-winter 2021-22. The dam removal is scheduled to begin in 2023 pending issuance of the Surrender Order.

1.1 Whitewater Boating on the Klamath River (from Keno to Iron Gate)

The Klamath River from Keno Dam to Iron Gate Dam drops nearly 2,000 feet in 44 miles. Current operation of the existing Klamath River Hydroelectric Project creates two bypassed segments with diminished flows (Big Bend and Ward's Canyon), a segment with low base flows and higher peaking flows (Hell's Corner), and a segment with close to run-of-the-river flows (Keno Segment). Other segments are inundated by the Project's four reservoirs.

Whitewater recreation will be substantially affected by the Proposed Action. Inundated segments will be uncovered, bypassed segments will have increased flows, the segments with flows affected by power generation will have fluctuations leveled-out and there will be new connections among segments. De-construction, restoration, and access changes may further affect the types, amount, or timing of whitewater boating. Studies will anticipate changes, but surprises are inevitable.

Overall, the Proposed Action is expected to improve whitewater boating, fishing, and other river-based recreation that support the region's tourism economy, including commercial rafting (Cross and Wallstrom, 2019). But this will require careful planning for the short term (e.g., disruptions during the deconstruction process) and the long term (e.g., when development choices will affect location of and amenities at access sites). A Recreation Facilities Plan will address management issues and facility needs; however, stakeholders have requested a study of flow needs and access options (Cross and Wallstrom, 2019) to better identify effects of the new flow regime on whitewater boating.

Recreation studies during relicensing (PacifiCorp, 2004) assessed flow needs for boating, fishing, and general recreation opportunities. However, these studies assumed the four dams would remain in operation and regulate flows (e.g., with peaking flows in one segment, and possibly boating releases in other segments). The Proposed Action will remove four hydroelectric dams, producing a more natural flow regime, with no peaking or bypass segments.

The full range of flows are important for whitewater because they produce a diversity of boating opportunities throughout the year. Lower flows are of particular interest for the 2020 study because they were not as well documented during 2004 relicensing studies, they are likely to constrain boating opportunities, and they occur during the summer season. There is a need to:

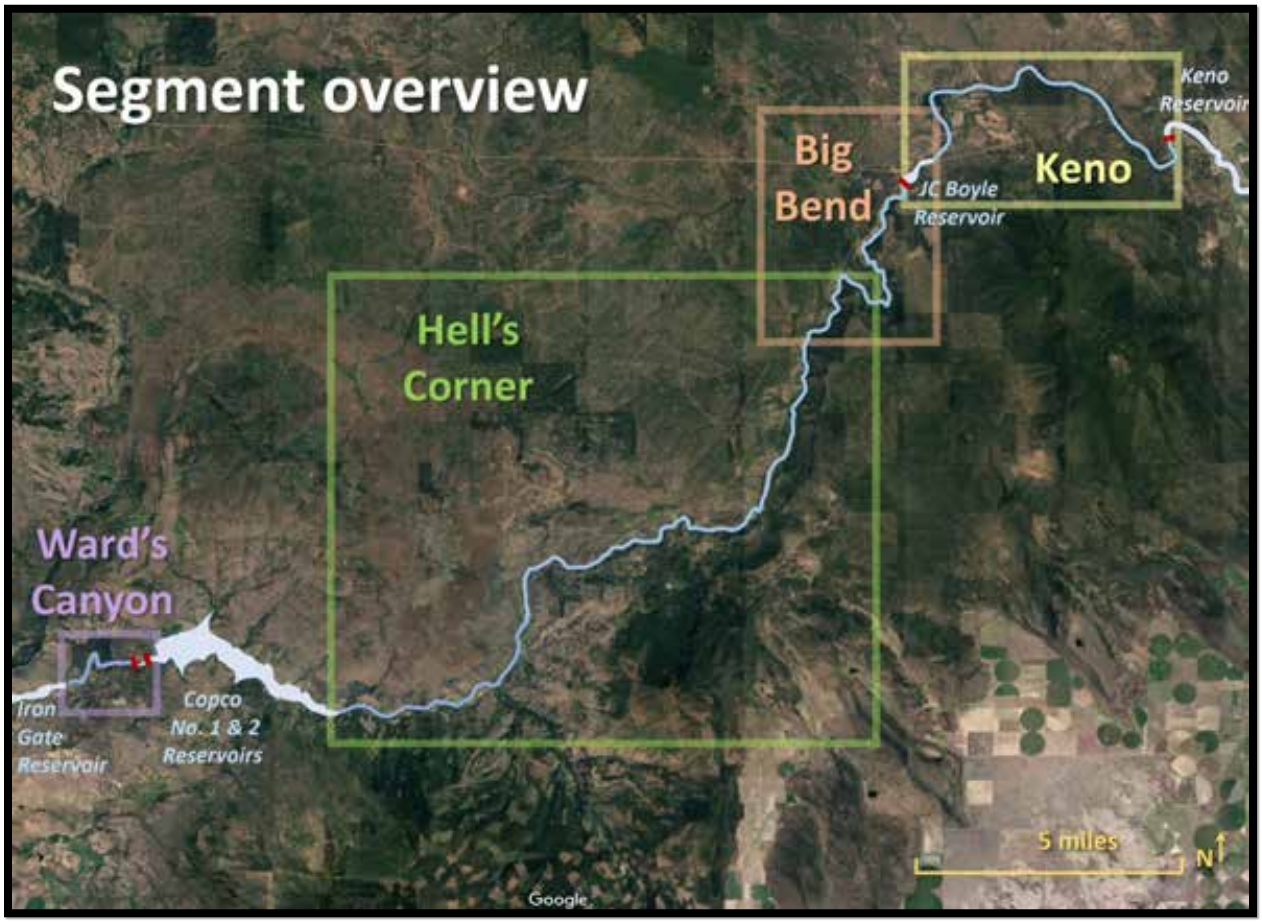
- More precisely determine the Proposed Action flow regime in the Keno, Big Bend, Hell's Corner, and Ward's Canyon Segments.
- Discuss how flows may affect boating opportunities on the four segments or their extensions/ connections through restored segments.
- Assess boating-related access needs and solutions during deconstruction, as well as over the long-term.
- Identify in-channel and riparian vegetation issues as a result of dam removal, particularly in Ward's Canyon.

The Renewal Corporation commissioned this Whitewater Boating Study focusing on the following boating opportunities, flow ranges, access issues, and riparian vegetation constraints.

- ***Keno Segment*** (from Keno Dam to J.C. Boyle Reservoir). Private and commercial boating anticipated during mid- to late-summer low flows.
- ***Big Bend Segment*** (aka Boyle Bypass Reach, from J.C. Boyle Dam to J.C. Boyle Powerhouse). Private and commercial boating anticipated during mid- to late-summer low flows. In addition, assess boatability of Sidecast Slide Rapid, a river feature created by erosion of the overburden generated during construction of J.C. Boyle Power Canal, which has been modified for fish passage as part of KHSA Interim Measure 8.
- ***Hell's Corner Segment*** (from the J.C. Boyle Powerhouse to Copco Lake, including the Klamath Wild and Scenic River (W&SR) and Oregon State Scenic Waterway (OSSW) segments). Private and commercial boating anticipated during mid- to late-summer low flows.
- ***Ward's Canyon Segment*** (aka Copco No. 2 Bypass Reach, from Copco No. 2 Dam to Iron Gate Reservoir). Non-commercial and commercial boating anticipated during mid- to late-summer low flows.

- Review ***boating-related river access issues for each segment,*** as well as new boating opportunities that connect existing river segments to those uncovered as reservoirs are drained. The study did ***not*** assess whitewater features in the reservoir-into-river segments, which can be better assessed after drawdown.
- Preliminary assessment of ***tree growth in the channel and riparian zone*** in Ward's Canyon due to years of reduced base flows and infrequent higher flows from the hydroelectric project. Current vegetation could create impasses and safety issues for future whitewater boating, and the study took advantage of the opportunity to consider possibilities for restoration/enhancement.

In general, the 2020 Whitewater Boating Study collected information from controlled flow assessments on Big Bend, Hell's Corner, and Ward's Canyon, while capitalizing on existing flows to assess the Keno Segment. Target flows were chosen to optimize boatability information about more natural Proposed Action flow regimes (see hydrology analysis summary below), considering assessments from earlier relicensing studies and changes in commercial boating equipment and practices in the intervening years.



Map 1. Segment overview.

1.2 Study Overview and Objectives

The Whitewater Boating Study included controlled flow assessments of one flow on Big Bend and two flows on Hell's Corner and Ward's Canyon. Target flows were chosen to bookend anticipated Klamath River mid- to late-summer flows under the Proposed Action, as identified in a hydrology analysis (CRC, 2020; see summary below). Controlled flows were not feasible on the Keno Segment due to irrigation, endangered species, and water rights commitments, but the existing flow at the time of the study reasonably represented mid- to late-summer conditions.

Non-commercial and commercial boaters traveled the river in their own craft to assess different types of trips. They completed formal evaluations and participated in focus groups for each run, and after all the runs. Assessments focused on boatability, whitewater challenge, skill and craft options, and potential river hazards and solutions (including non-natural features such as Sidecast Slide rapid or vegetation growth in bypass channels). The study also considered access locations and facility options near Keno Dam, Turtle Camp, and Copco No. 2 Powerhouse.

The Whitewater Boating Study includes information about the following:

- Recreation-relevant hydrology of anticipated flow regimes (see summary of hydrology analysis below).
- Whitewater boating opportunities on existing and to-be-restored river segments. Opportunities vary by equipment (e.g., craft or rigging), skill level, activity objective (e.g., technical, standard, or big water experiences), or specific flow-related conditions.
- Flow-quality relationships, including acceptable and optimal ranges for each opportunity, with specific focus on anticipated mid- to late-summer low flows.
- Opportunities for whitewater flow enhancements if water became available (e.g., due to changes in Keno operations, irrigation demand, return-flow rates, or requirements for endangered species).
- Existing and potential access for boating, advantages and disadvantages of different options, and potential improvements.
- Possible whitewater opportunities and use-levels with agencies considering whitewater and other resource values.
- Impacts of vegetation in bypassed reaches with altered flow regimes, especially Ward's Canyon.

1.3 Deliverables

The Whitewater Boating Study included several deliverables, generally reviewed sequentially by the Renewal Corporation and PacifiCorp, with revisions by Confluence after each review.

Hydrology analysis and target study flow requests. This standalone analysis estimated Proposed Action hydrology on the four Klamath River segments, providing a basis for target study flow requests. Relevant variables from the recent Biological Opinion (USFWS, 2019) included recent year hydrology, assumptions about climate change, farming practices, return-flow rates, and flow requirements for Endangered Species Act protected species in the Klamath River. A summary of the hydrology analysis is included in this report; the complete document is available here.

Study plan and appendices. The study plan included an overview of the study, a review of existing information, resource descriptions for each segment, the hydrology analysis and target study flow requests, study methods, study logistics plan, participation goals, focus group and survey instruments, and other considerations for conducting a safe and efficient study. It included a supplemental Covid-19 plan after the pandemic affected fieldwork options in 2020.

Draft and final study reports. The draft study report provided here includes a summary of study objectives, resource and boating opportunities, hydrology analysis findings, and a description of methods and findings. The final report will be accompanied by photo summaries with extended captions.

Presentation summarizing the study and key findings. Study findings will be summarized in a PowerPoint presentation of key findings and representative photos.

2 Methods

The following section summarizes river segment descriptions, previous work on flow-recreation issues, and the hydrology analysis. These led to the initial study flow requests, and several revisions of a Study Plan (previously published and available here). The remainder of the methods describes how the study was conducted, including modifications due to COVID-19 and mid-study findings.

Methods were consistent with professional practices for studying relationships between flows and whitewater boating or other recreation opportunities (Whittaker et al, 1993 and Whittaker, Shelby, and Gangemi, 2005). These were consistent with approaches that have been used in several FERC relicensing proceedings, and with FERC requirements under the Integrated License Process (ILP; FERC, 2004).

The overall goal was to quantify specific boating opportunities and flow needs for each of the four boating segments. In this case, relicensing studies (2000-2004) provided initial information from existing documents (guidebooks, websites, blog accounts), multiple-flow field reconnaissance by researchers and stakeholders, and controlled flow assessments.

However, relicensing studies assumed continued existence of the four hydroelectric dams that produced peaking and bypass segments. Now that the Proposed Action will decommission four dams and provide a continuous river with a more natural seasonal hydrology, the focus has shifted. Higher flows and associated boating opportunities will occur during spring run-off, with lower flows from mid- to late-summer. ***The 2020 study was designed to document effects of the Proposed Action on whitewater boating, with particular attention to information gaps such as seasonal shift of flows, newly restored river segments, and evaluation of summer low flows that were not well-documented during relicensing (given modern equipment, rigging, and practices).***

2.1 Summary of Existing Information and Study Area

Several existing information sources describe the whitewater recreation-related characteristics of the Klamath River from Keno to Iron Gate, including topographic maps, whitewater boating guidebooks, stream flow records, fish habitat surveys, aerial photographs, aerial video, and the 2000-2004 re-licensing studies. Much of this material was integrated into the whitewater boating sections of the Final Technical Report (FTR, PacifiCorp, 2004). It was also summarized in the Study Plan (Confluence, 2020), and an abbreviated version is provided below, organized by segment.

2.1.1 Segment Descriptions

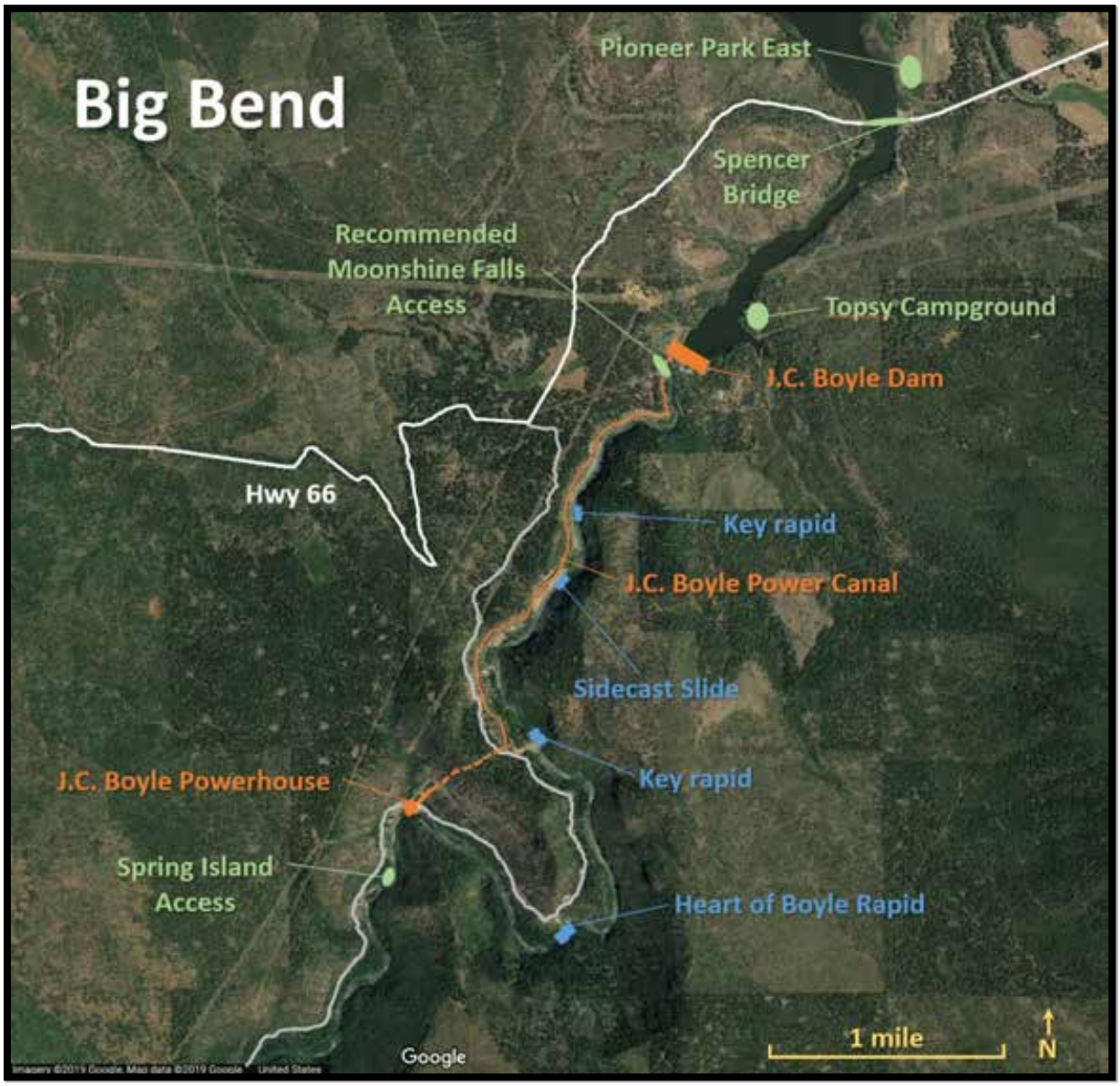
2.1.1.1 Keno Segment

Map 2. Keno Segment

- This segment is 5.2 miles long from Keno Dam to Spencer Bridge (includes about two miles on J.C. Boyle Reservoir).
- Gradient in the free-flowing segment is about 35 feet per mile; river has a pool/drop character.
- The channel is mostly single thread and relatively narrow (usually about 100 to 120 feet wide).
- The river has a few steep banks and cliffs in the first four miles, usually less than 200 feet above the river. The canyon gives way to rolling hills as one approaches Boyle Reservoir at the end of the run.
- It is largely undeveloped, with scenic rock outcroppings and conifer-forested hills.
- The segment has superlative birdwatching (e.g., cormorants, pelicans, herons, and eagles).
- There are several Class II-III rapids, but whitewater is less challenging than downstream reaches.
- There is a road to the dam put-in location on river right (high clearance vehicle recommended).

- There are several take-out options, but Spencer Bridge at Pioneer Park East is most commonly used.
- Private kayakers use a locational play boating wave near the dam during higher winter/spring flows; the wave is available from about 1,100 to 1,800 cfs, optimal from 1,300 to 1,600 cfs.
- There is currently little commercial whitewater boating use on the reach.
- Some fishing outfitters offer trips on the segment; relicensing studies identified the usable range from 300 to 1,000 cfs, with optimal boat-based fishing from 600 to 900 cfs.

2.1.1.2 Big Bend Segment (aka Boyle Bypass Segment)



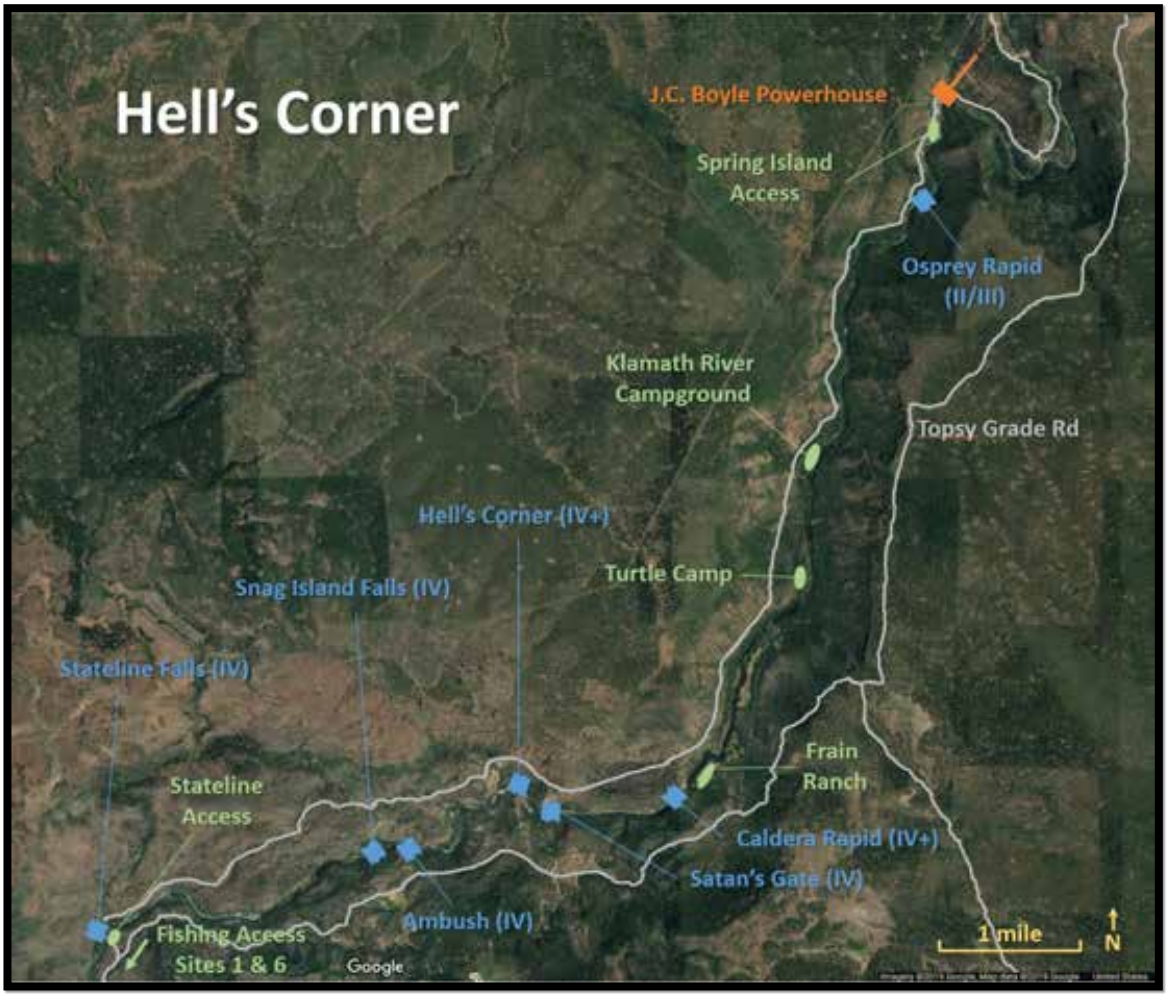
Map 3. Big Bend Segment.

- This segment is 4.7 miles long, with a gradient about 85 feet per mile. The river has several distinct drops, but is also steep between them, with few pools or glides.
- The channel is mostly single-thread and relatively narrow (usually less than 100 feet wide).
- The river runs through a steep canyon with basaltic boulder fields, scree, and brushy vegetation. Canyon walls typically rise 300 to 500 feet above the river. There are grasses and sedges in the riparian zone, and a few upland ponderosa pine forests.
- Cold water springs enter the segment from river left about a mile downstream of the dam. These accretion flows have ranged from 200 to 300 cfs, but were typically 220 to 250 cfs during relicensing

studies (Gannet et al., 2010). The springs appear to cool the river about 10 degrees F (Watershed Sciences, 2002).

- There is little development in the viewscape, except for the hydropower canal, road, and associated erosion on river right. The penstock and powerhouse are visible at the end of the run.
- There are several Class III-V rapids, with levels of challenge similar to Hell's Corner.
- Parts of former Moonshine Falls appear just below J.C. Boyle Dam. One paddle raft (R-2) ran the dam outlet at 1,600 cfs, but this was not assessed during the current study.
- Sidecast Slide, 1.2 miles below the Timber Bridge, is a Class IV-V rapid created by construction of the J. C. Boyle canal and road. It was lined or portaged by rafts during the relicensing study at 960 cfs, but was runnable at 1,500 cfs in all craft. KHSA early implementation measure No. 8 required PacifiCorp to remove several boulders from this rapid to improve fish passage in summer 2012. The present study re-assessed the rapid at late summer flows.
- A short road to a bridge just below the dam offers an undeveloped launch area.
- Spring Island Recreation Area is a take-out for Big Bend runs; boaters can also continue into Hell's Corner segment.
- There is no current commercial whitewater boating use because this bypassed reach typically has low base flows. Non-commercial boaters currently use the segment during spring run-off spill events.
- Relicensing studies produced information about boating opportunities between 800 and 3,000 cfs.
- The Whitewater Boating Study focused on likely late-summer Klamath River flows under the Proposed Action of about 800 to 1,100 cfs.

2.1.1.3 Hell's Corner Segment



Map 4. Hell's Corner Segment

- This segment consists of three parts: 1) a 5.5-mile Class II reach with 25 feet per mile gradient (Upper Hell's Corner, from Spring Island to Frain Ranch/Caldera); 2) a 5.5-mile Class IV-V gorge with 80 feet per mile gradient (Hell's Corner Gorge from Caldera to Stateline/Access # 6); and 3) a 5.5-mile Class II reach with 20 feet per mile gradient (from Stateline to Access #1).
- The channel is mostly single thread and narrower in the Gorge, but it has some islands and wider reaches in Upper Hell's Corner and downstream of Stateline.
- The river runs through an intermittent basaltic canyon with some nearby rolling terrain. There are scree, brush, and ponderosa pine forests within the viewscape. Immediate canyon walls typically rise less than 300 feet above the river, although peaks or walls in the distance may be twice as high.
- There is little accretion in this segment until Shovel Creek downstream of Stateline Access; other tributaries may add little more than 10 cfs in summer (Gannet et al., 2010).
- The 11-mile segment from J.C. Boyle powerhouse to the California border was designated an Oregon State Scenic Waterway (OSSW) in 1988 and a National Wild and Scenic River (WSR) in 1994;

the designations came in response to various Salt Cave Hydroelectric Project proposals and a formal Wild and Scenic River Study (USDI 1990). The 1994 WSR designation came through Section 2(a)(ii) of the WSRA (governor-petition to the Secretary of Interior rather than Congressional designation); this may affect future development of Parcel B lands in the designated segment.

