Defining Recreational Flow Needs in the Lower Dolores River

Stream Flow-Evaluations for Whitewater Boating

Nathan Fey
American Whitewater

Evan Stafford
CK Consulting / Reel Motion Media

Abstract:

Effects of in-stream flows on recreation values, such as whitewater boating, have profound impacts on the quality, quantity, and timing of whitewater boating opportunities in the Lower Dolores River. Recreational flows that provide the full range of whitewater boating opportunities for the Lower Dolores River, for various craft-types are not clearly defined. In this study, an online survey was completed by 366 commercial and non-commercial boaters, who evaluated flows for whitewater boating on the Dolores River, and identified low, acceptable and optimum flows for three different whitewater craft-types. Individual and group flow-evaluations, describe a range of flows that provide recreational value. Inverse "U-shaped" curves summarize the quality of boating opportunities for each measured stream-flow. Respondents also reported flows that provide certain recreation experiences, from technical low water to challenging high water trips, for different craft. Flow evaluations for each craft-type, provide information on flows in the Lower Dolores needed to sustain whitewater boating, and allow for a broader range of management opportunities that protect flow-dependant recreational values of the Lower Dolores River as described in the National Whitewater River Inventory (NWRI)[1].

[1] National Inventory of Whitewater Rivers; American Whitewater. http://www.americanwhitewater.org/content/River/view/

Contents

I. Introduction

The Dolores River, located in the southwest corner of Colorado, carves one of America's premier wild river canyons. For 170 miles, from McPhee Dam to the confluence with the Colorado River, the Dolores traverse some of the most remarkable landscapes in the desert southwest. The stream corridor provides rare fish and wildlife habitats, globally significant plant communities, and other flow-influenced natural resource values. In addition, the Dolores River provides high quality recreation values, such as whitewater boating. In their 1975 Wild and Scenic Rivers Report, the US Department of Interior recommended that Congress designate the Dolores River as Wild and Scenic for it's Outstandingly Remarkable Whitewater Boating Values. Increased need for out-of-stream agricultural, municipal, and industrial water use has decreased in-stream flows in the Dolores River below McPhee Dam. Recently, multiple efforts to pursue legal or administrative avenues for improving in stream flows for fish and recreation have begun in the Dolores River basin. This report provides information defining recreational flow-needs in the Lower Dolores River, including the quantity, timing, and frequency of stream flows that provide high-value whitewater boating opportunities below McPhee Dam.

Whitewater boating is a flow dependent recreational use of rivers, and considerable work evaluating flow-recreation relationships has occurred over the last several decades (Brown et al., 1992; Shelby, Brown, & Taylor, 1992; Whittaker et al., 1993). Many of the flow-recreation studies focus on whitewater floatboating, as flow often determines whether people have opportunities to take a trip and what level of challenge or social value is provided (Whittaker & Shelby, 2000). Different flow levels provide for varied floatboating opportunities. As flows increase from zero, different paddling opportunities and challenges exist within ranges of flows on a spectrum: too low, minimal acceptable, technical, optimal, high challenge, and too high. Standard methodologies[2] are used to define these flow ranges based on individual and group flow-evaluations. The various opportunities provided by different flow ranges are often described as occurring in various "niches" (Shelby et al., 1997). Studies have developed initial flow-evaluation curves for the Dolores River and provide a meaningful way to evaluate how flows affect recreation opportunities (Shelby & Whittaker, 1995). Mean responses to flow-evaluations provide useful descriptions of group agreement over flows, but highlight the need for sub-group evaluations, such as mean evaluations for each craft-type.