- There are 16 Class III, three Class IV, and two Class V rapids in the reach, most concentrated in Hell's Corner Gorge. Rapids are generally continuous in the Gorge; upstream and downstream reaches are more pool-drop.
- There is a developed put-in at Spring Island on river right below Boyle Powerhouse. There are take-out options on river left at Frain Ranch, Stateline Access, Access #6, and Access #1.
- The Topsy Grade road on river left from J.C. Boyle Dam to Frain Ranch at the start of the Gorge is in fair condition, but few people run this segment by itself. From Frain Ranch to Stateline Access, the road is generally in poor condition and requires high clearance 4-wheel drive and two hours to cover the 6 miles.
- The road from Stateline downstream to Iron Gate and Interstate 5 is mostly well graded gravel or paved, providing the most common boater take-outs. The shuttle from Spring Island to Stateline via Highway 66, I-5, and Copco Road is over 85 miles and takes over two hours.
- Under past Lower Klamath Project operations, daily peaking flows of 1,500 to 1,700 cfs through the summer have attracted considerable whitewater boating use on the Hell's Corner segment. Under the Proposed Action, these higher flows will typically be available in the spring or early summer, but not during mid- to late-summer (as discussed below in the hydrology summary). The Whitewater Boating Study focuses on low flows because they were not well documented during 2004 relicensing studies and may constrain boating opportunities; it describes assessments of higher flows because they were preferred in past studies and will occur at different times under the Proposed Action.
- Most boating trips take about 2 to 4 hours from Spring Island to Access Number 6, and trips to Access Number 1 take about an hour more. Trip times are affected by flows and may include a lunch break.
- Most outfitted trips use 13- to 15-foot all-paddle rafts or stern drives; they rarely offer inflatable kayaks. Non-commercial trips are commonly in kayaks and rafts.
- Relicensing studies produced information about boating opportunities between 700 and 2,500 cfs. The 2020 Whitewater Boating Study focuses on anticipated mid- to late-summer Klamath River flows under the Proposed Action (about 800 to 1,100 cfs).

2.1.1.4 Ward's Canyon Segment (AKA Copco II Bypass)

Map 5. Ward's Canyon Segment

- This segment is 2.0 miles long from Copco No. 2 Dam to Fall Creek access at the top of Iron Gate Reservoir. Overall gradient is 65 feet per mile, but it is steeper for the first mile, and flatter for the last .3 miles below the powerhouse.
- Under the Proposed Action, an additional half mile of Ward's Canyon (from near the start of Copco I dam to Copco No. 2 Dam) will be connected to the current bypass reach, making a roughly 2.5-mile run. Gradients in the first half mile are underwater but may exceed 100 feet per mile according to J.C. Boyle's engineering drawings (Cross and Wallstrom, 2019).
- The channel is mostly single thread and relatively narrow but has in-channel vegetation from artificially low flows since the early 1900s. There are brushy riparian areas, and full-sized trees in the channel near the dam and several reaches downstream. The in-channel vegetation creates boatability challenges and safety concerns.
- The river runs through an intermittent basaltic canyon with nearby rolling terrain. Immediate canyon walls typically rise less than 300 feet above the river, but one canyon has a near-vertical columnar basalt wall, among the most scenic along the Upper Klamath River.
- There is some flow accretion between the end of Hell's Corner Gorge and this segment. Tributaries include Shovel Creek, which usually provides 10 to 30 cfs but may exceed 100 cfs during winter-spring rain or run-off events.
- There are roughly five Class III and two Class IV rapids, depending on how those are delineated.
- There is an undeveloped and challenging put-in on river right near Copco No. 2 Dam (currently closed to public access), and a good take-out on river right at Fall Creek. Dam removal plans may consider access options near the current Copco II powerhouse site (river left), or upstream/downstream upon completion of the Proposed Action.

- There is a good shuttle road on river right, and an existing bridge across the river near Fall Creek.
- There is no current whitewater boating use because this segment does not have boatable flows except during rare spills. After dam removal, there will be opportunities to connect this short whitewater reach with upstream segments under existing Copco and Iron Gate Reservoirs (whitewater and scenic characteristics unknown).
- Relicensing studies provide information about boating opportunities between 300 and 1,200 cfs.
- The Whitewater Boating Study focused on likely late-summer Klamath River flows under the Proposed Action of about 800 to 1,100 cfs

2.2 Previously Assessed Klamath River Whitewater Boating Flows

Boating flows on the Klamath River between Keno and Iron Gate were previously assessed during relicensing studies, and results are available in the Relicensing Technical Report (PacifiCorp, 2004). These studies were designed assuming that operations would probably change with a new license, but the hydroelectric dams would continue to provide peaking and bypass reaches.

The Proposed Action removes regulated flows from the hydroelectric dams and provides new boating opportunities in the former bypass reaches. It also provides a new flow regime that better mimics natural seasonal variation (e.g., higher flows in spring and early summer; lower flows from mid- to late-summer), although still subject to upstream agricultural irrigation storage and diversions. This 2020 study addresses the full range of flow effects on whitewater boating, with particular attention to lower summer flows that were not the focus of the earlier studies.

For comparison purposes, results from the 2000-2004 boating studies have been summarized in Table 1. This is followed by short descriptions of boating opportunities and flow ranges for each segment, and the questions addressed in the 2020 study. Consistent with research on flows for boating, both 2004 and 2020 studies considered categories of whitewater opportunities as follows.

- *Technical whitewater* opportunities offer lower flow access to a whitewater segment, but typically have more limited route options through boulders; more boatability problems (hits, stops, and boat drags); and less powerful hydraulics and waves. Boaters may take smaller or more lightly loaded craft for these opportunities.
- *Standard whitewater* opportunities offer whitewater rapids and challenge roughly equal to the river's difficulty (Class I-VI rating). Boatability problems (hits, stops, and boat drags) are rarely encountered, hydraulics are more powerful, and waves are larger than for technical opportunities. Boaters can use a wider array of craft and loads with standard opportunities.
- *Big water* opportunities occur when flows noticeably increase the level of whitewater challenge. In general, hydraulics are more powerful and waves are larger than standard trips, although some rapids may be "washed out" at big water flows. Boatability problems are not relevant. These flows may be sought by some higher-skilled boaters and avoided by those with more limited skills or equipment.

- *Low flow outfitted rafting* and *standard outfitted rafting* opportunities have been distinguished in some studies (including Klamath River relicensing) to examine differences for specific craft length/width combinations, rigging options (e.g., paddle rafts vs stern row vs. center row set-ups), and loads (e.g., 3 vs. 6 passengers plus a guide).

Table 1. Summary of previously studied boating flows (from 2004 Relicensing Technical Report).

Segment	Previous Flows Assessed	Participants / Craft	Comments about Flow / Findings
Keno	700 cfs	6 total in kayaks and rafts	Boatable flow but little whitewater. 1,000 cfs provides better boatability and whitewater.
Big Bend / J.C. Boyle Bypass	370 cfs	5 total in kayaks and IKs	Not raftable; boatability challenges even for kayaks.
	690 cfs	9 total in kayaks & catarafts	Marginal technical boating. All rafts and most kayaks portaged Sidecast Slide.
	960 cfs	34 total in kayaks, rafts, and catarafts	Technical opportunity, but marginal standard boating. Rafts portaged Sidecast Slide.
	1,230 cfs	10 total in kayaks, raft, and cataraft	Notably improved boatability and whitewater. Standard opportunities. No portages.
	1,480 cfs	27 total in kayaks, rafts, and catarafts	Near-optimal standard boating for all craft.
Hell's Corner	360 cfs	On foot	Not suitable for boating Class IV-V rapids.
	730 cfs	5 in single kayaks, 1 in cataraft, 10 in 3 rafts (16 total)	Unacceptable technical boating. Rafts became stopped or had boat drags from several rocks.
	1,065 cfs	5 in single kayaks, 1 in cataraft, 6 in 2 rafts (12 total)	Acceptable technical boating, but lacks power. Possibly commercially viable in smaller rafts.
	1,360 cfs	5 in single kayaks, 1 in cataraft, 5 in 2 rafts (11 total)	Notably improved boatability and whitewater. Start of standard boating, but not yet optimal.
	1,570 cfs	2 in single kayaks, 1 in cataraft	Start of optimal standard trips.
	1,750 cfs	6 in single kayaks, 1 in cataraft, 6 in 2 rafts (13 total)	Optimal standard trips; some suggest it is near transition to big water trips.
	2,800 cfs	3 in single kayaks, 1 in cataraft	Optimal big water boating.
Ward's Canyon / Copco Bypass	10 cfs	On foot	Not boatable in any craft.
	175 cfs	2 in single kayaks, 1 in IK, 1 in cataraft (4 total)	Marginal technical boating for kayaks and IKs. Unacceptable for even a small cataraft/raft.
	650 cfs	2 in single kayaks, 1 in cataraft, 2 in 1 raft (5 total)	Start of acceptable standard opportunities, but still some boatability problems.
	1,200 cfs	3 in single kayaks, 1 in cataraft (4 total)	Transition between standard and big water boating. Similar to Hell's Corner at 1,300 cfs.

2.2.1.1 Keno Segment

- Kayakers use a locational play boating wave near the dam during higher winter/spring flows. The wave is available from about 1,100 to 1,800 cfs; it is optimal from about 1,300 to 1,600 cfs.
- Currently there is little outfitted whitewater boating use on the reach, and no outfitter assessed the single 700 cfs demonstration flow during relicensing studies.
- A few fishing outfitters offer trips on the segment, and they identified a usable range from 300 to 1,000 cfs, with optimal boat-based fishing from 600 to 900 cfs.
- The 2020 Whitewater Boating Study focused on re-assessing lower flows for current boaters and outfitters using modern craft or different rigging/passenger configurations (e.g., smaller, narrower, or paddle-based rafts, or inflatable kayaks).

2.2.1.2 Big Bend Segment

- The 2001-2004 relicensing studies defined acceptable and optimal flow ranges for several boating opportunities.
    - For kayaks, technical opportunities begin at about 800 cfs and become optimal at about 900 cfs. For rafts, technical opportunities begin at about 1,000 cfs and become optimal at about 1,300 cfs.
    - For both craft, technical opportunities transition to standard opportunities at about 1,300 cfs, with optimal standard trips from 1,300 to 1,800 cfs.
    - Standard opportunities transition to big water opportunities at about 1,700 cfs, and are optimal from 1,800 to 3,000 cfs.
    - Low flow commercial rafting begins at about 1,000 cfs, and transitions to standard commercial rafting at about 1,300 cfs.
- The 2020 Whitewater Boating Study focused on re-assessing lower flows for current boaters and outfitters using modern craft or different rigging/passenger configurations (e.g., smaller, narrower, or paddle-based rafts, or inflatable kayaks).
- Within this larger question, another issue is the viability of outfitted trips on mid- to late-summer flows (July through September). The hydrology analysis (summarized below) suggests these flows will range from about 800 to 1,100 cfs; the 2004 studies suggested this range is near-marginal for technical or commercial low flow rafting.
- Sidecast Slide, a Class IV-V rapid 1.2 miles below the Timber Bridge created by construction of the J.C. Boyle canal and road, was lined or portaged by rafts during the relicensing study at 960 cfs, but was runnable at 1,500 cfs in all craft. KHSA early implementation measure No. 8 required PacifiCorp to remove several boulders from this rapid to improve fish passage in summer 2012. The 2020 Whitewater Boating Study reassessed this rapid's boatability at mid- to late-summer flows.

2.2.1.3 Hell's Corner Segment

- Relicensing studies defined acceptable and optimal flow ranges for several boating opportunities.
    - For kayaks, technical opportunities begin at about 700 cfs, and become optimal at about 800 cfs. For rafts, technical opportunities also begin at about 700 cfs, and become optimal at about 900 cfs.
    - For kayaks, technical opportunities transition to standard opportunities at about 1,300 cfs. For rafts, this transition is at about 1,500 cfs. Optimal standard trips for both craft are from about 1,500 cfs to over 2,500 cfs.
    - Standard opportunities transition to big water opportunities at about 2,400 cfs, and these are optimal from 2,500 to 3,500 cfs.
    - Low flow commercial rafting begins at about 1,000 cfs and transitions to standard commercial rafting at about 1,300 cfs.
- The 2020 Whitewater Boating Study focused on re-assessing lower flows for current boaters and outfitters using modern craft or different rigging/passenger configurations (e.g., smaller, narrower, or paddle-based rafts, or inflatable kayaks).
- Within this larger question, another issue is the viability of outfitted trips at anticipated mid- to late-summer flows (July through September). The hydrology analysis (summarized below) suggests these flows will range from about 800 to 1,100 cfs; this range is near the margins for acceptable technical or commercial low flow rafting.

2.2.1.4 Ward's Canyon Segment

- The 2000-2004 relicensing studies defined acceptable and optimal flow ranges for several boating opportunities.
    - For kayaks, technical boating begins at about 300 cfs, and transitions to standard boating at about 500 cfs.
    - For rafts, technical boating begins at about 500 cfs, and transitions to standard boating from 500 to 800 cfs.
    - Optimal standard boating opportunities for both craft are from 800 to 1,200 cfs.
    - Outfitted rafting in larger boats (5 to 6 passengers plus a guide) probably requires about 1,000 cfs, and becomes optimal at about 1,200 cfs, although encroaching vegetation (low overhanging limbs and in-channel strainers) may limit this opportunity if not removed.
- The 2020 Whitewater Boater Study focused on re-assessing lower flows for current boaters and outfitters using modern craft or different rigging/passenger configurations (e.g., smaller, narrower, or paddle-based rafts, or inflatable kayaks).
- Within this larger question, another issue is the viability of outfitted trips at anticipated mid- to late-summer flows (July through September). The hydrology analysis suggests these flows will range from about 850 to 1,150 cfs; this range is near the margins for acceptable technical or commercial low flow rafting.

2.3 Summary Findings from the Hydrology Analysis

The following summarizes findings from a detailed Hydrology Analysis conducted by CRC as part of the Whitewater Boating Study Plan (Confluence, 2020) available here. An overview sidebar (at the end of this section) provides a summary of background information for interested readers, while the recreation-related hydrology conclusions are provided below.

Detailed information about historic or future storage, diversions, and water use in this system are beyond the scope of either document, although we have provided two hydrographs to illustrate anticipated ***annual flows*** (Figure 1) and ***mid- to late-summer flows*** (Figure 2) for Big Bend and Hell's Corner (which are similar). Similar hydrographs are available in the Hydrology Analysis (Confluence, 2019) for Keno and Ward's Canyon but not shown here; these follow the same pattern but account for accretion in those segments. As a rule of thumb during lower flow parts of the year, flows in the Keno Segment are generally 240 cfs lower than those in Big Bend/Hell's Corner, while flows in Ward's Canyon are generally 30 cfs higher.

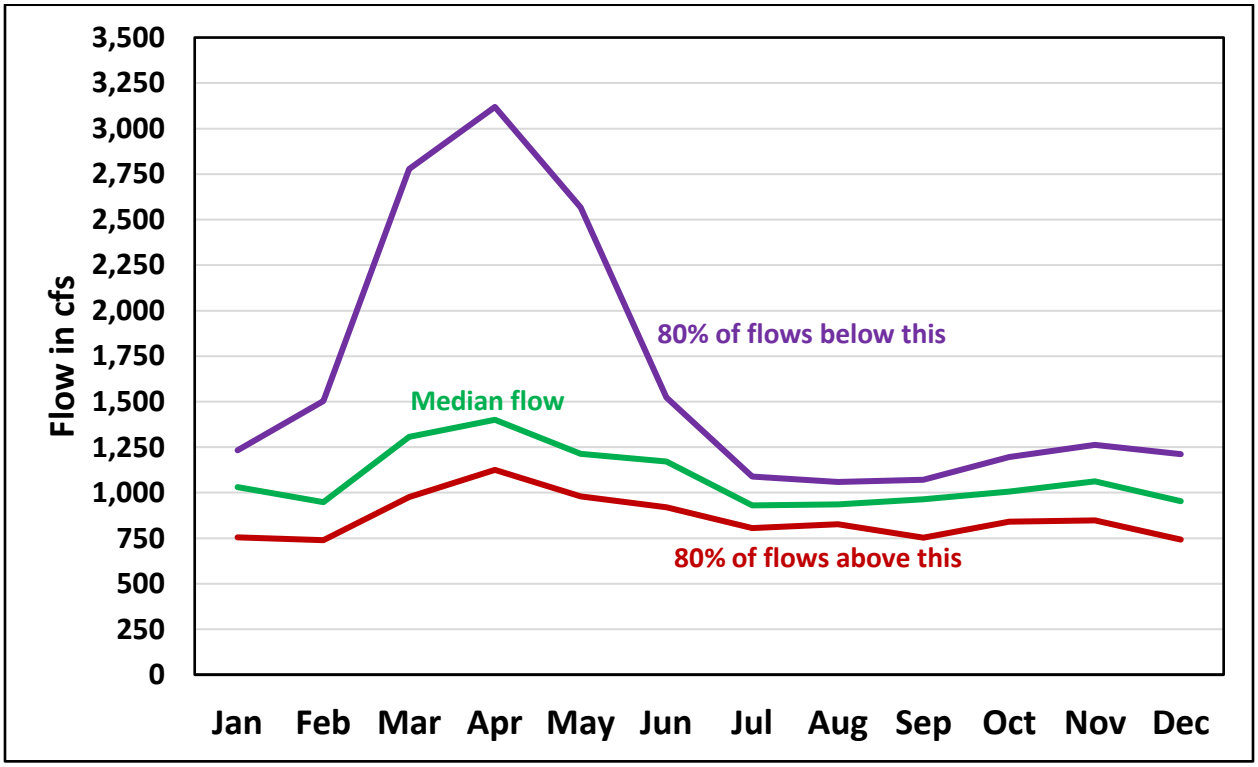


Figure 1. Annual hydrograph in the Big Bend/Hell's Corner Segments based on 20%, median, and 80% monthly flows from USGS Keno gage + 240 cfs accretion.

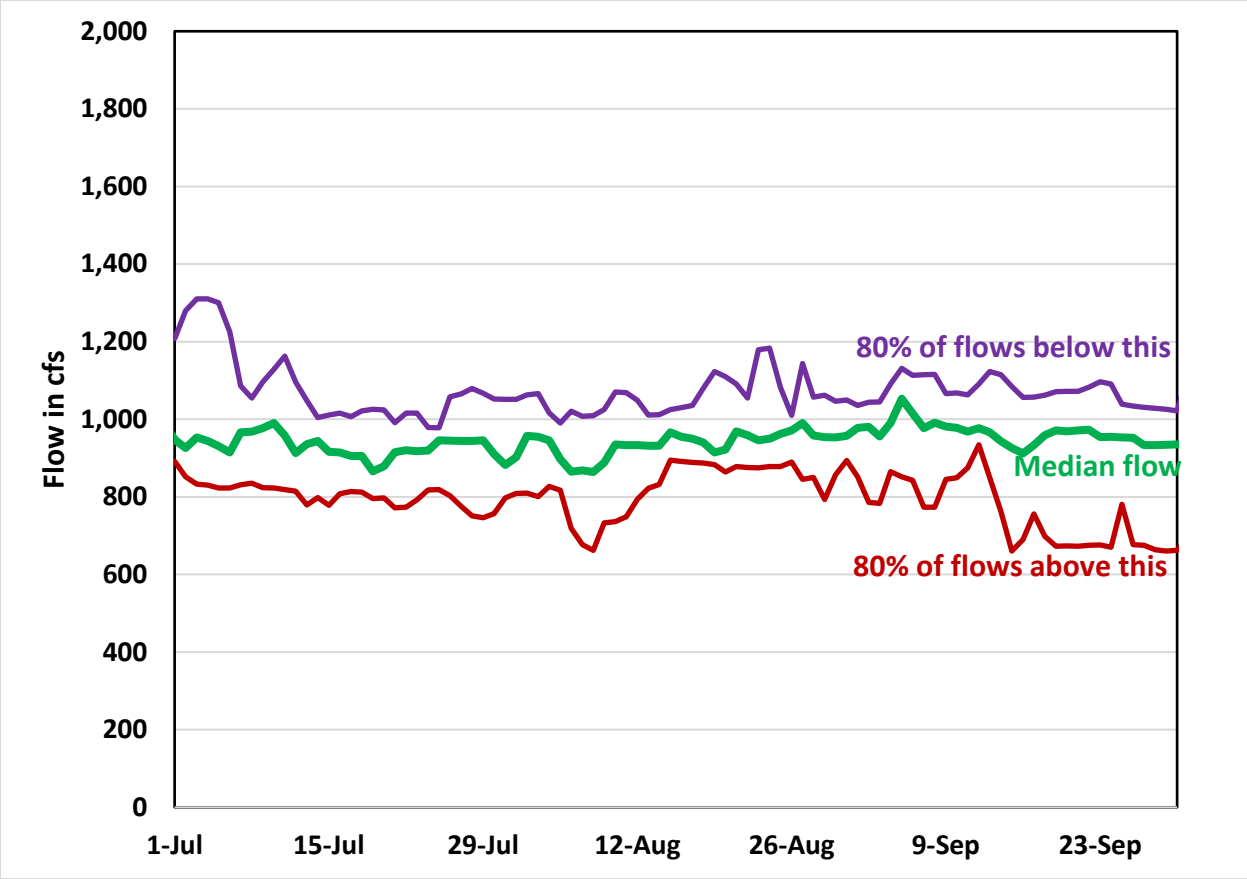


Figure 2. Mid- to late-summer hydrograph in Big Bend/Hell's Corner Segments based on 20%, median, and 80% daily flows from Keno gage + 240 cfs accretion.

These two hydrographs generally ***illustrate the more natural flow regime anticipated under the Proposed Action.***

- The ***annual hydrograph (Figure 1)*** shows how spring run-off flows are likely to be higher, often exceeding 1,500 cfs in March, April, and May. Although this graph uses monthly data that do not illustrate daily fluctuations, flows vary more from day-to-day during spring high flows, and in wetter years higher flows may continue into June (see Hydrology Analysis for more detail).
- The ***mid- to late-summer hydrograph (Figure 2)*** based on daily flows shows relatively stable lower flows from July through September, typically ranging from about 800 to 1,100 cfs.
- ***Overall, the Proposed Action shifts higher flows*** (currently occurring during summer months due to peaking) ***to spring months*** (when they will occur less predictably and on fewer days, due to variable inputs and decreased storage).

2.3.1 Estimating Proposed Action Flows for the Whitewater Boating Study

Gages are not available on every segment on the Klamath River, so modeling flows under the Proposed Action required assumptions about base flows from Keno Dam and accretion flows for each segment downstream. In general, we used USGS flows at Klamath River near Keno (USGS 11509500) as the starting point for estimating flows, with specific accretion in each segment based on previous hydrology work during relicensing (PacifiCorp, 2003; Gannet et al., 2010). The detailed hydrology analysis covers year-round flows, but this Whitewater Boating Study focuses on ***mid- to late-summer flows resulting from the Proposed Action***.

- Under the Proposed Action, flows in the ***Big Bend Segment*** are estimated to be ***Keno flows + 240 cfs*** from 1) Spencer Creek (which flows into J.C. Boyle Reservoir) and 2) springs downstream from J.C. Boyle Dam.
- Accretion in the ***Hell's Corner Segment*** from J.C. Boyle Powerhouse to Shovel Creek is probably less than 10 cfs (from groundwater springs and small tributaries such as Rock and Hayden Creeks). But most of this enters the segment downstream of the important rapids, so for study purposes, ***flows in Hell's Corner are treated the same as Big Bend: Keno flows + 240 cfs.***
- The ***Ward's Canyon Segment*** has accretion from the downstream end of the Hell's Corner Segment and tributaries to Copco Lake. For study purposes, we have assumed 240 cfs from Big Bend, 10 cfs from lower Hell's Corner, and 20 cfs from Copco Lake. ***Proposed Action flows in Ward's Canyon Segment are thus estimated as Keno flows + 270 cfs.***

2.3.2 Estimated Mid- to Late-Summer Flows by Segment Under the Proposed Action

2.3.2.1 Keno

- Under the Proposed Action, Keno will be the new release point for providing Bureau of Reclamation ESA species flows from UKL. These releases provide the flow regime in all subsequent segments (with additions from tributary or spring accretion).
- Daily flows will be fairly stable in mid- to late-summer, infrequently exceeding 900 cfs or dropping below 500 cfs from July through September. ***The most common flows will be about 700 cfs.***
- Under current Keno operations, dam releases sometimes vary within a day (up to 200 cfs) in response to irrigation diversions or return flows in order to hold Keno Reservoir steady.

2.3.2.2 Big Bend and Hell's Corner

- During the low flow season from July through September, flows will generally be between 800 cfs and 1,100 cfs, with the ***most common flow about 950 cfs.***

2.3.2.3 Ward's Canyon

- During the low flow season from July through September, flows will generally be between 800 cfs and 1,200 cfs, with the ***most common flow about 1,000 cfs.***

Low, median, and high flow estimates for July through September are summarized in Table 2 for all segments. The low and high flows (defined as the 80% and 20% exceedances) are reasonable ***bracket estimates*** for each segment. The median flow is a best single estimate of the typical free flowing river condition as a result of the Proposed Action during mid- to late-summer.

Table 2. Summary of estimated flows from July through September.

Segment	Low estimate 80% exceedance	Median 50% exceedance	High estimate 20% exceedance
Keno	556	703	833
Big Bend and Hell's Corner	796	943	1,073
Ward's Canyon	826	973	1,103

2.3.3 Summary Overview of Upper Klamath Water Storage and Use

Klamath Basin hydrology will remain complex after the four hydroelectric dams are removed. Water will still be stored during winter in Upper Klamath Lake (UKL) basin, with releases through the spring, summer, and early fall. This is part of the US Bureau of Reclamation (BOR) Klamath Project, which will continue to provide for agricultural, domestic, and habitat needs, while modifying the natural flow regime. The following is provided as background for interested readers; more details are available in the Hydrology Analysis.

- *BOR's Klamath Project affects flow in the river through 1) Upper Basin storage and flood control; 2) water deliveries based on an operational system called the Klamath Basin Planning Model (KBPM); and 3) minor modifications during facilities maintenance.*
- *Since 2001, BOR has managed UKL elevations and downstream flows to meet specifications in Biological Opinions (BiOps) prepared by USFWS or NMFS, addressing impacts on endangered Lost River suckers, shortnose suckers, and Coho salmon.*
- *BOR can store over 1.1 million acre-feet in three reservoirs, with most available for agriculture or wildlife habitat. Typical inflow occurs from October through May, with peak storage in April, and no storage from one year to the next. UKL water irrigates approximately 200,000 acres, mostly from April through October on the east side of the lake and river.*
- *Lake elevation and river flow decisions are adjusted monthly using the KBPM, which considers assumptions, analyses, and formulaic thresholds related to snowpack predictions and UKL inflows, reservoir bathymetry, agricultural water rights, waterfowl habitat water rights, groundwater return, accretion flows, sucker lake elevation needs, and downstream flow needs for Coho salmon or other ecological purposes (e.g., to disrupt parasites that may harm fish). Surplus water for instream flow purposes is managed through an Environmental Water Account (EWA).*
- *In general, the model provides Klamath River flows roughly equal to forecasted UKL inflow medians from March through September; the goal is to mimic a natural river hydrograph. The model also defines minimum flows by month, ranging from 900 cfs (July and August) to 1,325 cfs (April).*
- *The EWA can be used to provide supplemental flows for purposes such as surface flushing flows to reduce parasites that cause salmonid disease in warm and drier years, or short-term deep-flushing flows and May-June enhanced flows for Coho salmon habitat in wetter years.*
- *Climate change may affect agricultural withdrawals, return rates, lake evaporation rates, water temperatures, and water quality – all of which could affect the amount of water provided downstream. The current Model does not account for climate change effects, which are likely to include higher temperatures in spring and summer, a smaller snowpack (with more precipitation as rain rather than snow), earlier snow melt, and more frequent rain and snow events in the basin.*
- *The USFWS BiOp (2019) is based on 1981-2016 data (36 years), but the last ten water years better represent recent agricultural, operational, and climate change variables. That 10-year analysis suggests overall flows in Klamath River may be lower in the future, while summer flows may be slightly higher. The causes of these differences could reflect drought cycles, changing agricultural practices, greater water supply for the EWA, impacts from climate change, or a combination of the above.*

2.4 Target Flows for 2020 Assessment

After considering previous assessments, anticipated Proposed Action hydrology, and operational constraints from the existing hydropower project, Confluence identified the following initial target flows and rationales for the Whitewater Boating Study assessment (Table 3).

Table 3. Whitewater Boating Study Target Flows.

Segment	Previous flows assessed	Requested flows in segment	Rationale / comments
Keno	700 cfs	One flow: ~700 cfs	Opportunistic assessment of typical late summer flows; Keno releases cannot be enhanced.
Big Bend / J.C. Boyle Bypass	370 cfs 690 cfs 960 cfs 1,230 cfs 1,480 cfs	Two flows: ~800 cfs ~1,100 cfs	Bracket typical mid- to late-summer flows at the margin of commercially boatable range for small rafts or inflatable kayaks. Assess boatability of Sidecast Slide. Assumes 110 cfs from fish spillway + 230 cfs from springs.
Hell's Corner	370 cfs 730 cfs 1,060 cfs 1,360 cfs 1,750 cfs	Two flows: ~800 cfs ~1,100 cfs	Bracket typical mid- to late-summer flows at the margin of commercially boatable range for small rafts or inflatable kayaks. Assumes 110 cfs from fish spillway + 230 cfs from springs.
Ward's Canyon / Copco No. 2 Bypass	10 cfs 175 cfs 650 cfs 1,200 cfs	Two flows: ~800 cfs ~1,100 cfs	Bracket typical mid- to late-summer flows at margin of commercially boatable range for small rafts or inflatable kayaks. Assess effects of riparian and mid-channel vegetation on boatability.

3.1 Initial and Revised Study Plan

An initial Draft Study Plan was approved in August 2019, with the study scheduled for September. However, PacifiCorp was unable to provide requested flows for operational reasons, and harmful algae blooms in Copco Reservoir compromised safety for boaters in Ward's Canyon. The study was postponed until 2020. A revised Study Plan was completed in April 2020 to address operational issues and other logistics, including protocols for COVID-19.

The final Study Plan is provided here. It covered flow requests, the order of flows to be assessed, daily logistics, access, participants, safety and liability, survey instruments and focus groups, photographic documentation, COVID-19 protocols, and general study practices. These topics are summarized below, along with adjustments made during the study.

3.1.1 Order of Assessments

The Study Plan (Confluence, 2019) developed a logic for assessing flows in a particular order, based on safety and scientific considerations. This order was reconsidered as the study was implemented, in response to Covid and assessment results. Changes in target flows were proposed collectively by Confluence and stakeholders participating in the assessments and agreed upon by PacifiCorp.

- A single opportunistic flow in the Keno segment (about 800 cfs) was evaluated first. Keno had simpler shuttle logistics during the June fieldwork when Covid restrictions were greater.
- In Big Bend, results of assessments from the first flow (about 1,100 cfs) indicated that 1,100 cfs was a marginal flow, and boaters did not need to evaluate the scheduled 800 cfs.
- In Hell's Corner, a higher flow (about 1,100 cfs) was evaluated first, with a lower flow (830 cfs) on the next day. This reduced Covid risks because higher flows were closer to those boaters had seen before.
- In Ward's Canyon the low flow (about 800 cfs) was evaluated first. Based on that assessment, boaters decided higher flows would only improve an already high-quality opportunity; they requested a lower study flow (about 700 cfs) to better identify the low end of the acceptable range.

3.1.2 Daily Logistics

Logistics for the flow study were developed in collaboration with boaters, outfitters, and consultants with knowledge of the area. A detailed Logistics Plan included information about target flows, participants, craft, shuttle and meeting logistics, safety protocols, documentation responsibilities, public use during the assessments, and schedules for study days.

The national COVID-19 outbreak required considerable logistics and scheduling changes. After discussions with PacifiCorp, Renewal Corporation Confluence, Upper Klamath Outfitters Association (UKOA), American Whitewater (AW), and local boaters, the revised schedule separated the study into two parts. June fieldwork was scheduled on Keno and Ward's Canyon because of their easier

whitewater and simpler logistics (e.g., shorter shuttles). Big Bend and Hell's Corner were scheduled for July after COVID-19 restrictions in Klamath and Siskiyou Counties were slightly relaxed.

For Big Bend and Hell's Corner, boaters evaluated both segments at a single flow on the first day, then evaluated a lower flow on Hell's Corner the second day. For the shorter Ward's Canyon Segment, both flows were evaluated in a single day. Details for each segment are provided below.

3.1.2.1 Keno Boating (Tuesday June 9, 2020)

Participants assembled at Pioneer Park East near Spencer Bridge (Highway 66) about 8:00 am. Participants boated the river from about 11 am to 3 pm, with post-run surveys and a focus group discussion at the take-out at Pioneer Park East from 3 to 4 pm.

This assessment did not require operational changes to existing flows. USGS gage just downstream of the dam recorded flows about 800 to 810 cfs from 10:30 am to 2:30 pm while boaters were on the river. Water temperature was about 64 degrees F.

Participants included eleven boaters in ten boats (listed below):

- 6 hard shell kayaks
- 1 inflatable kayak
- 1 oar-based cataraft (1 rower; 14 feet)
- 1 paddle-based cataraft (2 paddlers; 14 feet)
- 1 oar-based raft (1 rower; 14 feet)

3.1.2.2 Ward's Canyon On-Land Scouting (Wednesday June 10, 2020)

The day before boating, participants assessed access at the put-in below Copco No. 2 Dam and scouted Ward's Canyon on foot for in-channel vegetation boating hazards. This reach is within a secured area for hydroelectric operations and is not currently accessible to the public.

3.1.2.3 Ward's Canyon Boating (Thursday June 11, 2020)

Participants assembled at Fall Creek Access on Iron Gate / Copco Road about 9:00 am. Participants boated the two-mile segment at 800 cfs from 10:00 to 11:30 am, and completed post-run surveys, and discussed the experience in the focus group at Fall Creek. Researchers and boaters decided to assess a lower flow than the Study Plan specified (700 cfs) in the afternoon, and the schedule was repeated. Boating occurred from 1 pm to 2:30, and post-run surveys and the focus group from 2:30 to 3:30 at Fall Creek.

Participants included ten boaters in eight boats (listed below):

- 3 hard shell kayaks
- 1 oar-based cataraft (1 rower; 14 feet)
- 1 paddle-based cataraft (2 paddlers; 14 feet)
- 3 oar-based rafts (1 rower each with a passenger in one raft; 14 feet)

3.1.2.4 Big Bend and Hell's Corner Boating (July 15, 2020)

Participants assembled near the Timber Bridge put-in downstream of J.C. Boyle Dam about 8 am. The target flow of about 1,100 cfs (860 cfs over the dam plus 240 cfs accretion from springs) was released starting at 7 am. Boating on stabilized flows in ***Big Bend*** began about 9 am and included lining/portaging at Sidecast Slide, and resolution of a pinned kayak just upstream of Heart of Boyle Rapid that put the group slightly behind schedule.

As scheduled, flows over the dam were shifted to flows through the powerhouse for the Hell's Corner assessment about 10:45 am. The changeover appears to have reduced flows for boaters in the last mile of the Big Bend segment, probably to about 950 cfs, approximately fifteen percent less than the target 1,100 cfs. A raft was stuck on a rock near the end of the reach, and boaters arrived at Spring Island just after noon. Detailed flow information from PacifiCorp was requested to verify the verbal estimates, but have not been available by the date of this report.

After the July 15 assessment at 950 to 1,100 cfs, study participants collectively decided to forego additional assessments of the Big Bend reach at a lower flow and focus attention on Hell's Corner.

We checked to ensure that powerhouse target flows were stabilized for the Hell's Corner segment. On the first day, the USGS gage recorded flows from 1,050 to 1,170 cfs in the afternoon, with an average of 1,090 cfs (very close to the 1,100 cfs target). Boaters continued downstream about 1:00 pm, reaching Caldera about 2:30 pm, Hell's Corner rapid about 3:30 pm, Stateline about 5:00 pm, and the take-out at Access Number 6 about 5:30 pm. Boaters completed surveys for both segments and participated in a focus group from 6:00 to 7:00 pm.

On July 15, participants included nine boaters in nine boats (listed below):

- 4 hard shell kayaks
- 1 oar-based cataraft (1 rower; 14 feet)
- 4 oar-based rafts (1 rower each; 14 feet)

3.1.2.5 Hell's Corner Boating (July 16, 2020)

Participants assembled at Spring Island about 9:00 am. Based on USGS gage information, target flows about 830 cfs were released at 9:00 am. Boating on stabilized flows began about 10 am and included scouting at Caldera and Hell's Corner rapids. Boaters reached the take-out at Access 6 about 4:00 pm, and they completed surveys and a focus group from 4:30 to 5:30 pm.

On the second day of the study, seven boaters participated in seven boats (listed below):

- 2 hard shell kayaks
- 1 oar-based cataraft (1 rower; 14 feet)
- 4 oar-based rafts (1 rower each; 14 feet)

3.1.3 Access and Other Considerations

The Study Plan (Confluence, 2019) recognized requirements outlined in the PacifiCorp Access Agreement, although two exceptions were needed, along with formal waivers from all participants. First, the study required road access to the river right put-in on the Keno Segment. Second, the study required access in Ward's Canyon and releases from Copco No. 1 and Copco No. 2 dams. The road to Copco No. 2 Dam is gated, and boaters launched down a steep bank at the dam on river right.

3.1.4 Participants

Given COVID-19 conditions in summer 2020, Confluence reduced participation after consultation with stakeholders. We worked with AW and UKOA to develop a representative panel of craft that included hard shell and inflatable kayaks, small catarafts, and self-bailing rafts. Rafts ranged in size from about 10 to 14 feet, most rigged for 1-person center rowing to reduce COVID-19 risk. Outfitters were encouraged to bring craft they considered commercially viable. Commercial rafters were organized by UKOA (limit of two from any one company), other boaters were invited by AW, and participants included BLM staff.

3.1.5 Safety and Liability

Confluence worked with UKOA and AW to develop a list of participants, and a boating safety plan. All were strong Class IV-V boaters with commensurate self-rescue skills. Safety issues included Class IV+ whitewater, poison oak, in-channel vegetation, and undeveloped access below Boyle and Copco No. 2 Dams.

Participants were responsible for bringing their own boating and safety gear in good working condition, along with agreements about group gear. Participants signed liability waivers developed by AW and UKOA with review by PacifiCorp and Renewal Corporation. The boating safety plan was developed by UKOA and AW with review by PacifiCorp and Renewal Corporation.

3.1.6 Survey Instruments and Focus Groups

Flow evaluation data was developed from surveys of participants, who answered questions before the study, after boating the river segment at each flow, and after they had observed all flows. Survey question format and content followed from the literature and several previous studies, including relicensing studies from 2004 (surveys are in Appendix C).

Focus groups occurred after surveys were completed for each segment. On days with multiple flows, separate discussions occurred after each. Focus groups covered the advantages and disadvantages of each flow, commercial viability of different craft and flows, and access and vegetation issues. The final close-out focus group included other management issues (e.g., facility development and carrying capacity).

3.1.7 Photographic Documentation

Confluence and stakeholders took photos and videos during the study to show changes in rapids or other features. Most were taken opportunistically, although a few key observation points (KOPs) were identified. The "best of" still photos are presented in a photo summary with extended captions to illustrate study findings.

3.1.8 Shuttles, Rafts, Food, and Accommodation

Due to COVID-19 considerations, Confluence hired outfitters to handle shuttles for individual study participants on Big Bend and Hell's Corner assessment days, and participants handled their own shuttles (including conducting bicycle shuttles) for Keno and Ward's Canyon. Participants were responsible for their own food throughout.

3.1.9 General Study Practices

Commonly accepted methodologies for studying flow-dependent resource values were followed (Whittaker, Shelby, and Gangemi 2005; Whittaker and Shelby 2002; Whittaker et al. 1993). Interviews and focus groups were conducted by researchers with social science training and followed standard quantitative and qualitative protocols. Researchers had experience with interviews and focus groups from previous studies, and used questions tested and refined in previous work. Similarly, survey questions were tested and used in several previous studies and addressed concerns about strategic responses (see Appendix C for survey instruments).

3.1.10 Study protocols to address COVID-19

The study developed a 14-page COVID-19 mitigation plan that listed Oregon/California and Siskiyou/Klamath County regulations, protocols to address them, and participant responsibilities. Confluence staff was appointed to establish, implement, and enforce distancing, sanitation, and other protocols. Key example protocols from the mitigation plan are listed below. No participant reported symptoms or confirmed infections from COVID-19 due to the study fieldwork.

- Boating and on-land components of the study were limited to 12 participants.
- Masks and distancing were used throughout (e.g., during shuttles, rigging, group discussions).
- Participants traveled by minimum distance routes and limited interactions to gas and take-out food.
- Participants were organized into pods responsible for their own logistics (boats, vehicles, and equipment). Pods were groups that live/work closely and were already together. Outfitters, AW, and CRC organized pods for their organizations.
- Participants completed online pre-trip questions about recent travel and health to eliminate those with COVID symptoms. CRC maintained a log of all participants in case contact tracing was necessary.
- Each participant printed an online liability waiver that included COVID warnings.

- Participants were instructed to bring personal equipment such as pens, hand sanitizer, boating gear, protective clothing, and human waste systems.
- Meeting and launch locations were chosen to maximize space for distancing.
- Participants brought their own food and beverages, no sharing between pods.
- No exchange of camping or cooking equipment, no “communal” entities such as water jugs or snack bags.

4 Results

4.1 Keno

4.1.1 Values

Whitewater Boater Study participants reported Keno segment offers Class II/III whitewater, forested and high desert scenery, and outstanding fishing and bird watching. It is isolated from roads and other development except near the dam and a transmission line crossing. There is one more challenging rapid known as Meatball at the end of the segment, but most are Class II+, distinctly less challenging than Big Bend, Hell's Corner, and Ward's Canyon.

4.1.2 Trip Types / Craft / Skill

At the Whitewater Boater Study flow of 800 cfs below Keno Dam, the segment's Class II/III rapids are ***well-suited for hard shell kayak trips***, particularly instructional trips for beginners or intermediates. Varied features and abundant eddies provide excellent opportunities for skill building.

After the completion of the Proposed Action flows in the segment offers ***marginal opportunities for outfitted trips***, particularly in larger rafts. Few rapids have strong hydraulics or large waves, and several reaches have shallow boulder gardens that produce multiple hits and stops for lightly loaded rafts.

Although some outfitters considered this flow and segment suitable for ***challenging inflatable kayaking*** among clients with more experience, others were less sure about demand for or risks of such trips. Several rapids require more than a single move to avoid obstacles and linking several moves in a complex rapid is challenging for less experienced boaters. Outfitters thought such trips would need safety set-ups at key locations to provide directions, physically redirect boats, or retrieve people or boats in case of mishaps.

4.1.3 Description of Flows

Boaters considered the ***800 cfs study flow close to the low end of the boatable range***. Although some suggested 500 cfs can be boated in a two-person raft, hard shell kayak, or inflatable kayak, the challenge and pace of the trip would be marginal. Major problems include the first half mile below the dam and the lower two-thirds of the segment, which have wide and rocky channels that would produce multiple hits and stops even with constant vigilance.

Boaters reported that flows in Keno occasionally drop several hundred cfs within a single day, which further limits the potential for outfitted trips. Trips at 800 cfs are already marginal; a drop of 200 cfs could leave some craft high and dry in shallower reaches.

Boaters thought whitewater trips would improve at higher flows. Rapids would be faster and more continuous, with stronger hydraulics and larger waves, and many rocks exposed at the study flow would be covered with a few hundred cfs more water. The segment might be suitable for guided paddle rafts about 1,200 cfs, offering a mellower alternative to the more challenging rapids in Hell's Corner. At flows over 2,000 cfs, whitewater would become continuous and offer a big water opportunity. While this might be in demand for higher skilled boaters (especially kayakers playboating on the Keno Wave), these flows are probably unsuitable for guided raft trips.

4.1.4 Boatability

At the Whitewater Boater Study flow, kayakers reported a median of 20 hits and one stop for the segment (with no boat drags or portages). Rafters reported a median of 31 hits and three stops (with no boat drags or portages). Hits are a less obtrusive condition, with boaters' tolerances between 10 and 80 per segment, although three rafters and two kayakers reported that numbers of hits do not matter. Tolerances for stops ranged from 3 to 20 per segment, with only two kayakers reporting that stops do not matter to them.

4.1.5 Flow Evaluation Curves

Boaters were asked to evaluate a range of flows on the close-out survey. Ratings were on a seven-point scale from "totally unacceptable" to "totally acceptable," with a "marginal" mid-point. Flow evaluation curves are based on mean evaluations of each flow, plotted separately for rafts and kayaks (Figure 1).

- Findings indicate late summer flows about ***800 cfs are marginal for kayaks and unacceptable rafts***. This fits with post-run focus group discussion.
- Rafting is marginal about 1,100 cfs, becoming acceptable about 1,300 cfs and optimal about 1,400 cfs.
- Ratings were higher for kayaks than for rafts below 1,400 cfs.

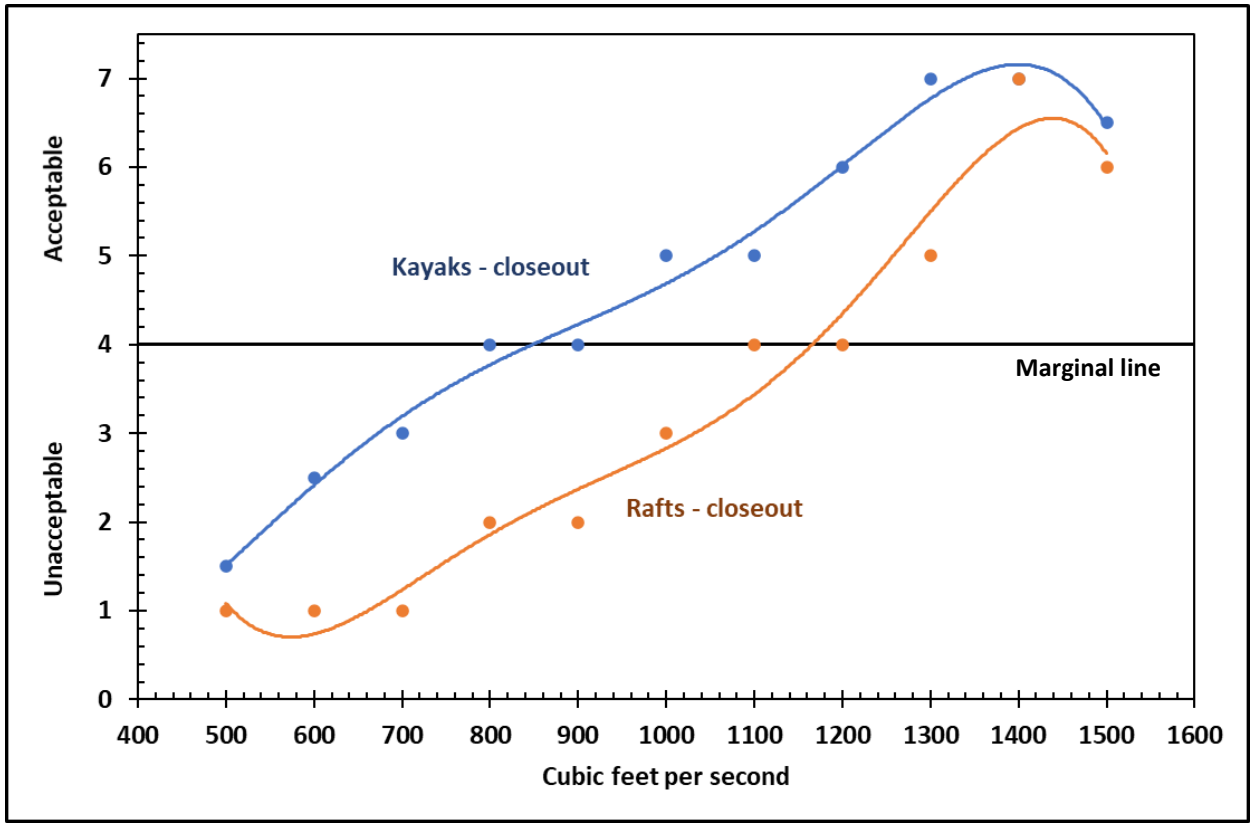


Figure 3. Keno flow evaluation curves.

4.1.6 Specified Flows

Boaters were asked to specify flows for different types of trips on this segment. Figure 2 summarizes the low end and optimal ranges for several opportunities, based on mean responses.

- Findings indicate that late summer flows about ***700 to 900 cfs below Keno Dam provide technical kayaking and rafting.***
- ***Standard kayaking*** is available from ***900 to 1,200 cfs.***
- Higher flows are needed to provide ***standard rafting trips***, which are available from about ***1,200 cfs to 2,000 cfs.*** In most years these flows will be available only in spring and early summer.
- ***Big water boating*** is starts about 1,500 for kayaks and about 2,200 cfs for rafts. In most years, these flows will be available only from March through May.

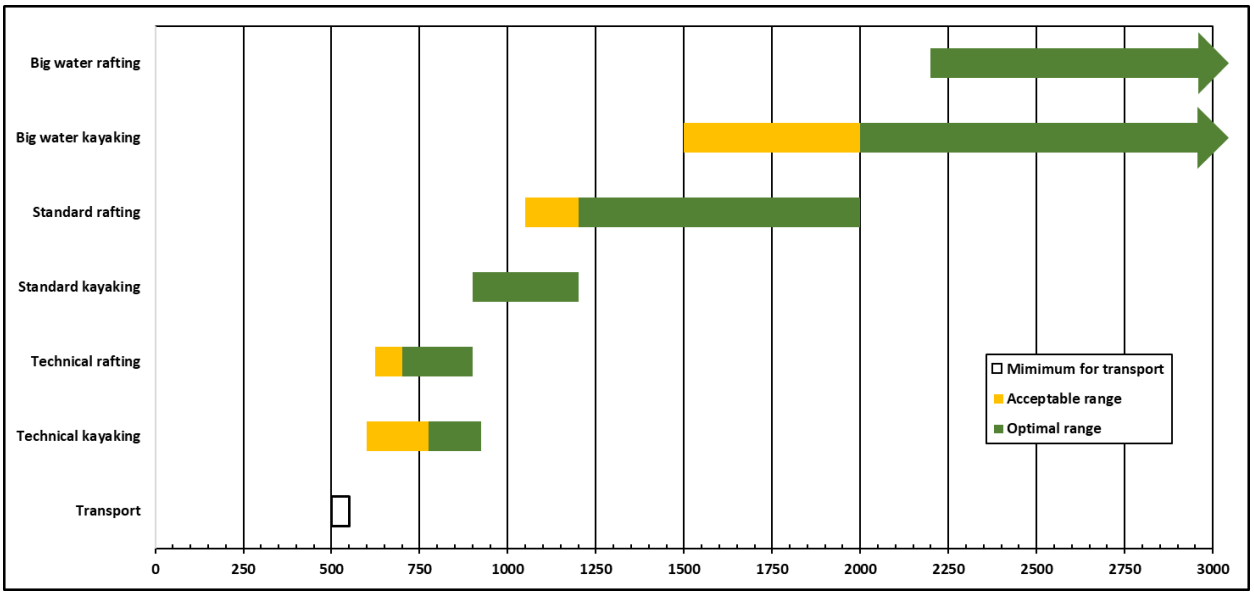


Figure 4. Specified flow ranges for Keno.

4.1.7 Other Boatability Considerations

Connecting segments

Keno could be connected with Big Bend, Hell's Corner, and Ward's Canyon segments downstream to produce a longer trip. For example, from Keno Dam it is about 8 miles to Topsy Campground, 8.5 to the Timber Bridge put-in for Big Bend, 13 to Spring Island, 16 to Klamath River Campground, 18.5 to Frain Ranch, 23 to Stateline, 25 to Access No. 6, 29 to Access No. 1, 35 the start of Ward's Canyon, and 37 to Fall Creek. Parts of these connected segments might be done as a long one-day trip by experienced kayakers or rafters, but they could also be a two- or three-day trip with camping. Participants raised the following considerations.