Whitewater Boating is enjoyed in different crafts, such as canoes, kayak, and rafts. Different craft types provide different opportunities for river-base recreation, from individual or small group trips, to large group multi-day excursions. Flows that provide greater social value for one type of craft, such as canoes, may not provide equivalent social value for rafting. Changes in flow can have direct effects on the quality of whitewater boating, for every craft type. Direct effects may change quickly and directly as flows change, such as safety in running rapids, number of boat groundings, travel times, quality of rapids, and beach and camp access. Indirectly, flows effect wildlife viewing, scenery, fish habitat, and riparian vegetation over the long term as a result of flow regime (Shelby et al. 1992b; Whittaker et al. 1993).

In order to minimize the effects of changing stream-flows on the Lower Dolores River from McPhee Dam, the US Bureau of Reclamation regulates streamflows "to encourage the most effective boating use by release of snowmelt runoff in anticipation of spills".[3] Clear definitions of recreational flow-needs in the Lower Dolores River will aide in the development of annual operating plans that balance Project Authorizations, and deliver predictable flows for recreational values, such as whitewater boating.

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[2] Whittaker, D., B. Shelby, J. Gangemi. 2005. Flows and Recreation, A guide to studies for river professionals. US Department of Interior, National Park Service, Anchorage, AK

[3] US Bureau of Reclamation; Definite Plan Report, 1977

II. Dolores River Whitewater Boating – Stream flow effects on recreational use.

In May of 1948, Otis "Doc" Marston led a group of adventurers down the Dolores River from Cahone to the Colorado River[4]. Prior to this expedition, earlier runs by Preston Walker and Norm Nevills indicate that the Dolores River has thrilled rafters and kayakers since the 1930s. In the years since, people from all over the world have traveled to the SW Corner of Colorado to experience the Dolores, a river widely regarded as second only to the Grand Canyon for it's whitewater boating opportunities.

In the 1975 Dolores River Wild and Scenic River Study Report[5], state and federal agencies recommended that 105 miles of the Dolores River be included in the National Wild and Scenic Rivers System for it's recreational values, including Rafting and Kayaking. Recreational use reached a high in 1976 of 3200 "boater-days". During the 46-year Period of Record for the WSR study, "boating opportunities occurred in nearly every year" (only 2 years had none).

In their 1977 Final Environmental Impact Statement for the Dolores Project, the Bureau of Reclamation (BOR) describes the increasing popularity of rafting and kayaking on the Dolores River. The Dolores Project was shown to adversely affect whitewater recreation below McPhee Dam, as flows were reduced. Based on the 46-year period of record for the 1976 WSR Study, changes in stream flow under the Dolores Project would result in 24 years with no boating opportunities or about one out of every five years (Dolores Project Final EIS, U.S. Bureau of Reclamation, 1977). Annual boating use was expected to decrease from over 2800 boating days to within a range of 1333 to 1937 boater days[6], *"depending upon the effectiveness of efforts to make the most efficient use of available flows through grouping in periods of 5 or more consecutive days and public awareness of forecasted flows" (Dolores Project FEIS, pg. C-38. 1977).* Usable Days, referred to as "launching Days[7]" under the 1977 FEIS, were projected to decrease by an annual average of 30.7 days between April 25 to July 1 (54.6 without Project / 23.9 with Project).

With the completion of McPhee Dam and Reservoir in 1987, the primary storage facility for the BOR's Dolores Project, 69 percent of the historic flow of the Dolores River is depleted annually (BLM, 1990), as opposed to 39 percent before Project construction. Flow-Evaluation surveys were conducted as part of a larger in stream flow needs assessment undertaken by the BLM and prompted by concern over effects from McPhee Dam on flow-dependant values (Shelby and Whittaker, 1995). With completion of the Dolores Project, user-days for whitewater boating have declined measurably below McPhee Dam. Commercial Use reached a peak on the Dolores River in 1995 at 3,257 User-days, injecting over $371,304 in direct expenditures into local economies with an economic impact of $950,538 (CROA. 2010). From 1988-1998, there were 1614 Commercial User-days annually on average, contributing $183,996 in direct expenditures. In the following decade, 1999 and 2009, these figures had dropped to 383 average annual commercial user-days and $43,662 in direct expenditures. In 2010 there were only 112 Commercial User-days and $12,960 in direct expenditures. The FEIS for the Dolores Project suggests that boating flows would not be available below McPhee Dam in the long term, depending on the "scheduling and prediction program for releases".