- Flows about 1,500 cfs would be needed to minimize boatability problems and improve travel speed, especially if boats are carrying camping equipment.
- Rapids are considerably more difficult in Big Bend, Hell's Corner, and Ward's Canyon, so combining them with the easier rapids in Keno is a mismatch in terms of difficulty.
- Camping requires either utilizing vehicle-accessible camps or carrying gear in boats. At present there are few campsites along the river, and some are not ideal locations for evenly spaced multi-day trips. The most likely existing camping options include Klamath River Campground or Frain Ranch after a first day of boating, and downstream of Stateline after a second. BLM's Topsy Campground probably comes too soon in the trip, and its sites will be farther from the river after J. C. Boyle Reservoir is drawn down. A drawn-down Copco Reservoir may reveal additional sites, but that is uncertain. Another option is to develop new camps, as one outfitter has done in Hell's Corner, but identifying sites and type of access (boat vs. vehicle) may involve permitting challenges. Outfitters were not enthusiastic about carrying gear in loaded rafts in challenging Big Bend and Hell's Corner, although non-commercial boaters might show more interest in these trips.
- Given these issues, flows in Keno alone are probably not the limiting factor. The requisite 1,500 cfs will be available only during higher flow times, and suitable camping locations and sites (e.g., campgrounds in appropriate locations, or river-accessible camps uncovered by the J. C. Boyle Reservoir drawdown).

Access

For ***put-in access,*** boaters considered the existing river-right site below Keno Dam acceptable, although the last mile of road is one-way and very rough, and it requires travel through a residential area. On river left the bank is steeper, but a put-in could be developed. This would utilize better roads through the existing PacifiCorp Campground, and would be closer to Highway 66 to shorten the shuttle to the take-out. Improvements would probably include a boat slide or trail from the bluff to the river; a trailer-accessible road may not be a low-cost option due to steepness.

Existing ***take-out access*** at Pioneer Park East is acceptable but includes about a mile of flat water on J.C. Boyle Reservoir. There is uncertainty about river gradients through the former reservoir or the location of the last Keno Rapids. Preliminary assessments based on lake bathymetry and topography suggest the

channel may widen downstream of Meatball Rapid, with moving water and possibly Class II rapids in route to Highway 66 or Boyle Dam.

Boaters thought it was premature to invest substantial infrastructure resources in new access near J.C. Boyle Dam, Pioneer Park East or West, or Topsy Campground, given uncertainty about the area under the reservoir after dam removal. Proposed fire access at the Highway 66 bridge (at Pioneer Park West) and the existing gravel lot and launch at Pioneer Park East will probably accommodate demand in the short run. Boaters indicated that any campgrounds or access improvements in this area will likely be utilized.

4.2 Big Bend

4.2.1 Values

Whitewater Boater Study participants reported Big Bend segment offers technical Class IV/V whitewater in a more confined canyon, with interesting scenery and some sense of isolation (currently impacted by the road and canal in the upper reach). It has narrow, large-boulder rapids that are more difficult than those upstream in Keno, and different in character from the more continuous lava-substrate rapids downstream in Hell's Corner. It has some in-channel and riparian vegetation (mostly brush and nettles) probably due to low by-pass flow regimes, which may be improved by annual high-flow events.

4.2.2 Trip Types / Craft / Skill

Whitewater Boating Study flow flows ranged from 950 to 1,100 cfs, including accretion. At these flows Big Bend's Class IV/V rapids are ***well-suited for hard-shell kayaks and small rafts***, but rapids may be too technical for large or outfitted rafts. Most rapids have narrow, technical lines, and some have strong hydraulics and larger waves.

Big Bend is likely to attract locals from the Rogue Valley and Klamath Falls, and travelling boaters visiting nearby destinations in Oregon and California (e.g., Illinois, Rogue, Smith, Salmon, or Middle Klamath). This summer flow is well-suited for ***kayakers' first trips*** on the segment, with good eddies for boat scouting.

Boaters indicated that ***Big Bend may offer a viable commercial raft trip***, but probably requires more water than the Whitewater Boating Study flow (see discussion below). Concerns included complex lines through rapids, several pinning or wrapping hazards, and the continuous whitewater.

4.2.3 Description of Flows

Boaters reported the ***950 to 1,100 cfs study flow near the low end of the acceptable range for rafts***. Although kayakers thought they could get down the river around 500 cfs, such flows would be attractive only to low flow boating aficionados. The major problems are pinning/wrapping hazards in Sidecast Slide and a few other rapids. For rafts, infrequent eddies in longer complex rapids are a challenge at lower flows. As noted in the methods section, Whitewater Boater Study flows decreased during the last part of this segment. This led boaters to conclude that a flow lower than 1,100 cfs would be unacceptable for most local and outfitter whitewater opportunities, obviating the need to assess a lower flow.

Boaters indicated that ***whitewater trips would improve at higher flows.*** Rapids would be more continuous with stronger hydraulics and larger waves, but probably would have multiple lines, more margin for error, and fewer pinning/wrapping hazards. The segment is likely to be ***optimal for larger or outfitted rafts about 1,500 cfs***, similar to the one-turbine peaking flows in Hell's Canyon, especially as boaters learn lines through the complex rapids. As flows increase from ***1,500 to 2,000 cfs***, the whitewater would become more continuous and ***transition to a big water opportunity***. This would

probably be more attractive for experienced private boaters, but less so for guided trips. As shown in the annual hydrograph (Figure 1), under the Proposed Action these flows will typically be available from March through May.

4.2.4 Boatability

At the study flow, kayakers reported a median of 25 hits and one stop for the segment (with no boat drags or portages, although one kayak pinned in one rapid). Rafters reported a median of 37 hits, four stops, and two boat drags (with one raft wrapped in one rapid). Hits are a less obtrusive condition, with boaters' tolerances between 10 and 50 for the segment, although one kayaker reported the number of hits does not matter. Tolerances ranged from 1 to 10 stops, and 0 to 5 boat drags per trip. The pinned kayak and wrapped raft were resolved in about fifteen minutes (with single line pulls and no mechanical advantage rigging).

Four of the nine boaters portaged Sidecast Slide (part lining and the remainder in-channel portaging). One rafter and all but one of the kayakers ran this rapid (all had some hits or stops). Boaters thought this rapid would not exist naturally, and it appeared that road/canal erosion debris is the main source of the overall constriction and pinning hazards. Although fish passage improvements (from early implementation of KHSA measures circa 2013) apparently have reduced sizes of a few boulders in the river right boating line, two to three remaining couch-sized boulders need to be fragmented or removed to provide clear boating channels at the study flow.

4.2.5 Flow Evaluation Curves

Boaters were asked to evaluate a range of flows on the close-out survey. Ratings were on a seven-point scale from "totally unacceptable" to "totally acceptable," with a "marginal" mid-point. Flow evaluation curves are based on mean evaluations of each flow, plotted separately for rafts and kayaks (Figure 3).

- Findings indicate that late summer flows about ***1,100 cfs are acceptable but not optimal for kayaks, and marginal for rafts***. This fits with post-run focus group discussions.
- Kayak ratings were higher than for rafts through most of the range, with similar evaluations only at the highest flows (1,500 cfs).
- The lower late-summer flows (about 900 cfs) are marginal for kayaks, unacceptable for rafts.

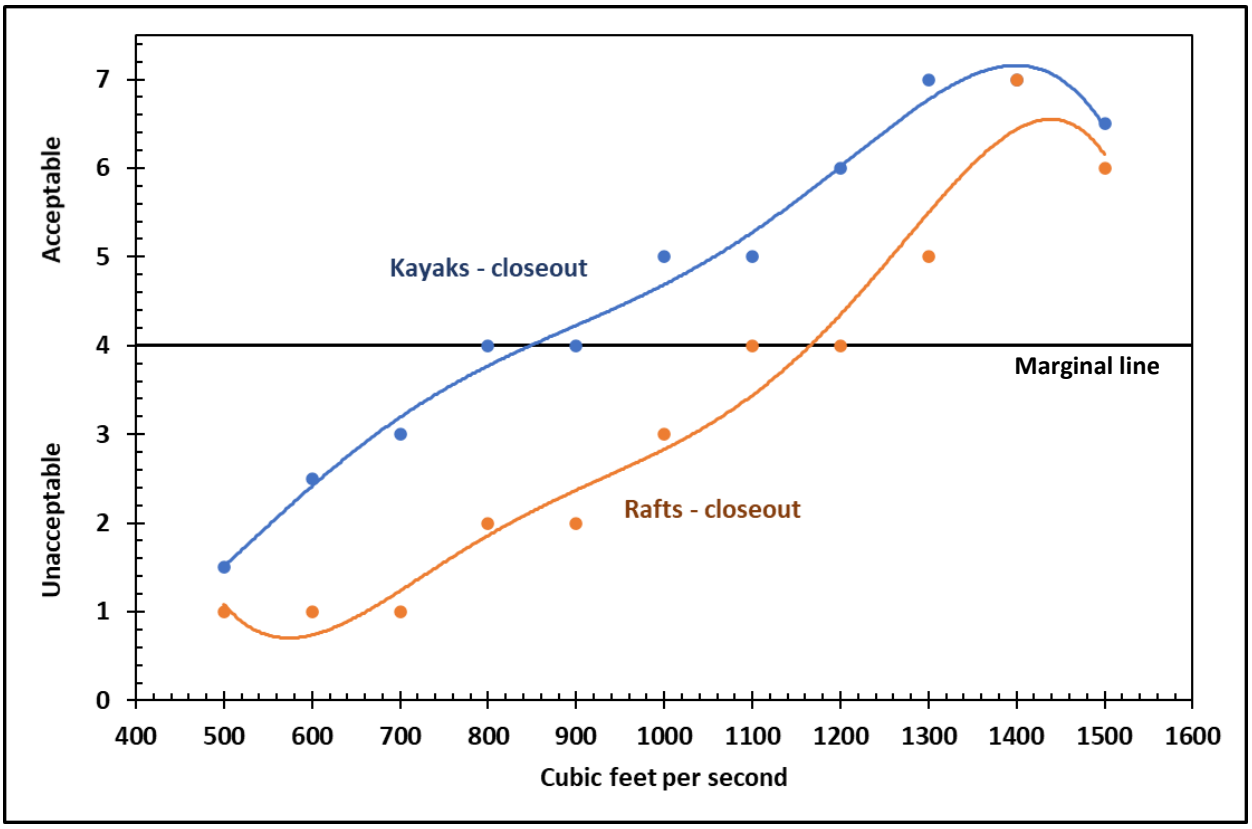


Figure 5. Big Bend flow evaluation curves.

4.2.6 Specified Flows

Boaters were asked to specify flows for different types of trips on this segment. Figure 4 summarizes the low end and optimal ranges, based on mean responses.

- Findings indicate late summer flows about ***700 to 1,200 cfs would provide technical kayaking and rafting trips.***
- Higher flows about ***1,200 to 1,700 cfs provide standard kayaking and rafting trips.***
- ***Big water boating*** is available at higher flows, above 2,200 cfs for kayaks and about 1,700 cfs for rafts. These opportunities will be available only at spring high flows.
- As shown in the annual hydrograph (Figure 1 on page 18), these flows will be available in most years from March through May.

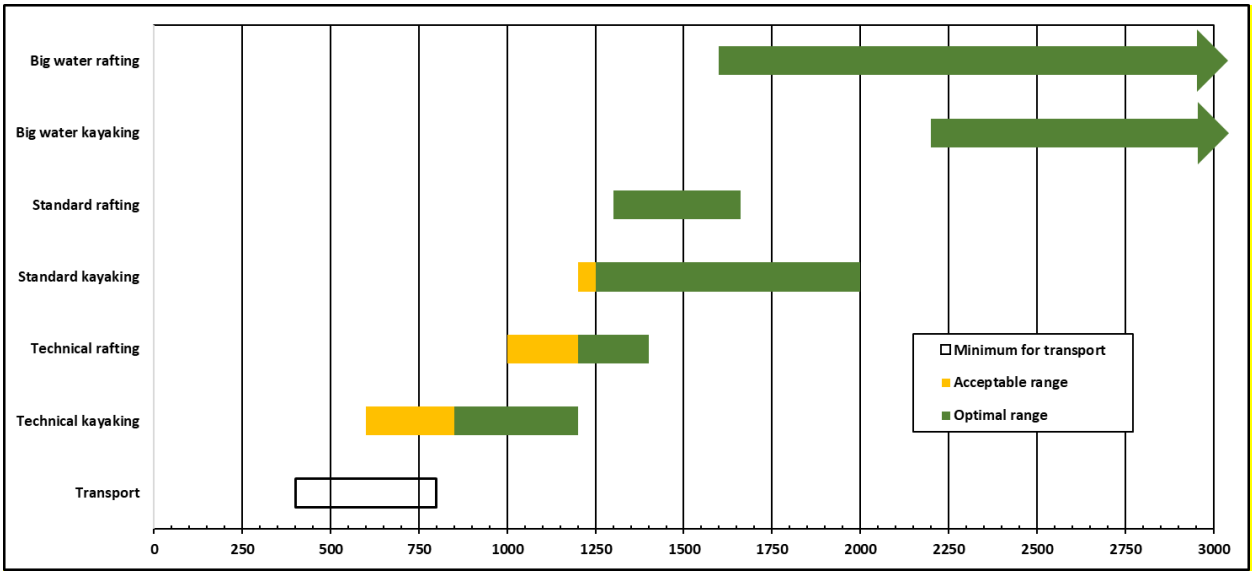


Figure 6. Specified flow ranges for Big Bend.

4.2.7 Other Boatability Considerations

Connecting segments

- Under the Proposed Action, Big Bend is most likely to be combined with Hell's Corner to produce a longer trip. For example, from Timber Bridge put-in it is almost five miles to Spring Island, eight miles to Klamath River Campground, 10.5 miles to Frain Ranch, 15 miles to Stateline, 17 miles to Access No. 6, 21 miles to Access No. 1, 27 miles to the start of Ward's Canyon, and 29 miles to Fall Creek. Parts of these connected segments might be done as a long one-day trip by experienced kayakers or rafters, but they could also be a two- or three-day trip with camping. Participants raised the following considerations.
- Flows about 1,500 cfs would be needed minimize boatability problems and improve travel speed, especially if boats are carrying camping equipment.
- Rapids in Big Bend and Hell's Corner are different in character but similar in difficulty, so combining these segments makes sense in terms of whitewater challenge.
- The Timber Bridge put-in is closer to Highway 66, shortening the shuttle compared to Hell's Corner only.
- Camping requires either utilizing vehicle-accessible camps or carrying gear in boats. At present there are no campgrounds in Big Bend, so the most likely existing camping options are at BLM's Klamath River Campground (three miles downstream of Spring Island) or dispersed camping at Frain Ranch (two more miles).
- This situation might change if new campgrounds are developed. Another option is to develop new camps, as one outfitter has done in Hell's Corner, but identifying sites and type of access (boat vs. vehicle) may involve permitting challenges. Outfitters were not enthusiastic about carrying gear in loaded rafts in challenging Big Bend and Hell's Corner, although private boaters might show more interest in these trips.
- Given these issues, late summer flows in Big Bend are probably not the limiting factor because requisite 1,500 cfs flows will be available only from March to May in most years. If recreation use of this segment develops over time, suitable camping locations and sites may need further attention.

Access

For ***put-in access,*** boaters considered the Timber Bridge site on river right below J.C. Boyle Dam acceptable. The trail/bank is steep and undeveloped, so a raft slide and/or graded trail might be needed if use increases. Leaving the bridge in place provides access to river left side, but this could increase competition for parking if the site attracts other non-boating recreation too.

Existing ***take-out access*** at Spring Island is excellent, but this site could have congestion and parking competition problems if use increased. The tight turn into Spring Island (requiring vehicles with trailers to travel a few hundred yards farther downstream to a turnaround area) remains a safety concern for outfitters.

Gaging

The Proposed Action will remove J.C. Boyle Dam and Powerhouse, so there will no longer be a flow compliance requirement for the PacifiCorp gage below the dam or the USGS gage 115107000 below J.C. Boyle Powerhouse. Funding for the USGS gage is undetermined at the time of this report, but if both gages were removed, flows in Big Bend can be estimated by adding about 240 cfs (to account for spring accretion) to the flow at the USGS 11509500 gage below Keno Dam.

Sidecast Slide

Kayakers found a boatable line in this rapid at low summer flows, but there are several non-natural hazards. Although one rafter (with no passengers) ran this rapid, it was marginal to unacceptable and the other rafters elected to portage. Fish passage modifications may have improved the channel for fish, but several large boulders remain in the center-left boating line; fragmenting techniques used for the fish passage modifications would probably be successful.

4.3 Hell's Corner

4.3.1 Values

Study participants reported Hell's Corner offers outstanding Class IV/V whitewater and good scenery in a backcountry setting, with a few dispersed camping areas such as Frain Ranch. The channel runs over old lava flows in Klamath Canyon, and many rapids have steep gradients and complex boulder configurations. Toward the end of the segment rapids become are more pool-drop, some influenced by Native American weirs built for irrigated agriculture.

4.3.2 Trip Types / Craft / Skill

Daily hydroelectric peaking flows of 1,500 to 1,700 cfs have provided dependably excellent summer whitewater in Hell's Corner for years. This segment attracts considerable guided rafting use from the Ashland-Medford area, local boaters from Oregon and California, and traveling boaters visiting nearby destinations (e.g., Rogue, Illinois, Smith, Salmon, or Middle Klamath Rivers).

At study flows of 1,100 cfs and 800 cfs, Hell's Corner's Class IV/V rapids are ***acceptable for hard-shell kayaks and small rafts.*** Although some rapids (especially Caldera) still have strong hydraulics, most have narrow, technical lines that are challenging for large rafts or those with full loads of commercial passengers. Total annual boating use on Hell's Corner is likely to decrease because there will be fewer days of high quality whitewater in summer, even though some boaters will shift their season of use from summer to winter/spring.

Participants indicated that ***Hell's Corner may continue to support commercial trips***, but they may involve smaller boats (12- to 13- foot rafts or inflatable kayaks), fewer passengers, or more water than the study flows (see discussion below). Concerns included complex lines through rapids, pinning or wrapping hazards, continuous whitewater, and higher skill levels required from guides and passengers.

Participants reported that study flows produced smaller and less powerful hydraulics than typical peaking flows of 1,500 to 1,700 cfs. Boaters discussed whether difficulty ratings should be downgraded for lower flows, but generally agreed that Class V skills are appropriate. For example, Class V Caldera and Hell's Corner rapids are easier to maneuver with more eddies and weaker hydraulics, but they have more pinning/wrapping hazards.

4.3.3 Description of Flows

Boaters reported the ***800 and 1,100 cfs Whitewater Boater Study flows were at the low end of the acceptable range for rafts***. Kayakers reported they could probably boat the river at even lower flows, but there was little enthusiasm for smaller waves, weaker hydraulics, and more abundant boatability problems. Even among guides who know lines through rapids from near-daily experience, the margins for error are small. Trips at these flows will have multiple hits and occasional stops, which are tough on gear and hazardous for passengers.

Boaters indicated that ***whitewater trips improve at higher flows.*** Rapids are more continuous with stronger hydraulics and larger waves, but develop easier lines, more margin for error, and have fewer pinning/wrapping hazards. The segment is ***optimal for larger or outfitted rafts from about 1,500 to 1,700 cfs.*** As flows increase from ***1,500 to 3,000 cfs***, whitewater in Hell's Corner becomes more continuous and ***transitions to big water boating***. Under the Proposed Action, these higher flows will be available during high water periods, typically from about March through May.

Boaters described differences between 800 and 1,100 cfs, some of which were specific to individual rapids. In general, the lower flow produced more limited route options, more technical lines, and more rocks that were easier to hit. Several mentioned that neither study flow offered the "fluffy" large waves that guides expect at peaking flows, even in small rapids.

4.3.4 Boatability

At 1,100 cfs, kayakers reported a median of 7.5 hits and no stops, boat drags, or portages, while rafters reported a median 6 hits and no stops, boat drags, or portages. There were slightly more boatability problems at 800 cfs: kayakers reported a median 10 hits and one stop, rafters reported a median of 20 hits and 1 stop. Two rafters reported boat drags (getting out to pull their boat off a rock) at 800 cfs.

Hits are a less obtrusive condition, with boaters' tolerances between 10 and 100 for the segment (median of 27.5), although one kayaker reported the number of hits does not matter. Tolerances for stops ranged from 1 to 10 per trip, and from 0 to 5 for boat drags. Boaters conducted on-land scouting at Caldera and Hell's Corner Rapids, and one raft was wrapped in Ambush Rapid (resolved quickly without mechanical advantage rigging).

4.3.5 Flow Evaluation Curves

Boaters were asked to evaluate a range of flows on the close-out survey. Ratings were on a seven-point scale from "totally unacceptable" to "totally acceptable," with a "marginal" mid-point. Flow evaluation curves are based on mean evaluations of each flow, plotted separately for rafts and kayaks (Figure 5).

- Findings indicate late summer flow about ***900 cfs is acceptable but not optimal for kayaks, and marginal for rafts***.
- Ratings were ***higher for kayaks than for rafts through most of the range***, with similar evaluations only at the highest flows (1,400 to 1,500 cfs).
- The ***marginal point*** where flows go from acceptable to unacceptable was about 700 cfs for kayaks and 900 cfs for rafts.

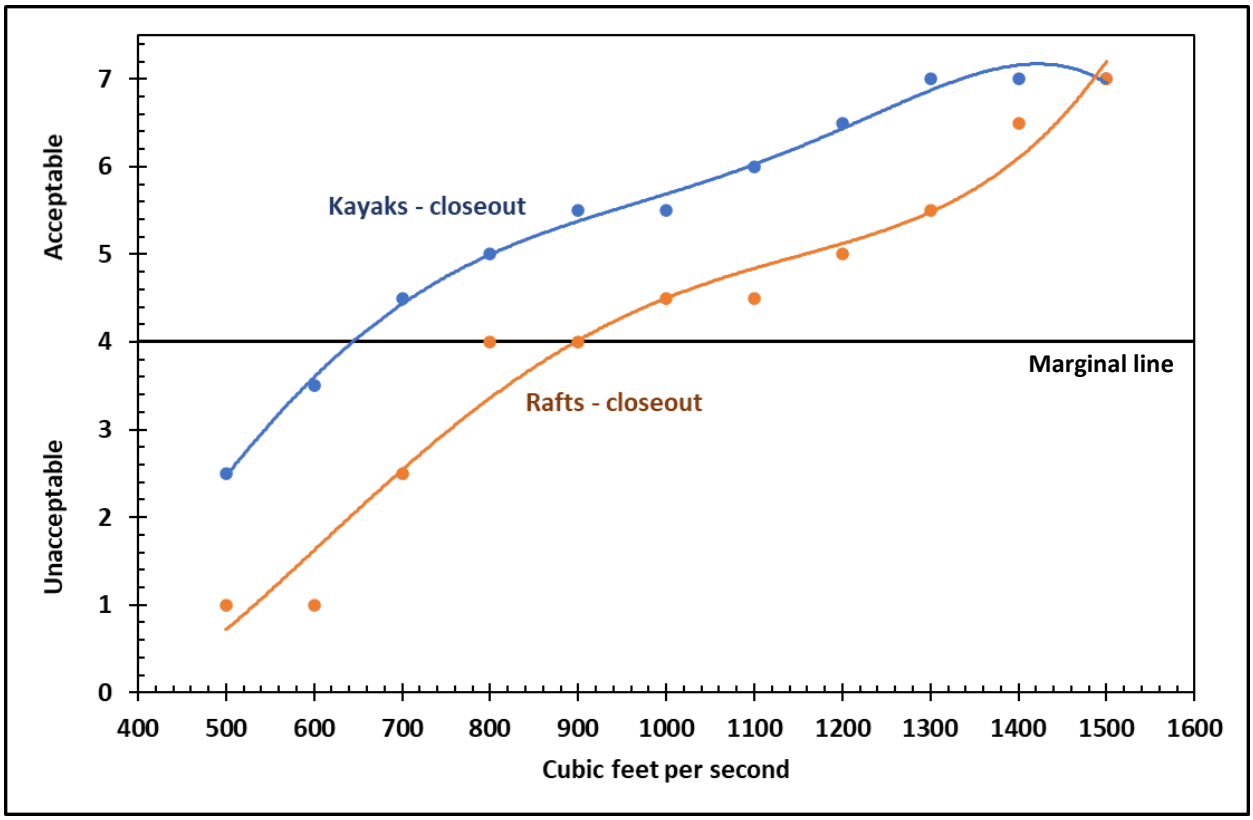


Figure 7. Hell's Corner flow evaluation curves.

4.3.6 Specified Flows

Boaters were asked to specify flows for different types of trips on this segment. Figure 6 summarizes the low end and optimal ranges for several opportunities, based on mean responses.

- Findings indicate summer flows about ***700 to 1,100 cfs would provide technical rafting and kayaking trips.***
- Higher flows are required for ***standard rafting, which starts around 1,400 cfs.***
- ***Big water boating*** is available at higher flows, starting about 2,000 cfs for kayaks and about 2,200 cfs for rafts.
- In most years, these higher flows will be available from March through May.

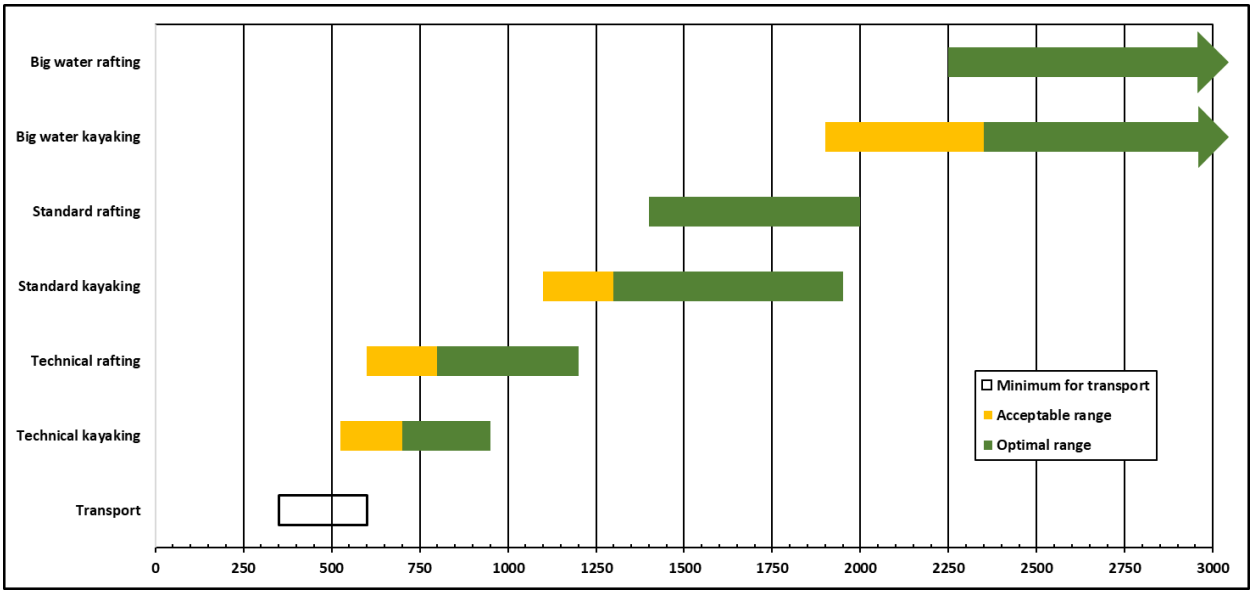


Figure 8. Specified flow ranges for Hell's Corner.

4.3.7 Other Boatability Considerations

Connecting segments

Boaters may be able to connect Hell's Corner with Big Bend or Ward's Canyon, with the following considerations.

- Flows about 1,500 cfs are needed to minimize boatability problems and improve travel speed, especially with heavily loaded boats. In most years, these trips will be available from March through May; in wetter years they may persist into June.
- Rapids in Big Bend and Hell's Corner are different in character but similar in difficulty, so combining these segments makes sense in terms of whitewater challenge.
- Camping requires either utilizing vehicle-accessible camps or carrying gear in boats. Existing developed camping at BLM's Klamath River Campground (three miles downstream of Spring Island) or dispersed camping at Frain Ranch (two miles farther) will probably see increased use from boaters connecting these segments.
- New camping options might be developed to help with lower summer flows or longer multi-day trips. Road accessible camps similar to the remote area used by a Hell's Corner outfitter would involve identifying suitable sites and overcoming permitting challenges. Outfitters were not enthusiastic about rafts loaded with camping gear in Big Bend and Hell's Corner, although private boaters might show more interest.
- Given these issues, returning the Klamath River to lower near-natural summer flows in Hell's Corner are probably not the limiting factor. The requisite 1,500 flows will be available only during higher flow times and camping locations and logistics will need further attention.

Access

Put-in access at Spring Island remains excellent, with only minor complaints about the tight turnaround from the access road. If use increased, however, this site has limited parking. ***Take-out access*** at Stateline, Access No. 6, and Access No. 1 is conveniently located, but all are small, undeveloped sites. If use increases or use patterns change, better organization and small-scale developments would probably be supported by boaters.

Gaging

The Proposed Action will remove J.C. Boyle Dam and Powerhouse, so there will no longer be a flow compliance requirement for the PacifiCorp gage below the dam or the USGS gage 115107000 below J.C Boyle Powerhouse. Funding for the USGS gage is undetermined at the time of this report, but if both gages were removed, flows in Hell's Corner can be estimated by adding about 240 cfs (to account for spring accretion) to the flow at the USGS 11509500 gage below Keno dam.

4.4 Ward's Canyon

4.4.1 Values

Whitewater Boating Study participants reported that Ward's Canyon offers Class III/IV whitewater, outstanding basalt canyon scenery, and fine wildlife viewing (including two great blue heron rookeries). In contrast to upstream segments, Ward's Canyon is a dramatic, narrow, steep-walled gorge. Even though it is only two miles long and has a nearby upland road and dam/powerhouse development at both ends, the river feels isolated and undeveloped. The rapids are pool-drop, with interesting boulders, eddies, and route options. The downside is the short length, although rapids or other attractive features may emerge after drawdown of Copco Reservoir upstream or Iron Gate Reservoir downstream. Under the Proposed Action, infrastructure removal at Copco No. 2 Dam and the Powerhouse may restore some of the reach's scenic values but in-channel trees and overhanging riparian vegetation pose safety/liability challenges in the former bypassed reach (discussed in greater detail below). With a short shuttle and proximity to the I-5 corridor, Ward's Canyon could become a regional whitewater attraction for both non-commercial and commercial boaters.

4.4.2 Trip Types / Craft / Skill

A concentrated low flow channel in Ward's Canyon produces powerful hydraulics and bigger waves compared to Big Bend and Hell's Corner. ***Flows about 800 to 1,100 cfs provide standard whitewater opportunities*** for hard shell kayaks, small rafts, and larger rafts with passengers. Higher flows available in spring and early summer will allow a greater range of craft types, and ***flows over 1,500 cfs will provide big water boating*** from March through May in most years. Although ratings generally focus on whitewater, difficulty of Ward's Canyon may be affected by restoration of in-channel and riparian trees, which currently constrain access to eddies and boating lines in some rapids. This might increase difficulty from Class III/IV to Class IV/V (see further discussion below).

4.4.3 Description of Flows

After the first study flow, boaters reported ***800 cfs provided acceptable standard boating for kayaks and rafts***. Recognizing that higher flows would increase quality, the study team ***requested 700 cfs for the second study flow*** (rather than the planned 1,100 cfs) to better assess how low summer flows would constrain guided rafting. Participants reported the lower flow was shallower in rapids and produced more hits and stops, and route choices were more constrained and technical. The 700 cfs flow defines the transition between technical and standard boating.

Participants reported that ***whitewater trips will improve at higher flows.*** Rapids will be more continuous with stronger hydraulics and larger waves, but easier lines, more margin for error, and fewer pinning/wrapping hazards. However, participants identified substantial impacts from in-channel trees and overhanging riparian vegetation (see discussion below). Most thought the segment would be ***optimal for larger or outfitted rafts from about 800 to 1,500 cfs.***

As flows increase from ***1,500 to 3,000 cfs***, Ward's Canyon would probably provide ***big water boating*** (available in most years from March through May).

4.4.4 Boatability

At 800 cfs, kayakers reported a median of 6 hits and no stops, boat drags, or portages, while rafters reported a median 15 hits, 1 stop, and no boat drags or portages. There were slightly more boatability problems at 700 cfs; kayakers reported a median 10 hits, with rafters reporting a median of 18 hits and 2 stops. Hits are a less obtrusive condition, with boater tolerances between 15 and 100 for the segment (median of 25), although one rafter and one kayaker reported the number of hits does not matter. Tolerances ranged from 2 to 10 stops, and 0 to 5 boat drags per trip.

Most participants had never boated the reach before, a few rapids had narrow and challenging lines, and the extensive in-channel trees and overhanging riparian vegetation constrained scouting options. But even with these challenges there were few boatability issues, and more experience would allow for larger rafts with heavier loads.

4.4.5 Flow Evaluation Curves

Boaters were asked to evaluate a range of flows on the close-out survey. Ratings were on a seven-point scale from "totally unacceptable" to "totally acceptable," with a "marginal" mid-point. Flow evaluation curves are based on mean evaluations of each flow, plotted separately for rafts and kayaks (Figure 7).

- Findings indicate Proposed Action ***summer flows over 800 cfs will provide acceptable but not quite optimal boating for kayaks and rafts.***
- Ratings were higher for kayaks than for rafts below about 900 cfs.
- The marginal point where evaluations go from acceptable to unacceptable was about 500 cfs for kayaks and 650 cfs for rafts.

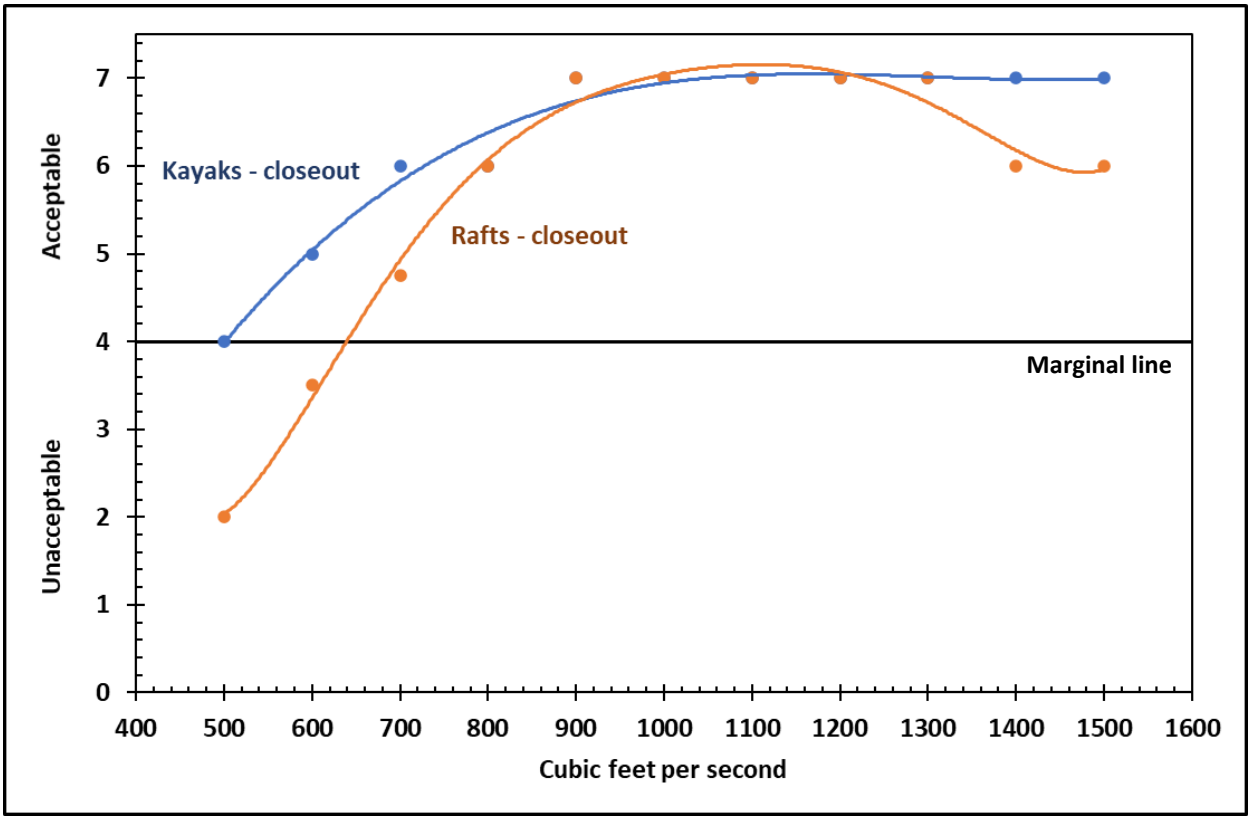


Figure 9. Ward's Canyon flow evaluation curves.

4.4.6 Specified Flows

Boaters were asked to specify flows for different types of trips on this segment. Figure 8 summarizes the low end and optimal ranges, based on mean responses.

- Findings indicate Proposed Action summer flows about ***800 to 1,100 cfs would provide standard rafting and kayaking trips***.
- ***Technical trips could occur at lower flows***, with technical kayaking from about 500 to 800 cfs and technical rafting from 600 to 800 cfs.
- ***Big water boating*** starts about 1,100 cfs for rafts and 1,300 cfs for kayaks. Under the Proposed Action, these flows will typically occur from March through May.

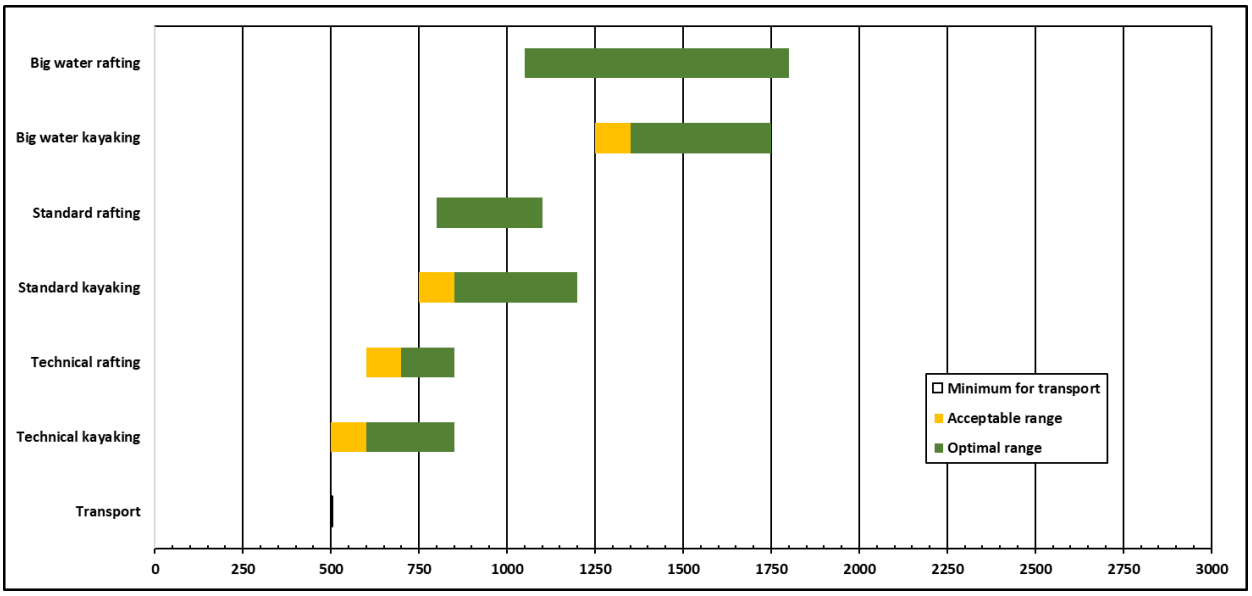


Figure 10. Specified flow ranges for Ward's Canyon.

4.4.7 Other Boatability Considerations

Connecting segments

Under the Proposed Action, Klamath River flows may allow boaters to connect Ward's Canyon with Big Bend or Hell's Corner segments, with the following considerations.

- Flows required to minimize boatability problems and improve travel speed are more likely to be an issue in the upstream segments than Ward's Canyon.
- Rapids in Ward's Canyon are slightly easier than those in Big Bend and Hell's Corner, so connecting these segments may be a mismatch.
- There is likely to be about 8 miles of slower, less difficult boating between Hell's Corner and the start of Ward's Canyon (from Stateline through current Copco Reservoir). Although the precise gradient and number of rapids in the inundated reach is unknown, it is probably about 18 feet per mile (Cross 2019), which would typically produce Class I/II water.
- There are no obvious camping locations in Ward's Canyon, and few in the segment between Hell's Corner and Ward's Canyon (which has considerable private land).
- New camping options might be developed after the Proposed Action is implemented to help boaters utilize low summer flows on multi-day trips. Road accessible camps, similar to the one used by a Hell's Corner outfitter, would require identifying sites and handling permitting challenges. Outfitters were not enthusiastic about carrying gear in loaded rafts in Big Bend, Hell's Corner, or Ward's Canyon, although other boaters might show more interest in such trips.
- Proposed Action flows in Ward's Canyon are probably not the limiting factor for trips connecting segments. The 1,500 flows required for Big Bend and Hell's Corner will be available only during higher flow times (generally March through May), and suitable camping locations and sites will need further attention if this use becomes popular.

Access

The Whitewater Boater Study ***put-in access at Copco No. 2 Dam is very restrictive***. The parking area is high above the river and launching involved carrying boats to the river's edge and lowering them with ropes down a concrete dam abutment. Boaters then had to scramble down an eroded trail through poison oak to a riverbank with overhanging vegetation. In its current state, this area is not conducive to boater access.

Participants strongly supported new access at a site known as Copco Valley, upstream of the mouth of Ward's Canyon (currently under Copco Reservoir). The access site needs to provide 1) a take-out option for less skilled boaters using the (likely) Class I-II segment currently inundated by Copco Reservoir, and 2) a put-in option for the Class IV Ward's Canyon run. This site has received design and planning attention; it involves an access road down steep grades with uncertain soil stability and cultural impact issues.

As the permanent Copco Valley site is developed, a short-term temporary put-in for Ward's Canyon may be possible at the Copco No. 2 Dam site. The existing road allows vehicle access to the Dam abutments high above the river, and a boat slide could provide access to the water. This does not provide an acceptable take-out for the Class I-II segment currently inundated by Copco Reservoir because more difficult rapids are expected to emerge between the proposed Copco Valley access and Ward's Canyon.

The ***take-out at Fall Creek*** is functional and has been used for years to access Iron Gate Reservoir, but the current site requires some parking and launching organization to accommodate increased use. Rapids may also emerge during drawdown of Iron Gate Reservoir, especially at a location about one mile below Fall Creek where adjacent topography suggests a canyon constriction. ***New access downstream of those rapids would improve the length of Ward's Canyon runs.*** The road is adjacent to the reservoir until the mouth of Jenny Creek about 2.2 miles below Fall Creek, but bank gradient and stability are unknown because they are submerged. Below Jenny Creek the road is farther up the canyon wall.

Gaging

The Proposed Action will remove J.C. Boyle Dam and Powerhouse, so there will no longer be a flow compliance requirement for the PacifiCorp gage below the dam or the USGS gage 115107000 below J.C Boyle Powerhouse. Funding for the USGS gage is undetermined at the time of this report, but if both gages were removed, flows in Ward's Canyon can be estimated by adding about 270 cfs accretion to the flow at the USGS 11509500 gage below Keno dam.

Guided trip viability

Ward's Canyon is likely to provide the best guided whitewater trips on the Upper Klamath River. The run is short but has several good rapids throughout the segment, and outfitters believe passengers will be attracted to back-to-back runs with a lunch/shuttle break. The shuttle is short and efficient (assuming an improved put-in at Copco Valley), and access to the reach from tourism centers in the Rogue Valley or Mount Shasta is on good roads, with considerably less driving than for Hell's Corner or Big Bend (on winding Highway 66 and gravel side roads).

In general, outfitters did not believe Ward's Canyon offers a replacement for peaking flows in Hell's Corner. They were divided over whether summer flows in Ward's Canyon would allow six-passenger rafts or require smaller four-passenger rafts with a lower profit margin. This may depend on resolution of in-channel and riparian vegetation issues (see discussion below) and the ability to learn new boating lines in rapids.

In-channel vegetation and restoration

The flows in the bypassed Ward's Canyon segment have been reduced for over a century, generally held at the 10 cfs compliance minimum with brief exceptions during spring high flows. This altered flow regime has resulted in considerable encroachment of in-channel and riparian growth consisting of shrubs and trees that range from 12- to 36-inches in diameter.

In-channel trees and overhanging riparian vegetation impede route choices, access to eddies, and walking along the bank. With the Proposed Action's much higher flows, a new riparian zone will be established; many trees below the mid- to late-summer base flow will eventually die and become sweepers or strainers, and larger trees will probably remain for many years.

Taken together, this vegetation poses hazards to boaters and affects the quality of recreation experiences. Removal of vegetation will be considerably more difficult after the reach returns to free-flowing condition, and the Renewal Corporation recommends in-channel vegetation removal prior to completing the Proposed Action.

5 Conclusions and Implications

This section is a brief review of conclusions from the Whitewater Boating Study.

5.1 Keno

Keno will continue to provide boating opportunities as in the past. Keno is a short but scenic Class II/III run (5 miles), with fishing and bird-watching a bigger attraction than whitewater. In many areas of the country a segment like this would be heavily used, given its proximity to a small city and reasonable access. Proposed Action summer flows of 600 to 800 cfs will be boatable, and when J.C. Boyle Reservoir is returned to a river, the longer run may attract greater use.

But the segment is ***not a substitute for better whitewater downstream***, especially in Hell's Corner. Keno is much shorter, with fewer and less exciting rapids, and diminished scenic values in its lower two miles. More importantly, Keno's typical summer flows will be 200 to 300 cfs less than downstream segments (due to spring inflows in Big Bend). Proposed Action summer flows will be boatable, although they will provide acceptable but less-than-optimal technical trips, precluding larger rafts and guided passenger loads. Keno's put-ins and take-outs are also far from the more populated Rogue Valley where outfitters and most guided passengers are based, requiring long travel times for a short boating trip. Keno may provide some form of guided boating during dam de-construction, but it is unlikely to be a long-term guided whitewater attraction. We expect Keno will continue to support ***limited guided fishing and consistent local boating and fishing.***

Improved access could handle problems from existing use or facilitate additional use. The current river right put-in includes about a mile of rough road, with foot-deep ruts when it is wet. Developing a launch or boat slide on river left is an alternative to those improvements, with some longer-term advantages due to the existing campground facilities and better access roads that do not travel through a residential area.

5.2 Big Bend

Big Bend will provide an exciting new technical boating opportunity in a scenic narrow canyon that will feel isolated from development after the dam, canal, and road are restored. The segment's Class IV/V rapids are numerous and challenging like the renowned whitewater in Hell's Corner, and they are interestingly different in character (e.g., larger boulders and more concentrated hydraulics). This 5-mile whitewater segment may also become slightly longer, depending on the rapids that emerge after J.C. Boyle Reservoir returns to a river. Road access at the top and bottom of the segment will provide an easy shuttle, and Proposed Action summer flows of 800 to 1,100 cfs will provide challenging technical whitewater for kayaks and small rafts.

But ***Big Bend is not a substitute for the current whitewater opportunities in Hell's Corner***. The segment is much shorter, its canyon scenery has been diminished by the dam, road, and canal, and it is unclear how restoration can remove evidence of past development. As a stand-alone run, it has fewer rapids than Hell's Corner, and several rapids have more challenging pinning/wrapping hazards. In addition, Big

Bend's put-in ***and*** take-out are farther from the Rogue Valley where outfitters and clients are based (the Hell's Corner take-out is a much shorter drive).

Big Bend's Proposed Action summer flows will be higher than bypassed flows. Flows will be boatable but provide less-than-optimal technical trips, well below flows that would provide standard whitewater boating for rafts carrying guided passenger loads. This segment is likely to attract consistent unguided boating use, particularly in spring when Proposed Action flows are higher, or as part of a longer trip connecting several segments. But at typical summer flows, Big Bend is unlikely to attract extensive whitewater boating use.

Big Bend requires few access improvements aside from parking organization and a slide/trail at the put-in (depending on access options after J.C. Boyle Reservoir is drawn down). Regardless of use levels, ***the non-natural constriction at Sidecast Slide probably needs work*** (beyond already-completed fish passage modifications) to provide a boatable channel at summer flows.

5.3 Hell's Corner

The Hell's Corner segment will provide high quality standard whitewater opportunities during the spring season. The most commonly guided 16-mile trip from Spring Island to Access Number 6 provides outstanding whitewater and excellent canyon scenery in a backcountry canyon with minimal visible impacts. Best-known for 18 named rapids (six are Class IV or V), the segment is among a handful of nationally renowned whitewater day trips. In most years, these opportunities will be available from March through May, and may continue into June in wetter years.

From mid-summer on, Hell's Corner will provide acceptable technical whitewater for kayaks and small rafts. These flows will be sub-marginal for standard kayaking and rafting, probably requiring smaller boat/passenger configurations that would affect commercial viability. Summer flows will be boatable and rapids will remain, but they will lack big waves and powerful hydraulics. Physical characteristics such as the scenery and backcountry setting will also remain, and the segment will provide connections to restored segments for longer multi-day trips, a new boating opportunity.

Hell's Corner accesses are well-located and require few improvements. The put-in is already well-developed and convenient (with the exception of the awkward turn into the launch area that cannot accommodate trailers). The take-out options are also well-located, although some would benefit from improvements such as better organization or ramp hardening.

5.4 Ward's Canyon

Previously unboatable due to restricted access and very low bypass flows, ***Ward's Canyon will provide an exciting new whitewater boating opportunity***. The segment has the best scenery of the Upper Klamath River, in a narrow canyon with elaborate columnar basalt displays and good wildlife viewing, and it feels isolated despite its two-mile length. With drawdown, dam removal, and access at Copco Valley, the segment will include another mile of river with whitewater. Regardless of eventual length, Ward's Canyon currently has several fun-but-not-scary Class III/IV rapids, and they will be boatable at

low summer flows of 800 to 1,100 cfs in the segment. Close to the I-5 corridor along mostly paved roads, the segment has the easiest access of any Upper Klamath run, and an efficient shuttle road out of sight and sound of the river allows multiple runs in a day.

Summer flows will provide optimal technical boating and acceptable standard whitewater boating. This is the "happy story" for summer boating following Proposed Action dam removal and restoration, and it is likely to attract considerable guided and unguided use. Ward's Canyon will not replace the longer and more challenging Hell's Corner segment at peaking flows, but it will offer good-quality whitewater boating all summer long.

The segment will need attention to access. Ward's Canyon currently lacks an appropriate put-in, and there are few good stopping or hang-out locations in the heavily vegetated canyon. Planned new access above the head of the canyon (at Copco Valley) would increase the segment's length, thus including rapids that emerge after Copco Reservoir is drawn down and Copco No. 1 and No. 2 Dams are removed. The study put-in could probably be functional on a temporary, short-term basis with some parking improvements and a boat slide below the to-be-removed dam. The current take-out at Fall Creek is well-located but needs organization and development. Drawdown of the Iron Gate Reservoir might uncover scenic or whitewater features that would lengthen the run and argue for re-locating the take-out downstream, toward the mouth of Jenny Creek.

Ward's Canyon has hundreds of trees that have grown in the channel and riparian area during a century of very low bypass flows. After restoration of Proposed Action flows, the channel will be inundated and no longer accessible on foot. The reach should be cleared of safety / liability hazards from in-channel trees and overhanging riparian vegetation prior to initiating the Proposed Action, because after the reach has full flow, access will be very limiting (see side bar below on restoration issues).

5.4.1 Sidebar: In-channel Vegetation and Restoration in Ward's Canyon

The Copco dams and powerhouses were completed from 1921-25, and they have altered flows in the bypassed Ward's Canyon segment for a century. For most of the year, fish compliance flows have been limited to about 10 cfs, with exceptions during a few days or weeks when spring high flows exceeded generating capacity of the powerhouse. This altered flow regime encouraged considerable tree growth ***outside the 10 cfs channel, but within the post-removal inundated channel (700-900 cfs in summer, higher in spring).*** Observations during the boating suggest these are mostly alder (with a few ponderosa pines), and many have large diameters (estimated range 12 to 36 inches).

These trees and other brushy vegetation impede 1) boating routes, 2) access to eddies, and 3) walking/scouting along the bank. This poses strainer/visibility hazards to boaters. Post-removal, higher flow regimes are likely to inundate and kill many of these trees, which may become sweepers or logjams that present additional safety hazards. Because of the size, they are likely to remain for many years. In general, entrapment is associated with about a third of whitewater fatalities.