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[4] Running the Dolores River, Otis Marston, 1948

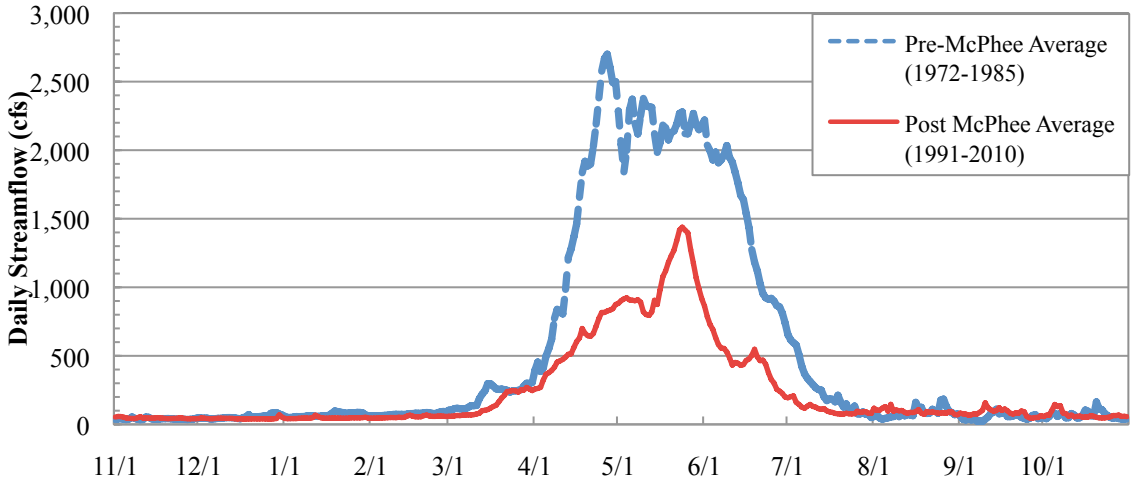
[5] Colorado Department of Natural Resources, U.S. Department of Agriculture, and U.S. Department of Interior, Dolores River: Wild and Scenic River Study Report December 1975.

[6] Figures based on maximum use rate of 80 percent of flows during may 21 to June 10 (BOR, 1977).

[7] In their 1977 FEIS, the US Bureau of Reclamation defines a "launching Day" as "the occurrence of riverflows of 500 second-feet of greater of snowmelt runoff. Under Project Conditions all launching days would occur in groups of 5 or more consecutive days" USBOR, Dolores Project FEIS, Pg. C-38)

Table A

Dolores River at Bedrock
Average Daily Streamflow (USGS Gage 09169500)



Note: Daily streamflow at the Dolores River at Bedrock streamgage is based upon data obtained from USGS (National Water Information System).

III. Recreational Flow Assessment – Defining Whitewater Boating Stream flow Needs

In stream flow, the amount of water in a river, fundamentally affects recreation quality in most river settings. In the short term, flows determine whether a river provides opportunities for boating, and they affect attributes such as the challenge of whitewater or trip aesthetics (Brown, Taylor, & Shelby, 1991; Whittaker et al., 1993; Whittaker & Shelby, 2002). Longer-term flow regimes may also have effects on ecological resources (Bovee, 1996; Richter et al., 1997; Tharme, 2002), riparian environments (Jackson & Beschta, 1992), or channel features such as beaches, pools, and riffles (Hill et al., 1991).