Experience from flow restoration in other bypass segments (e.g., Tennessee's Cheoah, and California's Pit and Upper North Fork Feather rivers) suggests in-channel vegetation is difficult and costly to remove after the river has a substantially higher restored flow regime. Many trees are in the middle of rapids with strong adjacent currents, adding challenging variables to the timber removal equation. On-land fieldwork confirmed that the entire channel is accessible on foot. The question remains: exactly which in-channel trees should be removed?

It was beyond the scope of this study to inventory vegetation, assess hazards at a detailed level, or develop/recommend silvicultural prescription(s) to mitigate them. But Confluence was asked to take advantage of being in this closed location with proposed action flows and a team of expert boaters to ***assess vegetation, hazards to boaters, and possible mitigation.*** These topics were specifically considered in post-trip focus groups and are reported here.

We acknowledge that alteration of in-channel or riparian vegetation to reduce hazards could affect complexity, shade, channel morphology, or other ecosystem characteristics related to other restoration goals. ***These issues need additional attention and integration among disciplines before developing or implementing specific restoration objectives or strategies.***

With those caveats, Confluence offers three conceptual levels of in-channel hazard mitigation as a contribution to starting this conversation.

- At the more extensive and expensive end of the spectrum, it is possible to identify restored-flow channel edges at the upper end of the boating range (e.g., 1,500 cfs), and then remove all trees exceeding a certain standard (e.g., 4 to 6-inch diameters). This ***maximum hazard removal*** option is more comprehensive, but it would require removal of more trees (perhaps 2,000 to 3,000; a ***very rough estimate*** based on participant discussion). This maximum hazard removal option is also more likely to conflict with other (e.g. salmonid or riparian wildlife) restoration goals that value large wood, shade, and ecosystem complexity.

- At the ***minimal hazard removal*** end, one could identify a smaller subset of key locations where in-channel or over-hanging vegetation creates the greatest hazards in rapids, blocks routes, prevents access to eddies, or obscures scouting sightlines. Under this option, only the most problematic trees and vegetation would be removed (probably specifying individual trees rather than taking all trees below a certain water line or over a certain size). This option requires interaction between restoration experts (who assess removal options), aquatic and riparian biologists (who assess effects on other restoration goals), and boaters (who assess rapids, boating routes, and hazards). Brainstorming suggested this might require removal of about 250 to 500 trees (***very rough estimate*** based on participant discussion) along with some brush or overhanging branches.

- A ***medium hazard removal*** option effort could combine elements of both approaches. This might produce a mixed prescription that removes all large diameter trees (e.g., over 8 inches) in the anticipated summer channel (e.g., 800 or 1,100 cfs), with further removal of problem trees in key locations in the channel that would be inundated at higher but still boatable flows (e.g., from 800 to 1,500 cfs). As with the minimal hazard option, this medium hazard removal option requires assessments of rapids and specific hazards within target flow ranges.

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7 Appendix A: Summary of Pre-boating Survey Results

Participants completed a pre-boating survey before arriving to the study site. Topics included:

- Name, affiliation, and contact information
- Age
- Gender
- Skill level and years of experience for each type of whitewater craft
- Days per year spent boating
- COVID-19 symptoms, exposure, and test results

Participants reported:

- Class V skill in their preferred craft (except one reported Class IV skill)
- Average of 72 days per year whitewater boating
- Average of 28 years of experience in their preferred craft
- No COVID-19 symptoms, contacts, or positive test results

8 Appendix B: Study Participation

Cell values are type of craft. N/A means the boater did not participate in that segment

Name and affiliation	Keno 700 cfs	Ward's Canyon 800 cfs	Ward's Canyon 700 cfs	Boyle / Big Bend 1,100 cfs	Hell's Corner 1,100 cfs	Hell's Corner 800 cfs
Confluence						
Bo Shelby	Center row raft	Center row raft	Center row raft	Center row raft	Center row raft	Center row raft
Doug Whittaker	Center row cataraft	Center row cataraft	Center row cataraft	Center row cataraft	Center row cataraft	Center row cataraft
Dan Shelby	Hardshell kayak	Hardshell kayak	Hardshell kayak	Hardshell kayak	Hardshell kayak	Hardshell kayak
UKOA						
Will Volpert	Paddle cataraft	Paddle cataraft	Paddle cataraft	Center row raft	Center row raft	Center row raft
Bart Baldwin	Inflatable kayak	Center row raft	Center row raft	Center row raft	Center row raft	N/A
Willie Long	Paddle cataraft	Paddle cataraft	Paddle cataraft	N/A	N/A	N/A
Peter Wallstrom	Inflatable kayak	Center row raft	Center row raft	Center row raft	Center row raft	Center row raft
Steve Walters	N/A	Center row raft	Center row raft	N/A	N/A	N/A
Trevor Fulton	N/A	N/A	N/A	Hardshell kayak	Hardshell kayak	N/A
American Whitewater						
Tom O'keefe	Hardshell kayak	Hardshell kayak	Hardshell kayak	Hardshell kayak	Hardshell kayak	Hardshell kayak
Scott Harding	Hardshell kayak	Hardshell kayak	Hardshell kayak	N/A	N/A	N/A
Priscilla Macy-Cruser	N/A	N/A	N/A	Hardshell kayak	Hardshell kayak	N/A
Bill Cross	N/A	Center row raft	Center row raft	N/A	N/A	Center row raft
Grant Weidenbach	Hardshell kayak	N/A	N/A	N/A	N/A	N/A
BLM						
Zane Reinard	Hardshell kayak	N/A	N/A	Hardshell kayak	Hardshell kayak	N/A

9 Appendix C: Survey Instruments

Post Run Survey (administered after each run for each segment)

Date of run: _____ / _____ / 2020 Flow: _____ cfs Your name:_____

1. What type of craft did you use for this run? (Circle one)

   Kayak: ❑Play boat ❑Creek boat ❑River boat ❑Inflatable kayak
   Raft: ❑Self-bail ❑Bucket ❑Cataraft
   Rigging: ❑Center row ❑Stern row ❑Paddle
   Length _____ Number of passengers _____

2. In general, what class (I to VI) was the whitewater difficulty at this flow? _____

3. Please estimate the number of hits, stops, boat drags, and portages you had on this run.

   I **hit** rocks or other obstacles (but did not stop) about… _____ times
   I was **stopped** after hitting rocks or other obstacles about… _____ times
   I had to get out to **drag or pull my boat** off rocks or other obstacles about… _____ times
   I had to **portage** around unrunnable rapids or sections… _____ times

4. Did you have any unusual problems (e.g., became pinned, wrapped a boat, had to swim, etc.) during your run? Please provide a brief description and location of any incident (continue on back if needed).

5. Please evaluate the flow on this run for your craft and skill level for each of the following characteristics. (Circle one number for each item).

	Totally Unacceptable			Marginal			Totally Acceptable
Boatability	1	2	3	4	5	6	7
Availability of technical rapids	1	2	3	4	5	6	7
Availability of powerful hydraulics	1	2	3	4	5	6	7
Availability of playboating areas	1	2	3	4	5	6	7
Overall whitewater challenge	1	2	3	4	5	6	7
Safety	1	2	3	4	5	6	7
Aesthetics	1	2	3	4	5	6	7
Rate of travel	1	2	3	4	5	6	7
Overall Rating	1	2	3	4	5	6	7

6. In general, would you prefer a flow that was higher, lower, or about the same as this flow?

❑Much lower ❑Slightly lower ❑About the same ❑Slightly higher ❑Much higher

7. If this flow were provided periodically, are you likely to return for future boating?

❑Definitely no ❑Possibly ❑Probably ❑Definitely yes

Closeout Survey (administered after last boating run on a segment)

Date: _____ / _____ / _____ Your name: _____

1. Given what you know about the quality of whitewater and other features on this segment of the Upper Klamath River, please tell us the maximum number of hits, stops, boat drags, and portages that are tolerable for a high-quality trip in your craft. If you "don't care," place an X in the space provided.

I will tolerate up to _____ **hits** per trip (contacts with rocks/other obstacles that do not stop you).
I will tolerate up to _____ **stops** per trip (contacts with rocks or other obstacles that stop you, but you do not have to get out of your boat to continue downstream).
I will tolerate up to _____ **boat drags** per trip (where you need to get out of your boat to get it off rocks or other obstacles).

2. Please provide overall evaluations for this reach for your craft and skill level. Please consider all the flow-dependent characteristics that contribute to high quality trips (e.g., boatability, whitewater challenge, safety, availability of surfing or other play areas, aesthetics, and rate of travel). (If you do not feel comfortable evaluating a flow you have not seen, don't circle a number for that flow).

	Totally unacceptable			Marginal			Totally acceptable
500 cfs	1	2	3	4	5	6	7
600 cfs	1	2	3	4	5	6	7
700 cfs	1	2	3	4	5	6	7
800 cfs	1	2	3	4	5	6	7
900 cfs	1	2	3	4	5	6	7
1,000 cfs	1	2	3	4	5	6	7
1,100 cfs	1	2	3	4	5	6	7
1,200 cfs	1	2	3	4	5	6	7
1,300 cfs	1	2	3	4	5	6	7
1,400 cfs	1	2	3	4	5	6	7
1,500 cfs	1	2	3	4	5	6	7
2,000 cfs	1	2	3	4	5	6	7

Based on your boating trips on the Upper Klamath River, please specify the flows that provide the following types of experiences on this reach. *(It's okay to specify flows you have not seen, but which you think would provide the type of experience in question).*

Flow in cfs

Think of the river as a waterway used for transportation. What is the lowest flow you need to simply get down this reach in your craft? _____

Some people are interested in a "technical" whitewater trip at lower flows. Think of this **"technical trip"** in your craft.

What is the lowest flow providing an acceptable experience for this type of trip? _____

What is the best or optimal range of flows for this type of trip? _____ to _____

Some people are interested in trips at somewhat higher flows that typically provide stronger hydraulics and more route choices through rapids. Think of this **"standard trip"** in your craft.

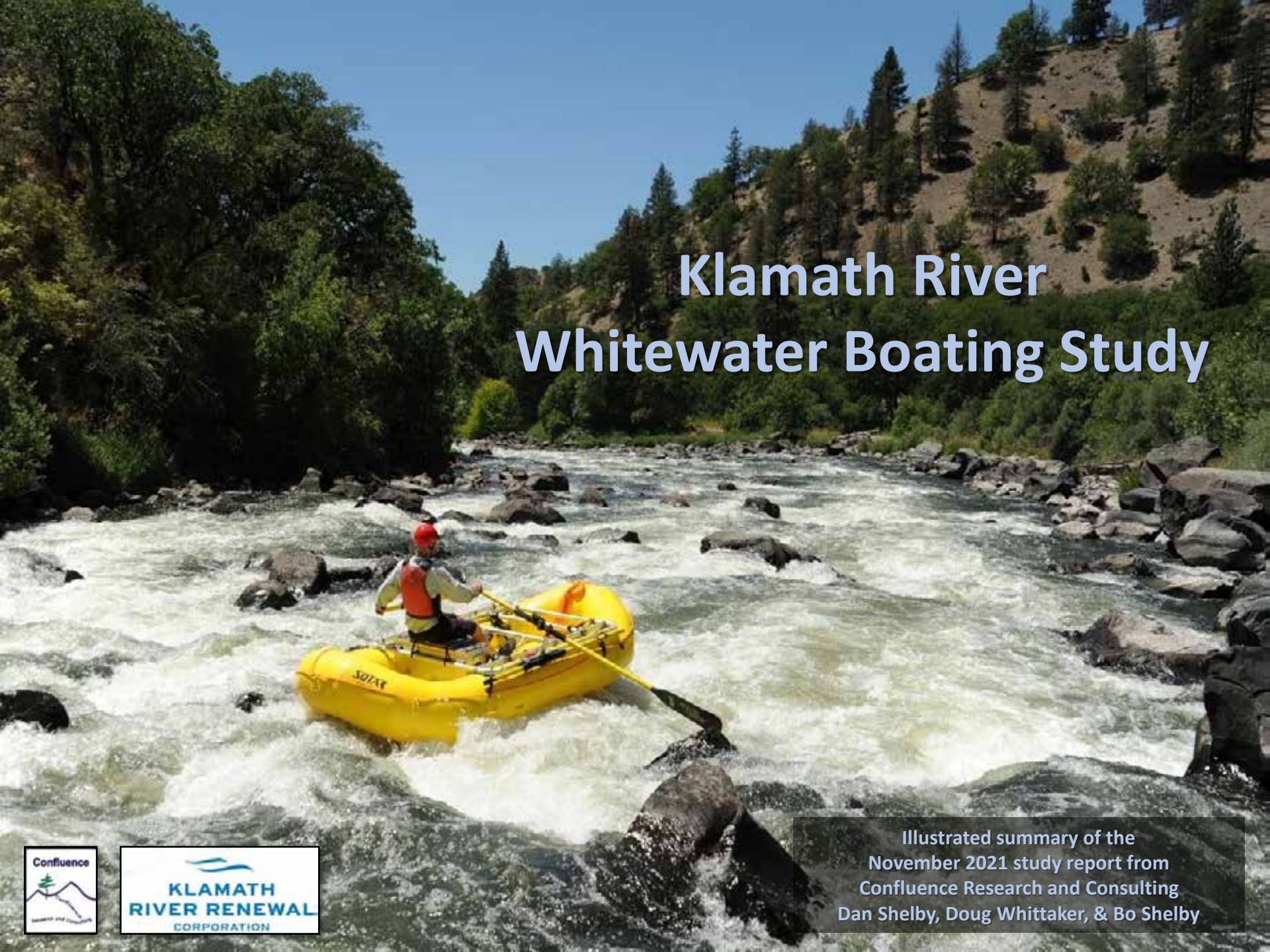
What is the lowest flow that provides an acceptable experience for this type of trip? _____

What is the best or optimal range of flows for this type of trip? _____ to _____

Some people are interested in trips at much higher flows that feature more powerful hydraulics and large waves. Think of this **"big water trip"** in your craft.

What is the lowest flow that provides an acceptable experience for this type of trip? _____

What is the best or optimal range of flows for this type of trip? _____ to _____



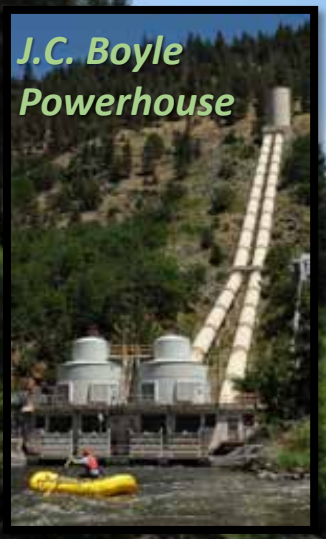
Klamath River Whitewater Boating Study

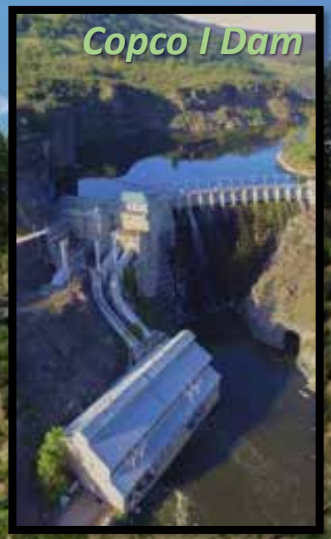
Illustrated summary of the
November 2021 study report from
Confluence Research and Consulting
Dan Shelby, Doug Whittaker, & Bo Shelby

Confluence

KLAMATH RIVER RENEWAL CORPORATION

Klamath River restoration





Stakeholders signed an agreement in 2016 to remove four dams rather than relicense the hydroelectric project. The Klamath River Renewal Corporation was created to execute dam removal (hereafter called the Proposed Action), scheduled to begin in 2023.

Klamath River

The Proposed Action will affect boating on four river reaches (in light blue) and three reservoirs (in turquoise).

Upper Klamath Lake

Klamath Falls

Keno Reservoir (Lake Ewauna)

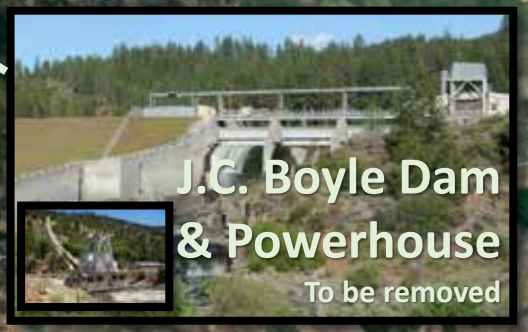
N

5 miles

J.C. Boyle Reservoir

Keno

Big Bend



Hell's Corner

Oregon

California

flow

Copco Reservoir

Iron Gate Reservoir

Ward's Canyon

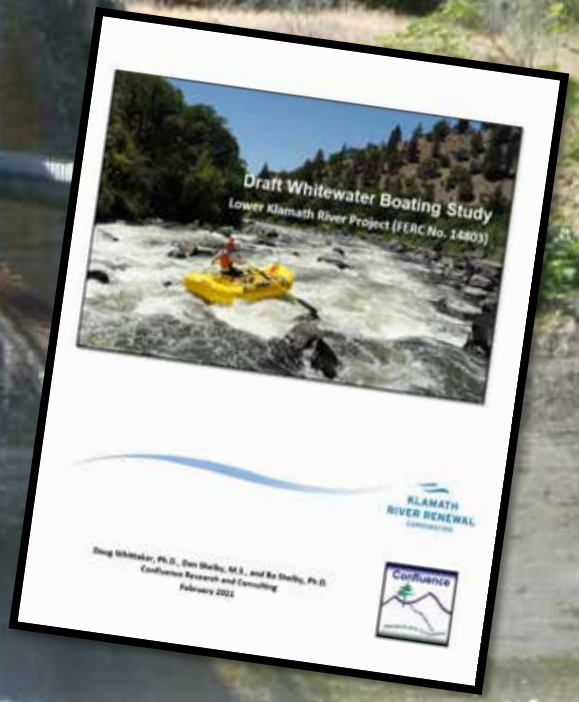
Google Earth

Confluence

Whitewater recreation

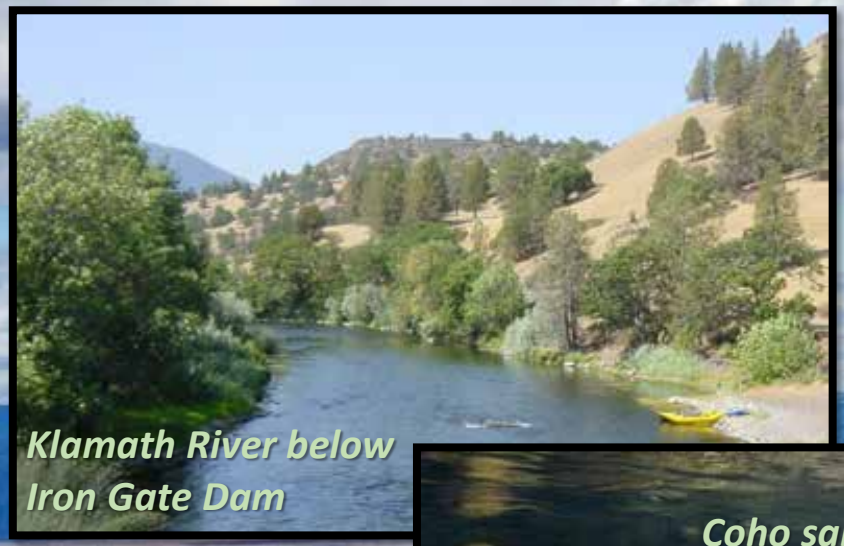
Whitewater recreation will be substantially affected by the Proposed Action. Inundated segments will be uncovered, bypassed segments will have increased flows, segments with power generation will have fluctuations leveled-out, and there will be new connections among segments. De-construction, restoration, and access changes may further affect the types, amount, or timing of whitewater boating.

Whitewater Boating Study



The Klamath River Renewal Corporation contracted this study of the four river segments. The report describes the Proposed Action flow regime; boating assessments of those flows; connections between restored segments; and issues with boating-related access and in-channel/riparian vegetation.

Flows prescribed by endangered fish



Klamath River below Iron Gate Dam

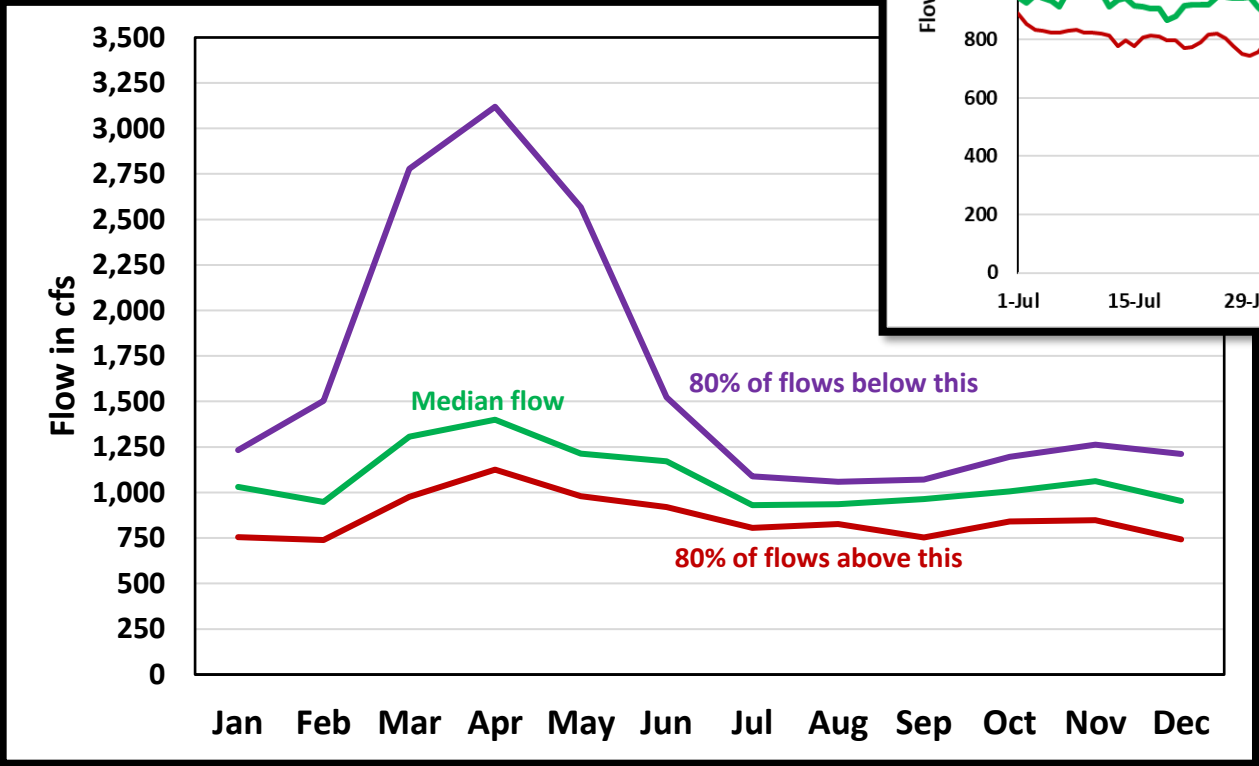
Coho salmon

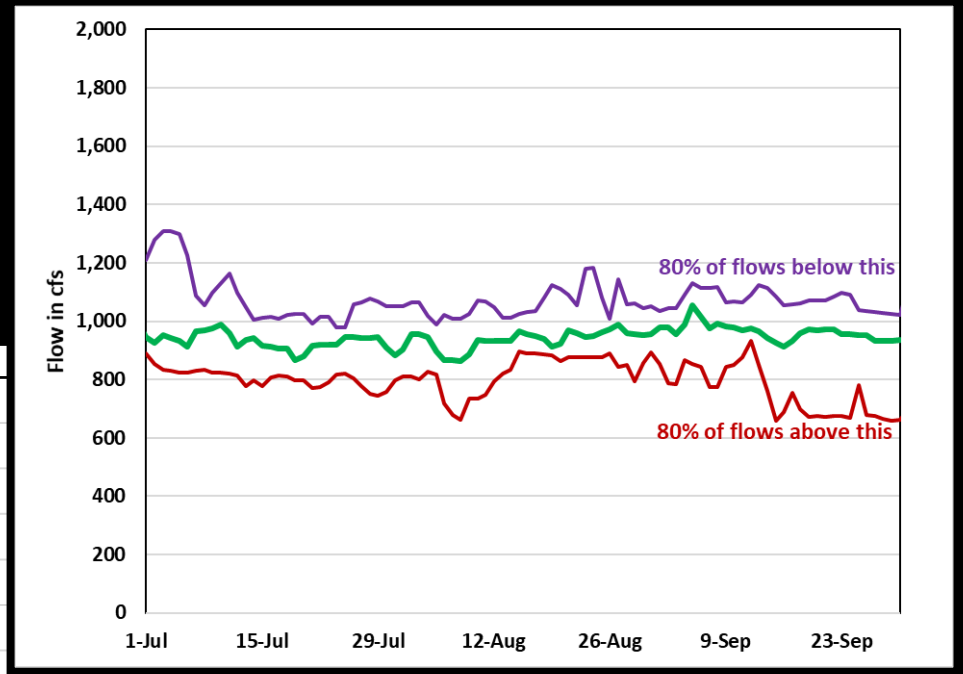
Lost River Sucker

Under the Proposed Action, flows from Upper Klamath Lake (main photo) and downstream of the last dam (top left photo) are prescribed by the current Biological Opinions for fish protected under the Endangered Species Act.

In Upper Klamath Lake, the Shortnose and Lost River suckers are endangered, and two other suckers are species of concern. In the Klamath River, Southern Oregon Northern / Coastal California Coho salmon are a threatened species.

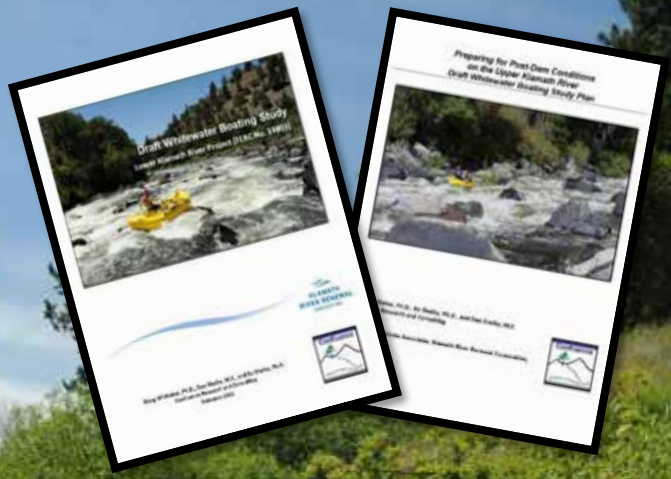
Proposed Action hydrology





The Proposed Action will create a more natural flow regime through the year (left). Overall, it shifts higher summer flows (due to hydroelectric peaking) to spring months (when they will occur less predictably and on fewer days, due to variable inputs and decreased storage). During the summer, flows will typically range from 800 to 1,110 cfs in Big Bend, Hell's Corner, and Ward's Canyon.

Methods

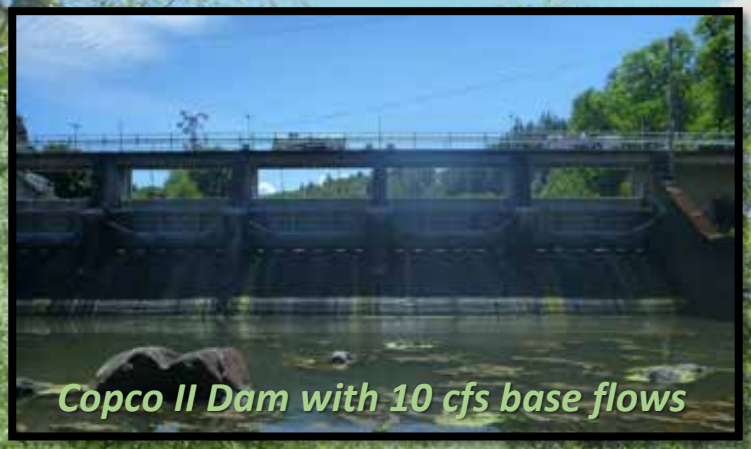


Methods are summarized below, with more detail in the Study Plan and Report.

Controlled flow assessments

The study assessed controlled flow releases in the Big Bend, Hell's Corner, and Wards Canyon segments (shown here). Boaters assessed existing flows in the Keno Segment.

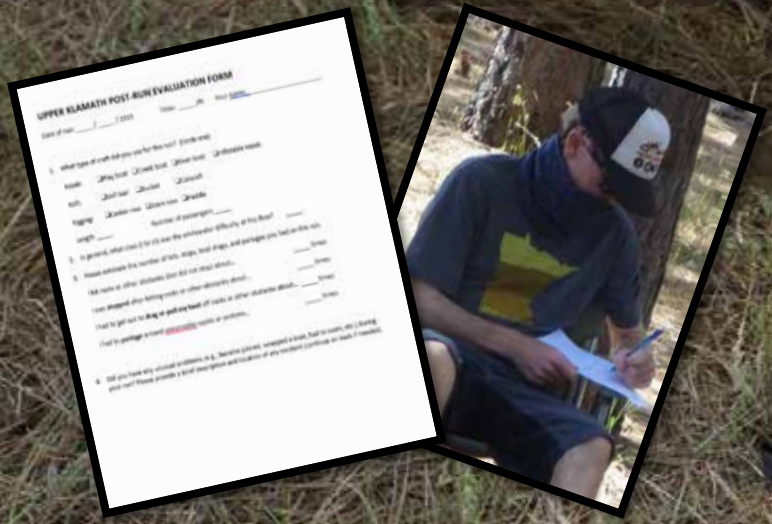
On-land scouting in Wards Canyon



Copco II Dam with 10 cfs base flows

The day before boating, participants assessed access at the put-in below Copco No. 2 Dam, and scouted Ward's Canyon on foot (shown here) for vegetation hazards. This reach is within an area secured for hydroelectric operations, and it is not currently accessible to the public.

Surveys



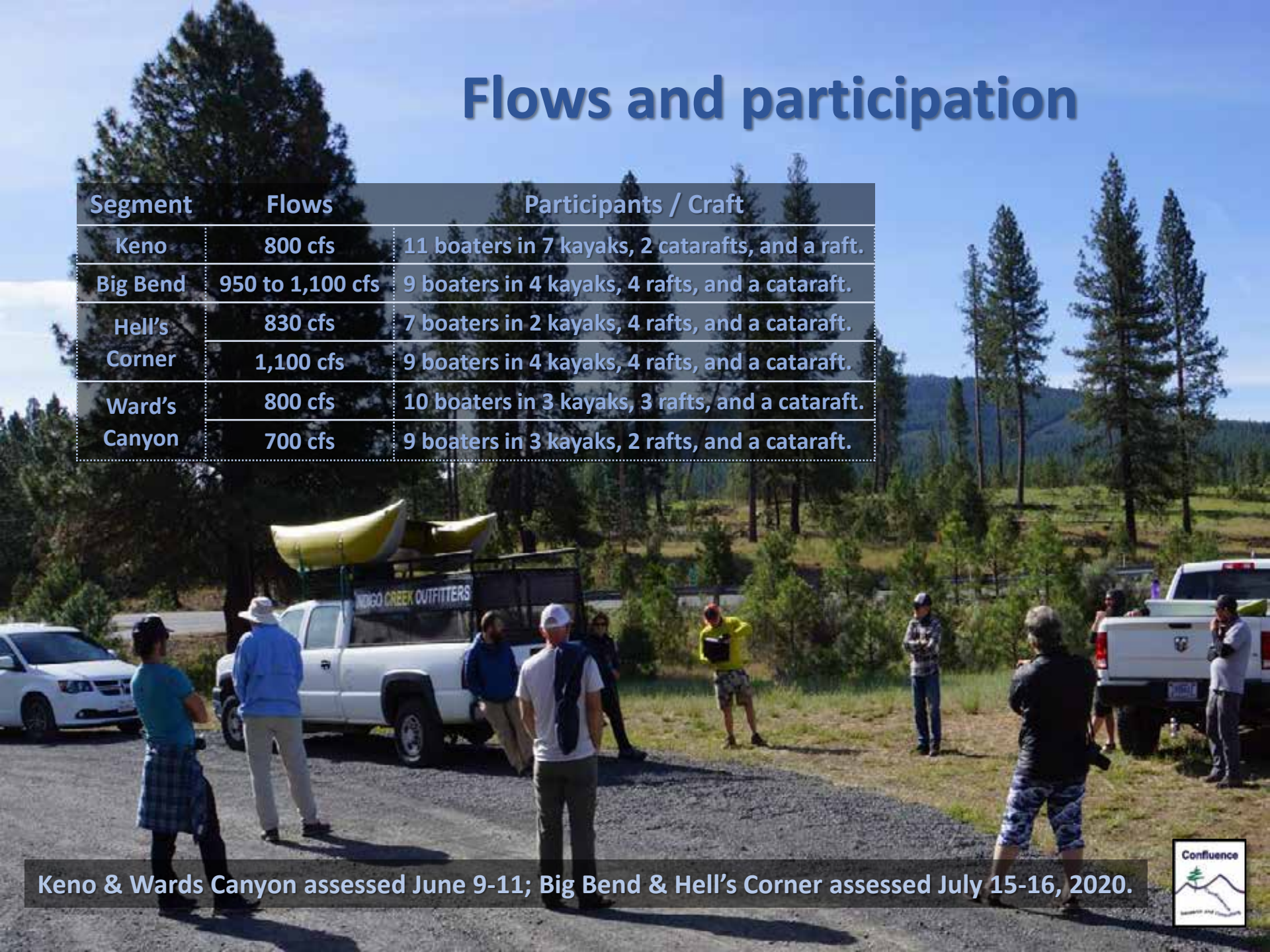
Boaters completed a pre-study survey about their boating experience, surveys after each run, and a close-out after all runs for a segment were finished.

Focus Groups

After boating a segment and completing individual surveys, participants gathered to discuss their evaluations, access, connectivity, in-channel vegetation, or other issues (Spring Island shown here after boating Big Bend).

Flows and participation

Segment	Flows	Participants / Craft
Keno	800 cfs	11 boaters in 7 kayaks, 2 catarafts, and a raft.
Big Bend	950 to 1,100 cfs	9 boaters in 4 kayaks, 4 rafts, and a cataraft.
Hell's Corner	830 cfs	7 boaters in 2 kayaks, 4 rafts, and a cataraft.
	1,100 cfs	9 boaters in 4 kayaks, 4 rafts, and a cataraft.
Ward's Canyon	800 cfs	10 boaters in 3 kayaks, 3 rafts, and a cataraft.
	700 cfs	9 boaters in 3 kayaks, 2 rafts, and a cataraft.

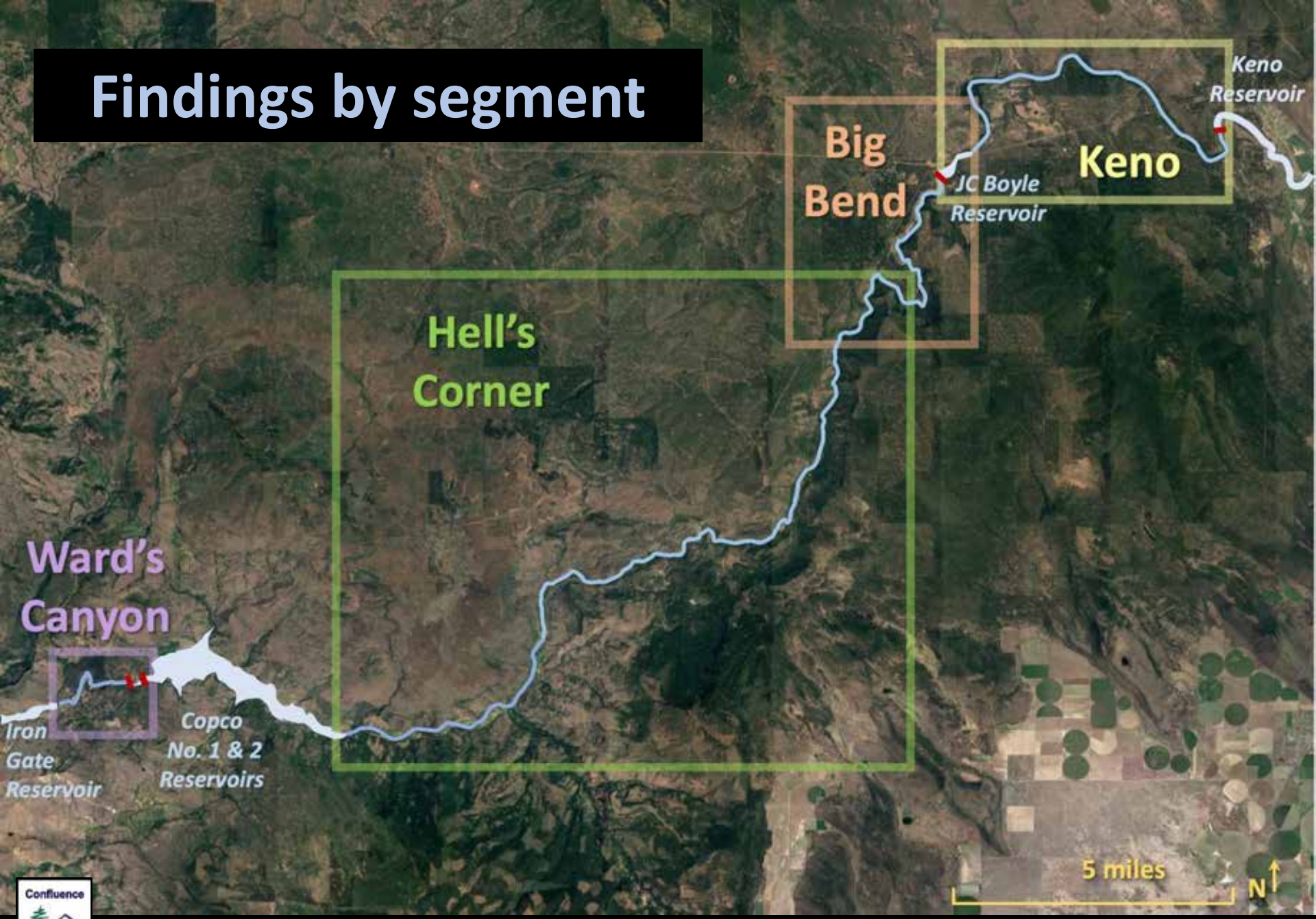


Keno & Wards Canyon assessed June 9-11; Big Bend & Hell's Corner assessed July 15-16, 2020.

Covid Protocols

The pandemic required several Study Plan adjustments, including splitting fieldwork into two sessions (June and July 2020), reduced participation, on-land masking protocols, bicycle and individual vehicle shuttles, and increased sanitation. No participants reported catching Covid during the study.

Findings by segment



Findings and conclusions follow, organized by segment.

Keno segment

Keno offers Class II/III whitewater, forested and high desert scenery, and outstanding fishing and bird watching. It is isolated from roads and other development except near the dam and a transmission line crossing.

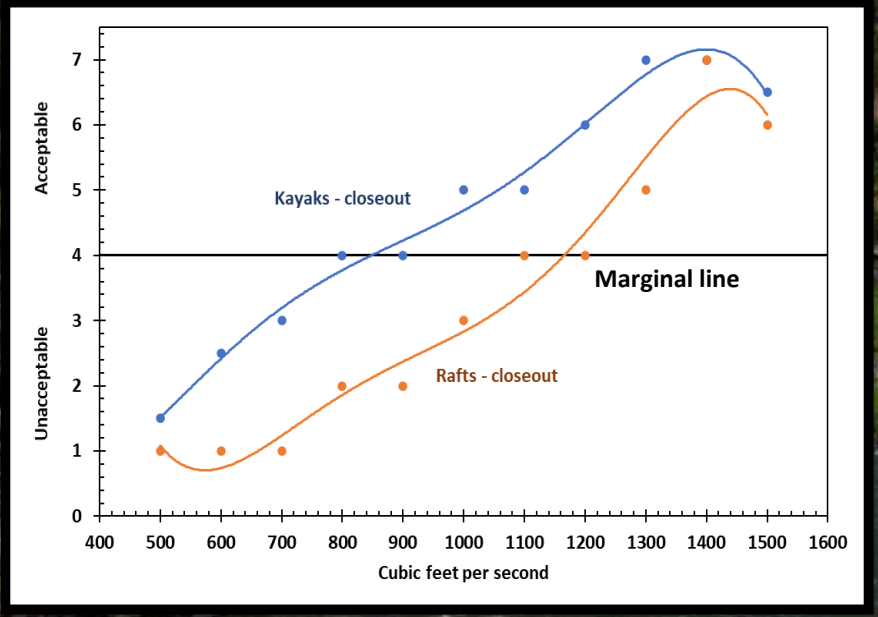
Keno whitewater

Keno has a few rapids with good hydraulics at 830 cfs. The Keno Wave near the put-in is a "park and surf" location for local kayakers during winter/spring high flows (1,100 to 1,800 cfs).

Meatball

"Meatball" is the hardest rapid on the Keno Segment, with a rock garden entrance and twisting final drop. Some outfitters considered Keno suitable for inflatable kayaking among experienced clients, but others demurred. Outfitters agreed such trips would need safety set-ups to provide directions, physically redirect boats, and retrieve people or boats in case of mishaps.

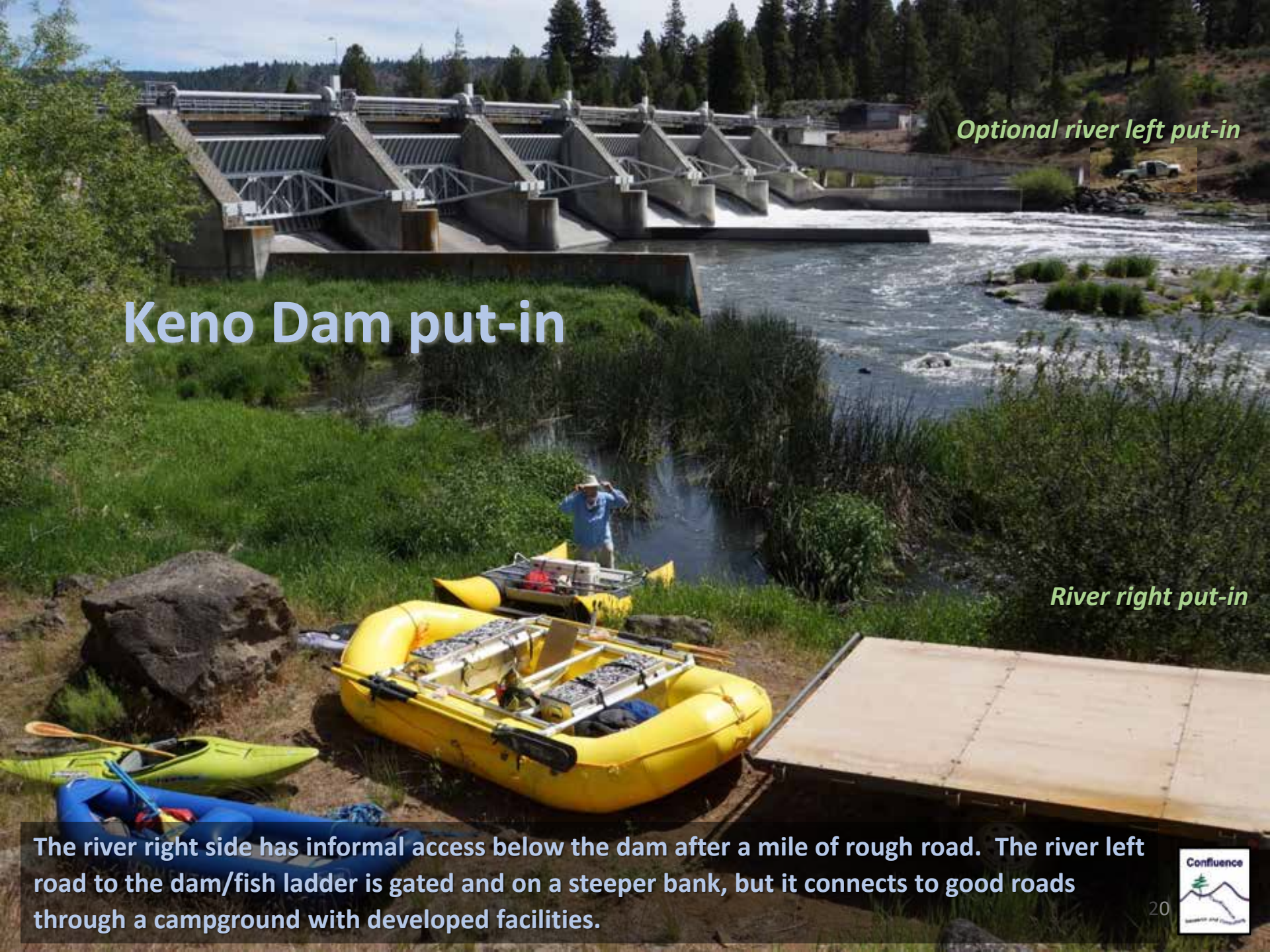
Keno flow assessments



Proposed Action summer flows of 600 to 800 cfs below the dam will be boatable, but the segment is not a substitute for better whitewater downstream.

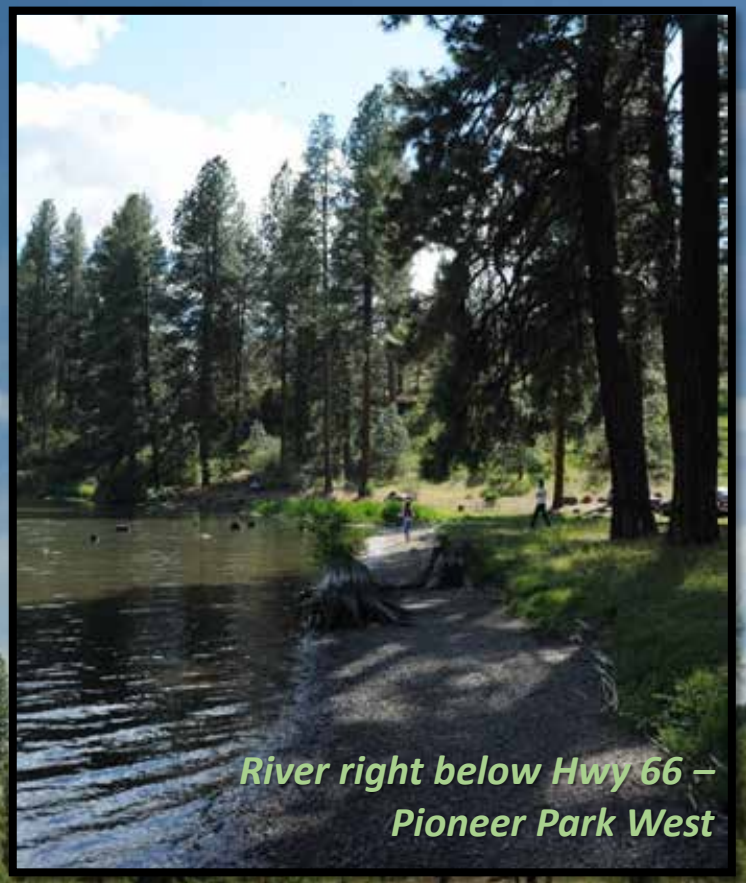
Late summer flows about 800 cfs are marginal for kayaks and unacceptable for rafts.

Rafting is marginal about 1,100 cfs, becoming acceptable at 1,300 cfs and optimal at 1,400 cfs.



The river right side has informal access below the dam after a mile of rough road. The river left road to the dam/fish ladder is gated and on a steeper bank, but it connects to good roads through a campground with developed facilities.

River left above Hwy 66 – Pioneer Park East



River right below Hwy 66 – Pioneer Park West

Pioneer Park East

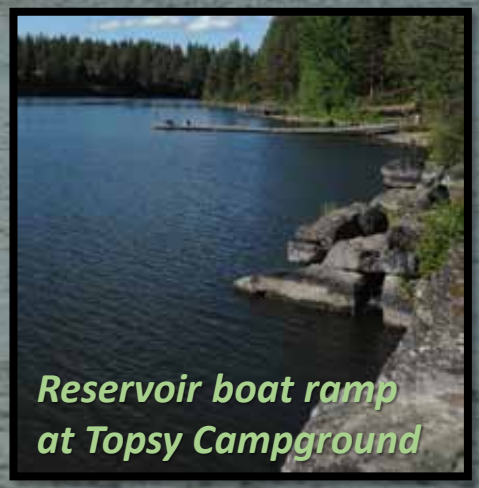
Pioneer Park access

Pioneer Park East has an existing gravel boat ramp, abundant parking, and portable toilets. Proposed improvements at Pioneer Park West could take advantage of the gradual slope closer to the highway, and a good beach.

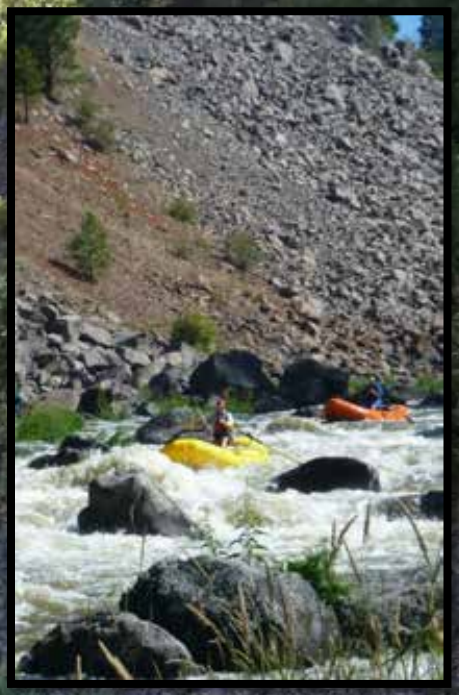
Under J.C. Boyle Reservoir


Meatball tail-out into reservoir

When J.C. Boyle Reservoir is restored to a river, the scenic Keno segment could connect to Big Bend, Hell's Corner, and Wards Canyon segments downstream to produce a longer trip. Multi-day trips will probably require higher flows in spring to handle heavier loads for camping. The gradient and whitewater difficulty of restored river segments are unknown.


Reservoir boat ramp at Topsy Campground

Big Bend segment



Big Bend offers technical Class IV/V whitewater in a confined canyon, with interesting scenery and some sense of isolation (currently diminished by hydro development). Road access at the top and bottom of the five-mile segment will provide an easy shuttle.

Big Bend whitewater

Big Bend's Class IV/V rapids are numerous and challenging like Hells Corner, but have a different character (e.g., larger boulders and more concentrated hydraulics).

Boatability conditions

At low summer flows

At the study flow of 950 to 1,100 cfs below the springs, rafters reported a median of 37 hits, four stops, and two boat drags. Kayakers reported 25 hits and one stop with no boat drags, although a kayak pinned in one rapid. Boaters recovered the kayak in 15 minutes.

Reduced flow during study

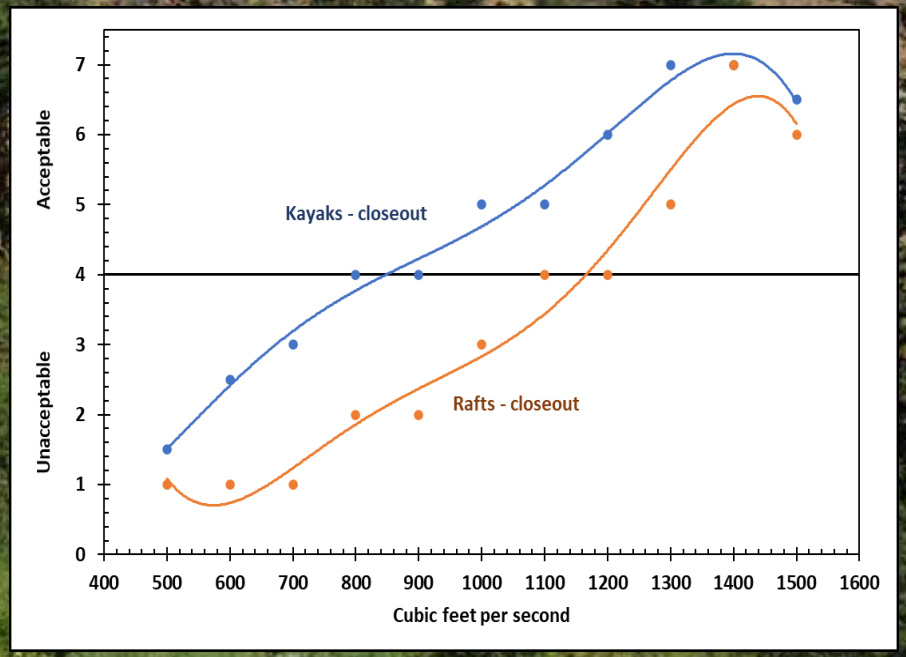
From 1,100 cfs to about 950 cfs

Running behind schedule, boaters had reduced flows in the last mile due to a planned shift from dam to powerhouse releases. Decreased boatability led to a wrapped raft (inset photos). Participants concluded that still-lower flows would be marginal or unacceptable, and they decided not to boat a planned lower flow (about 800 cfs).