To develop standards that define whitewater boating flow needs on the Dolores River, American Whitewater collected and organized personal evaluations of resource conditions, and recreation-relevant hydrology consistent with NPS methodologies. An online survey conducted in 2010, involved 366 commercial and non-commercial boaters. Respondent numbers for the Dolores River Flow Survey were the largest to date for any American Whitewater flow survey and it has one of largest respondent groups for any flow-recreation experience based survey since the technique was developed in the early 1980's. For the survey n = 366 with 97% of respondents identifying themselves as private paddlers, 76% identifying themselves as advanced or expert paddlers, and 82% paddling 5-20+ days per season. A wide range of craft types were surveyed with rafters (64%), kayakers (30%), and canoeists (6%) all represented.

Study respondents were asked to evaluate overall recreation quality for each measured flow on the Dolores River, using a seven-point "acceptability" scale (unacceptable -3 and acceptable 3). Using a survey-based normative approach, individual evaluations of flows are aggregated into social norms, which describe the group's collective evaluation of those same stream flows (Shelby et al., 1996; Whittaker, 1997). Structural norm characteristics were used to graphically represent the range of acceptable flows for whitewater boating opportunities. Mean evaluation for each flow condition is plotted graphically to create the social norm or flow-acceptability curves. This approach has been applied to stream flows for recreation in several studies, including the Colorado River (Shelby and Whittaker, 1995, Shelby et al. 1992a, Vandas et al. 1990)

Flow-Acceptability curves

Flow-acceptability curves graphically relate flow to evaluations of recreational quality. In most cases, the curves show inverted U shapes where low flows and high flows provide low quality recreation conditions, while medium flows provide more optimal conditions. Flow Acceptability Agreement Index (Potential for Conflict Index or FAAI) determines minimum acceptable flows and respondent agreement regarding the acceptability of each specific flow level (Figures and Tables 1-5, Appendix A). Mean aggregate evaluations for Segments 1-5 of the Lower Dolores River are summarized in Table B.

Table B
Acceptable and Optimal Flows for Whitewater Boating
Dolores River below McPhee Dam

Lower Dolores River Segment	Lowest Acceptable Flows (CFS)	Optimal Flows (CFS)	Highest Acceptable Flows (CFS)
1) Bradfield to Dove Creek	900	1900-2100	10,000+
2) Dove Creek to Slickrock	900	2100-2500	10,000+
3) Slickrock to Bedrock	900	2100-2500	10,000+
4) Bedrock to Gateway	900	2100-2700	10,000+
5) Gateway to Colorado River	900	1900-2700	10,000+

Lowest acceptable flow for all segments below McPhee Reservoir was 900 cfs (mean), however aggregated acceptability values barely hovered above the neutral line, ranging from 0.08 - 0.47 (means range between unacceptable -3 and acceptable 3). Flow Acceptability Agreement Index statistics for 900 cfs show considerable disagreement between respondents, ranging between 0.38 – 0.51 (FAAI statistics range between 0 complete agreement, to 1 complete disagreement). An open response question asking respondents to identify the lowest acceptable flow returned median scores between 700-800 cfs, suggesting that the minimum acceptable flow for a large percentage of respondents is lower than 900 cfs (Table 6).

Optimum flows ranged between 1900 – 2700 cfs, with extremely high agreement levels (FAAI's ranging between 0.0 – 0.05). Mean acceptability for high flows never fell below the neutral line, even up to 10,000 cfs. An open response question asking respondents to identify the highest acceptable flow returned a median score of 5000 cfs, suggesting that recreation quality declines as flows exceed 5000 cfs, but may not drop below acceptable levels.

Specific Flow Evaluation

Survey Respondents reported flows that provide different paddling experiences, or "niches" along a spectrum: minimum, low, technical, standard, high challenge, and too high. These "niches" relate stream flow to the full range of whitewater boating opportunities. Aggregate flow evaluations for each study segment define each "niche" opportunity or whitewater boating experience (Table C). Specific flow-evaluations for each craft-type are summarized in Table D.