Big Bend flow assessments

Big Bend will provide a new technical boating opportunity, with Proposed Action flows considerably higher than current bypassed flows.

Summer flows about 1,100 cfs below the springs are acceptable but not optimal for kayaks, and marginal for rafts. Lower late-summer flows about 900 cfs are marginal for kayaks, and unacceptable for rafts. Most summer flows will not support standard guided rafting trips.



Higher flows in Big Bend

1,600 cfs from 2002 study

Participants indicated that whitewater trips would improve at higher flows, with more continuous rapids, stronger hydraulics, and larger waves; this will produce multiple lines, more margin for error, and fewer pinning/wrapping hazards. The segment is likely to be acceptable about 1,200 cfs, and optimal for larger or guided rafts about 1,500 cfs, especially as boaters learn lines through the complex rapids. These flows will be available in most years from March through May.

Moonshine Falls

1,100 cfs during 2020 study

Rafters at 1,600 cfs in 2002.

Before hydroelectric development, Moonshine Falls was located in the vicinity of J.C. Boyle Dam; it may be further uncovered by Proposed Action restoration. It is unknown whether new rapids will be boatable from the upstream Keno segment, although rafters successfully ran the drop below the dam during 2002 relicensing study releases.

Sidecast slide

In-channel portage on river left

Running center line

Kayakers found a boatable line in Sidecast Slide at Proposed Action summer flows (1,100 cfs), but there are several non-natural hazards. Although one rafter (with no passengers) ran this rapid, it was marginal to unacceptable and the other rafters decided to portage. Boulder fragmenting techniques used for the fish passage modifications would probably be successful.

Restoring Big Bend

Big Bend is a scenic canyon that has been modified by hydro development, including eroded canyon walls along the road/canal in the segment's first two miles.

Timber Bridge put-in

The Timber Bridge put-in on river right below J.C. Boyle Dam is acceptable for occasional use, but the bank is steep and undeveloped, so a raft slide and/or graded trail might be needed if use increases. Leaving the bridge in place provides access to the river left side, but this could increase competition for parking if the site attracts non-boating recreation.

Spring Island and river gages

Spring Island provides good access to Big Bend and Hells Corner. The Proposed Action will remove J.C. Boyle Powerhouse and possibly compliance gages; flows in Big Bend or Hell's Corner could then be estimated from the Keno USGS gage (adding 240 cfs for springs accretion).

Big Bend conclusions

Big Bend will provide a new boating trip in a scenic canyon during higher spring flows. Proposed Action summer flows will be higher than bypassed flows, providing acceptable technical kayaking, but too low for standard whitewater or guided passenger loads.


Hell's Corner segment
Hell's Corner offers outstanding Class IV/V whitewater and good scenery in a backcountry setting, with a few dispersed camping areas.
Confluence

Spring Island to Caldera

The first five miles of Hell's Corner has a lower gradient, fewer rapids, good fishing, and road access for undeveloped camping. Proposed Action (non-peaking) summer flows may increase boat-based fishing in this reach.

Hell's Corner whitewater

There are 16 Class III, three Class IV, and two Class V rapids in Hell's Corner. The channel runs over old lava flows, and many rapids have steep gradients and complex boulder configurations. Toward the end of the segment rapids become more pool-drop, some influenced by Native American weirs built for irrigated agriculture.

Caldera

Caldera is a Class V rapid at the start of the gorge. The river is narrower here, with large waves and strong hydraulics at flows over 1,500 cfs (provided by daily peaking now, available in spring under the Proposed Action). Some hydraulics remain at Proposed Action summer flows, but boating lines are more technical, especially for rafts.

Hell's Corner Rapid at 1,100 cfs

Hell's Corner is the other Class V rapid (and gives the segment its name); it is a long complex boulder garden that becomes more technical as flows decrease. The higher study flow (1,100 cfs) had stronger hydraulics, and slightly more margin for error when dodging boulders.

Hell's Corner Rapid at 800 cfs

At the lower study flow (800 cfs), most rafts hit multiple rocks through this rapid, even without passengers. Outfitters expressed concerns about commercial viability at this flow, including smaller boats/loads, passengers falling out of boats, or retrieving swimmers.

Boatability conditions

Ambush Rapid raft recovery at 800 cfs

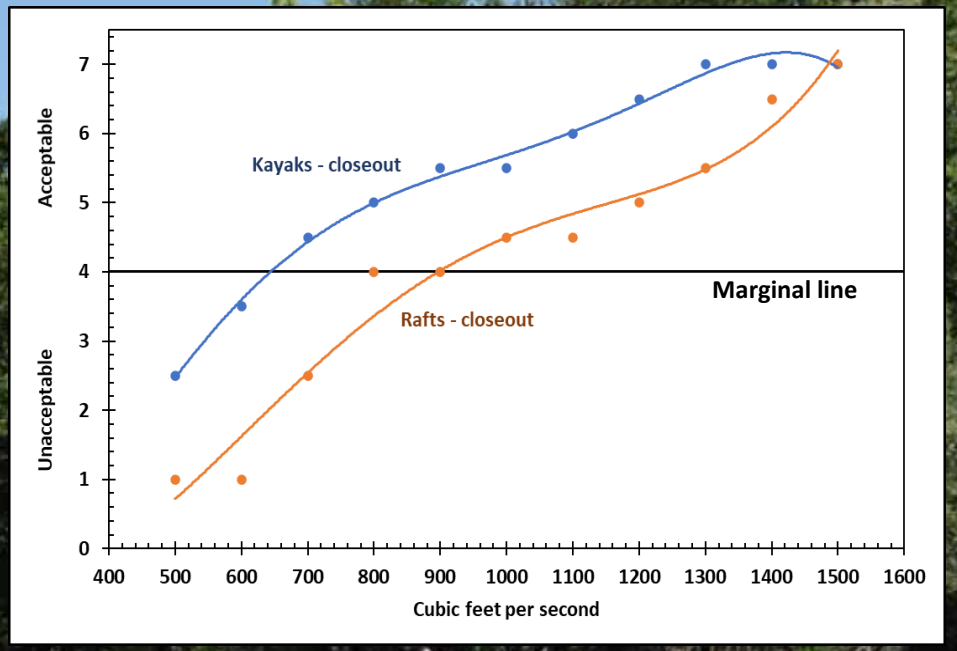
Boat stop in Hell's Corner at 800 cfs

Rafters reported more boatability problems at 800 cfs, with a median of 20 hits, one stop, and one boat drag (compared to 10 hits and no stops or drags at 1,100 cfs). One raft was wrapped at Ambush Rapid at 800 cfs; recovery took about 15 minutes. Trips at these flows are tough on gear and hazardous for passengers.

Hell's Corner at higher flows (from 2002 study)

Hell's Corner has nationally-renowned whitewater at flows over 1,500 cfs. Under the Proposed Action, these opportunities will be available in most years from March through May, although less predictably and on fewer days. Photos of 1,700 cfs from 2002 relicensing studies.

Hell's Corner flow assessments



Hell's Corner will provide high quality standard whitewater boating during spring flows over 1,300 cfs. Late summer flows about 800 to 1,100 cfs are acceptable but not optimal for kayaks, and marginal for rafts. Ratings were generally higher for kayaks than for rafts, with similar evaluations only at the highest flows.

Klamath River camping

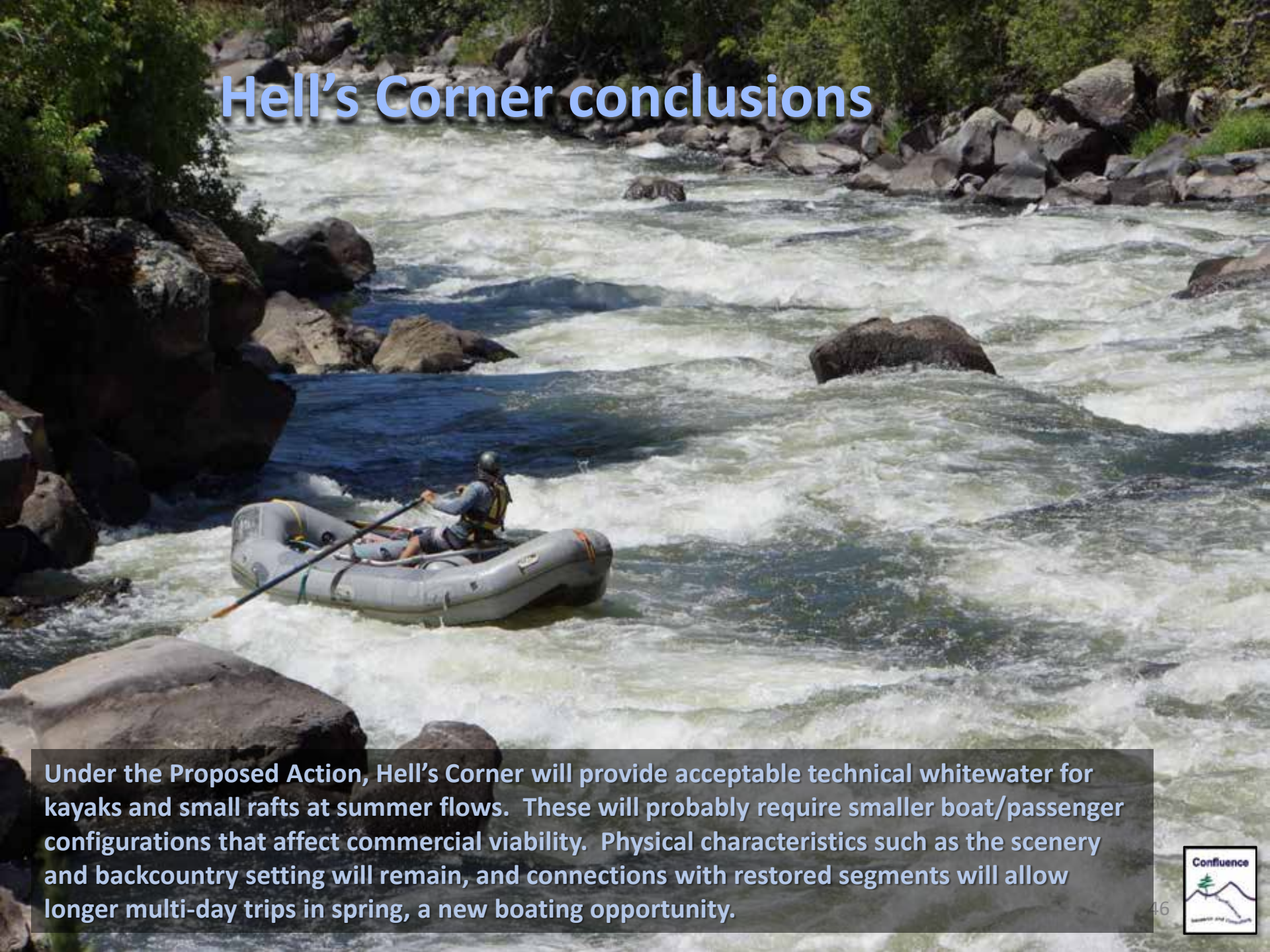
The Hell's Corner segment currently has road-accessible dispersed camping at Klamath River Campground (pictured here) and Frain Ranch, and one outfitter has developed a boat-in camp farther downstream. New multi-day trips connecting segments may be available during higher spring flows under the Proposed Action.

Hell's Corner Access

Access Number 6

Take-out options on the Hell's Corner segment are well-located, although some would benefit from improvements such as better organization or ramp hardening.

Hell's Corner conclusions



Under the Proposed Action, Hell's Corner will provide acceptable technical whitewater for kayaks and small rafts at summer flows. These will probably require smaller boat/passenger configurations that affect commercial viability. Physical characteristics such as the scenery and backcountry setting will remain, and connections with restored segments will allow longer multi-day trips in spring, a new boating opportunity.

Ward's Canyon segment

Ward's Canyon offers Class III/IV whitewater, outstanding basalt canyon scenery, and fine wildlife viewing (currently including two Great Blue Heron rookeries). In contrast to upstream segments, Ward's Canyon is a dramatic, narrow, steep-walled gorge that feels isolated and undeveloped despite its short length (about two miles).

Ward's Canyon whitewater

700 cfs

Ward's Canyon rapids are pool-drop, with interesting boulders, eddies, and route options. With a short shuttle and proximity to the I-5 corridor, Ward's Canyon could become a regional whitewater attraction for both guided and unguided boaters.

First drop

Inset photos at 700 cfs

Main photo at 800 cfs

At 800 cfs, the first drop below the dam was steep but well-covered, with more margin for error. At 700 cfs the boatable line was narrower, and some boats hit the center rock.

Powerful hydraulics

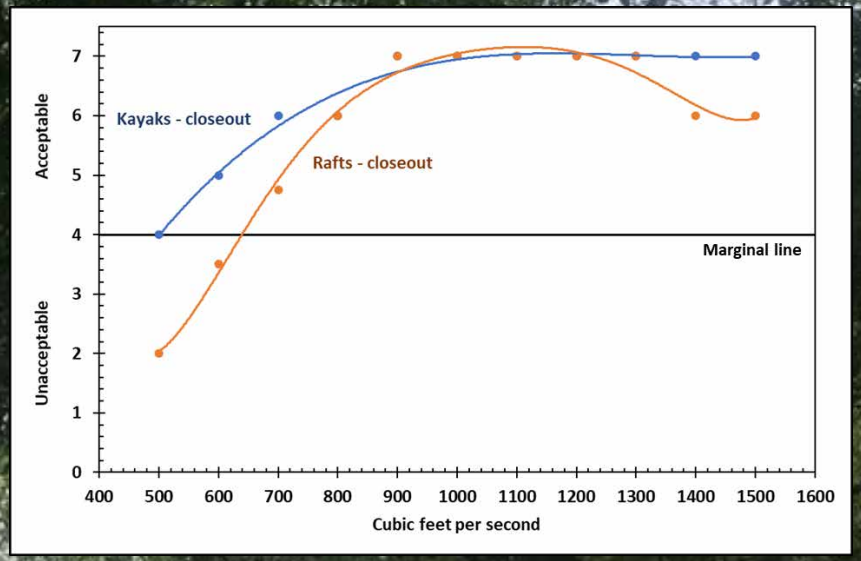
Even at 700 cfs

A concentrated low flow channel in Ward's Canyon produces powerful hydraulics and bigger waves at summer low flows (compared to Big Bend and Hell's Corner).

Ledge Rapid

At 800 cfs (main photo), this rapid had few boatability problems. At 700 cfs (all insert photos), only one raft (top left insert photos) found a clean line. Kayaks had multiple routes at both flows.

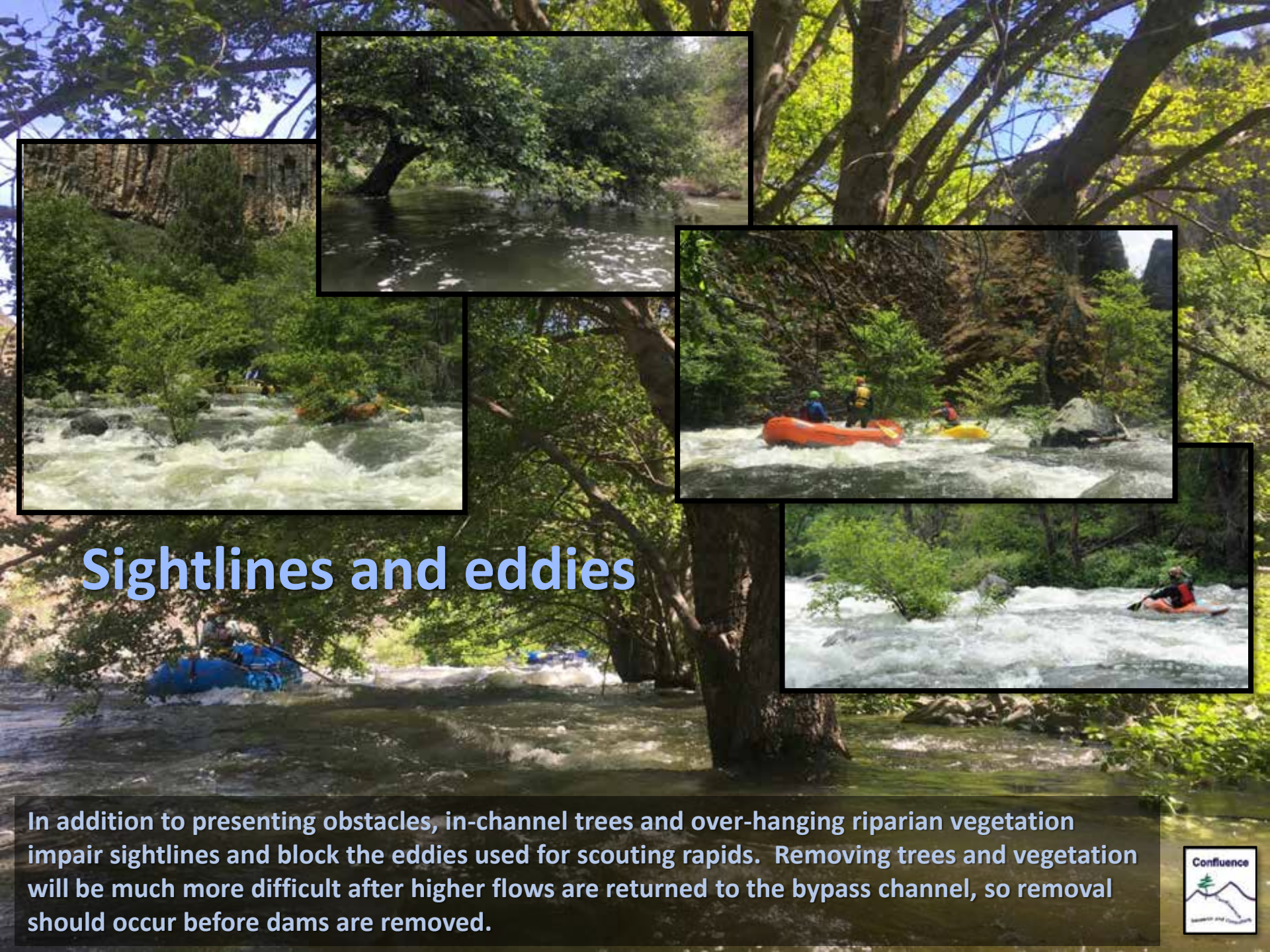
Ward's Canyon flow assessments



The first study flow of 800 cfs provided acceptable standard boating for kayaks and rafts. Recognizing that higher flows would increase quality, boaters requested 700 cfs for the second run to determine whether this lower flow would constrain guided rafting. This was shallower and more technical, but still provided acceptable rafting. Whitewater trips will improve at higher flows, with easier lines, more margin for error, and fewer pinning/wrapping hazards.

In-channel and riparian vegetation

Ward's Canyon has hundreds of trees that have grown in the de-watered channel during a century of very low hydro project bypass flows. Some trees have large diameters and will present safety/liability hazards for boaters at restored Proposed Action summer flows.



Sightlines and eddies

In addition to presenting obstacles, in-channel trees and over-hanging riparian vegetation impair sightlines and block the eddies used for scouting rapids. Removing trees and vegetation will be much more difficult after higher flows are returned to the bypass channel, so removal should occur before dams are removed.

Proposed Copco Valley access

Iron Gate Reservoir
(to be restored)

Ward's
Canyon

Copco I & II
dams (to be
removed)

Existing Road

Existing Copco
Lake Access

Proposed new
river access

Anticipated
restored
channel

Copco Reservoir
(to be restored)

This new site has received planning and design attention (see insets from Recreation Facilities Plan), despite cultural impact issues and an access road with steep grades and uncertain soil stability. This new access is important as a put-in for Ward's Canyon as well as a take-out for the easier segment upstream. As these issues are resolved, temporary Ward's Canyon access at Copco No. 2 Dam is an option.

Copco No. 2 Dam put-in

Access at Copco No. 2 Dam is currently restrictive, with parking high above the river, no ramp (boats were lowered down the dam abutment), and an eroded trail/overgrown riverbank. A boat slide and improved trail might allow temporary use of this site while Copco Valley access is developed.

Fall Creek take-out

The existing take-out at Fall Creek is functional and has been used for years to access Iron Gate Reservoir. The site requires better organization of parking and launching if use increases.

Potential powerhouse access

The Recreation Facilities Plan suggests access may be developed at this site when the existing powerhouse is removed, although the bank is precipitous, and the transmission sub-station is slated to remain. Study participants preferred downstream options due to easier road access, friendlier topography, and better location relative to restored river segments.

Possible Jenny Creek access

Fall Creek access

New rapid at constriction (view from downstream)?

Existing Jenny Creek access

New access?

Anticipated restored channel

Rapids may emerge in the restored channel after drawdown of reservoirs (main photo). For example, about one mile below Fall Creek (inset photo) the adjacent topography suggests a canyon constriction and possible rapid. If so, a new access at Jenny Creek would add this rapid to Ward's Canyon trips.

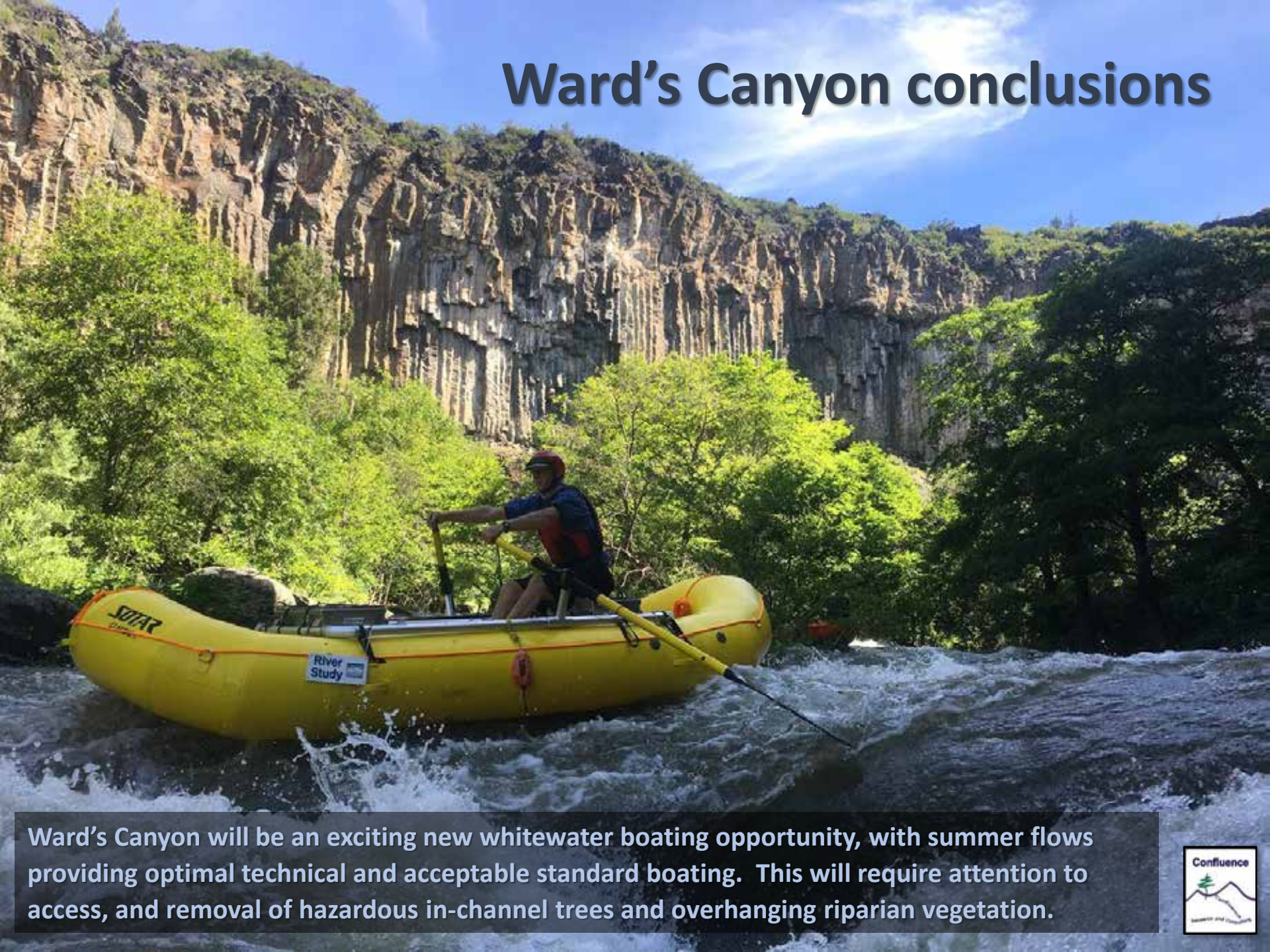
Confluence

Google

Guided rafting viability

Ward's Canyon will probably provide the best guided whitewater trips on the Upper Klamath River during lower summer flows. The run is short but has good rapids, and outfitters believe back-to-back runs with a lunch break will attract passengers. The shuttle is efficient, and good roads provide access from tourism centers in the Rogue Valley or Mount Shasta.

Ward's Canyon conclusions



Ward's Canyon will be an exciting new whitewater boating opportunity, with summer flows providing optimal technical and acceptable standard boating. This will require attention to access, and removal of hazardous in-channel trees and overhanging riparian vegetation.

Acknowledgements

Thanks to the boaters, photographers, and staff from BLM, CFWD, ODFW PacifiCorp, KRRC, AECOM, and McMillen Jacobs Associates who facilitated, participated in, or reviewed the study.

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