Table C

Median Minimum, Low, Technical, Standard, High and Maximum Flows
Dolores River below McPhee Reservoir

Lower Dolores River Segment	Minimum Flow (CFS)	Low Flow (CFS)	Technical Flow (CFS)	Standard Flow (CFS)	High Flow (CFS)	Maximum Flow CFS)
1) Bradfield to Dove Creek	700	900	800	1500	3500	5000
2) Dove Creek to Slickrock	800	1000	900	1500	3500	5000
3) Slickrock to Bedrock	800	1000	800	1500	3500	5000
4) Bedrock to Gateway	800	1000	800	1400	4000	5000
5) Gateway to Colorado River	800	1000	900	1700	3500	5000

Table D

Median Minimum, Low, Technical, Standard, High and Maximum Flows
Dolores River below McPhee Reservoir

Lower Dolores River Flows **Canoe**	Minimum Flow (CFS)	Low Flow (CFS)	Technical Flow (CFS)	Standard Flow (CFS)	High Flow (CFS)	Maximum Flow CFS)
1) Bradfield to Dove Creek	600	900	700	1550	2250	3000
2) Dove Creek to Slickrock	700	1100	700	1500	3000	3200
3) Slickrock to Bedrock	500	900	700	1500	2500	3000
4) Bedrock to Gateway	700	900	700	2000	3000	3500
5) Gateway to Colorado River	500	775	600	1200	2500	1900

Lower Dolores River Flows **Kayak**	Minimum Flow (CFS)	Low Flow (CFS)	Technical Flow (CFS)	Standard Flow (CFS)	High Flow (CFS)	Maximum Flow CFS)
1) Bradfield to Dove Creek	700	900	900	1500	3000	5000
2) Dove Creek to Slickrock	700	1000	800	1500	3000	5000
3) Slickrock to Bedrock	700	800	800	1500	3500	5000
4) Bedrock to Gateway	700	1000	800	1500	4000	6000
5) Gateway to Colorado River	700	1000	900	1500	3500	5000

Lower Dolores River Flows **Raft/Cataraft**	Minimum Flow (CFS)	Low Flow (CFS)	Technical Flow (CFS)	Standard Flow (CFS)	High Flow (CFS)	Maximum Flow CFS)
1) Bradfield to Dove Creek	700	900	850	1500	3500	5000
2) Dove Creek to Slickrock	800	1000	900	1500	3300	4000
3) Slickrock to Bedrock	800	1000	800	1500	3500	5000
4) Bedrock to Gateway	800	1000	900	1500	3500	5000
5) Gateway to Colorado River	800	1000	900	1800	3500	5000

Specific flow evaluations can define specific flows needed to provide the full range of whitewater boating opportunities for each craft type. Table E summarizes defined recreational flow needs for whitewater boating on the Dolores River below McPhee Dam, measured at Dolores River below McPhee streamgage. Table F summarizes defined flow needs for whitewater boating in the Dolores River from Bedrock to Colorado River, measured at Dolores River near Bedrock Streamgage.

Table E

Recreational Flow Ranges for the Lower Dolores River
Segments 1-3 (Dolores River below McPhee streamgage)

Craft-type	Minimum Flow (CFS)	Low Flows (CFS)	Standard Flows (CFS)	High Flows (CFS)
Canoe	500 - 700	700 – 1100	1100 – 1500	1500 –3000
Kayak	700 - 900	900 – 1500	1500 – 3000	3000-5000
Raft	700 - 800	800 - 1500	1500 – 3500	3500-5000

Table F

Recreational Flow Ranges for the Lower Dolores River
Segments 4-5 (Dolores River near Bedrock streamgage)

Craft-type	Minimum Flow (CFS)	Low Flows (CFS)	Standard Flows (CFS)	High Flows (CFS)
Canoe	500 - 700	700 – 900	1200 – 2500	2250 –3500
Kayak	700 - 1000	1000 – 1500	1500 – 4000	4000-6000
Raft	800-1000	1000 - 1500	1500 – 3500	3500-5000

Results suggest several interesting findings. First, they highlight the significant differences between open canoes and other common whitewater craft. All four identified experience niches are described by flows that are lower for canoes than other craft types. In addition, minimum flows for rafts are considerably higher than those for all other boats, highlighting the differences in flows required by larger craft.

Secondly, there is a considerable difference between overall flow evaluations for whitewater boating, and for specific flow evaluations for each craft – type. Integrating overall and specific flow evaluations aides in describing the value of resource conditions affected by flow, and prove useful in effective river management or annual operating planning process by identifying the full range of flows that provide for a particular Whitewater Boating opportunity. The greater the range for whitewater boating, the greater the opportunity for resource managers to provide the most appropriate boating use given hydrologic conditions.

IV. Conclusion

This draft summarizes American Whitewater's 2010 assessment of flow needs for whitewater boating in the Lower Dolores River. An online survey conducted in 2010, involved 366 commercial and non-commercial boaters, with 97% of respondents identifying themselves as private paddlers, 76% as advanced or expert paddlers, and 82% paddle 5-20+ days per season. A wide range of craft types were surveyed with rafters (64%), kayakers (30%), and canoeists (6%) all represented.

Survey-based normative evaluations of flow were used to rate minimum, optimal, and high flow needs for whitewater boating. In aggregate, survey respondents rated flows of 900 cfs as lowest acceptable, while flows between 1900-2700 cfs provide for optimal flows across all five study-segments. Highest acceptable flows were greater than 10,000 cfs for all whitewater craft.

Disagreement over flow acceptability suggests that a large number of respondents found flow levels above 5,000 cfs, unacceptable. Using a similar graphical approach, aggregate flow-evaluations were plotted for each study segment, and highlight some disagreement on flow-acceptability (Appendix B). Results suggest that for different whitewater boating craft, different sets of challenges and flow values may exist. Specific Flow evaluations are used to identify flows needed for distinct opportunities or experience "niches" – Low Flow Challenge, Optimal, and High Flow Challenge. Flow-needs across the full range of experiences are summarized in Tables G and F for each craft-type, and report significantly lower flows for whitewater open-canoes, than for kayaks or rafts.

Table G

Flow Ranges for Low, Optimal, and High Challenge Whitewater Boating Opportunities
Lower Dolores River ***– Bradfield Bridge to Bedrock*** *(Dolores River below McPhee streamgage)*

Craft-type	Low Flows (CFS)	Optimal Flows (CFS)	High Flows (CFS)
Canoe	500 – 1100	1100 – 1500	1500 –3000
Kayak	700 – 1000	1000 – 3000	3000-6000
Raft	700 - 1000	1000 – 3500	3500-5000

Table H

Flow Ranges for Low, Optimal, and High Challenge Whitewater Boating Opportunities
Lower Dolores River - ***Bedrock to Colorado River*** *(Dolores River near Bedrock streamgage)*

Craft-type	Low Flows (CFS)	Optimal Flows (CFS)	High Flows (CFS)
Canoe	500 – 900	900 - 2500	2500 – 3500
Kayak	700 - 1000	1000 – 3500	3500 – 6000
Raft	800 – 1000	1000 – 3500	3500 – 5000

Stream-flows affect the recreation experience in a number of ways from determining whether a stretch has recreational value, or provides a range of opportunities from technical low flows or a high water, high challenge experiences. This report provides key information needed in understanding the relationship between instream flows and whitewater boating, and can aid in the creation of standards for flow allocation negotiations. Defined flow-needs for recreation are crucial elements in any management planning or decision-making process. On rivers with hydroelectric projects and where Wild and Scenic River Suitability is under consideration, flow management is a central issue.

Literature Cited (incomplete)

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Appendix A

Figure 1

Flow Acceptability Agreement Index Curve for Bradfield Launch to Dove Creek Pump Station
(Flows represented are flow levels at USGS Dolores below McPhee Reservoir Gauge)

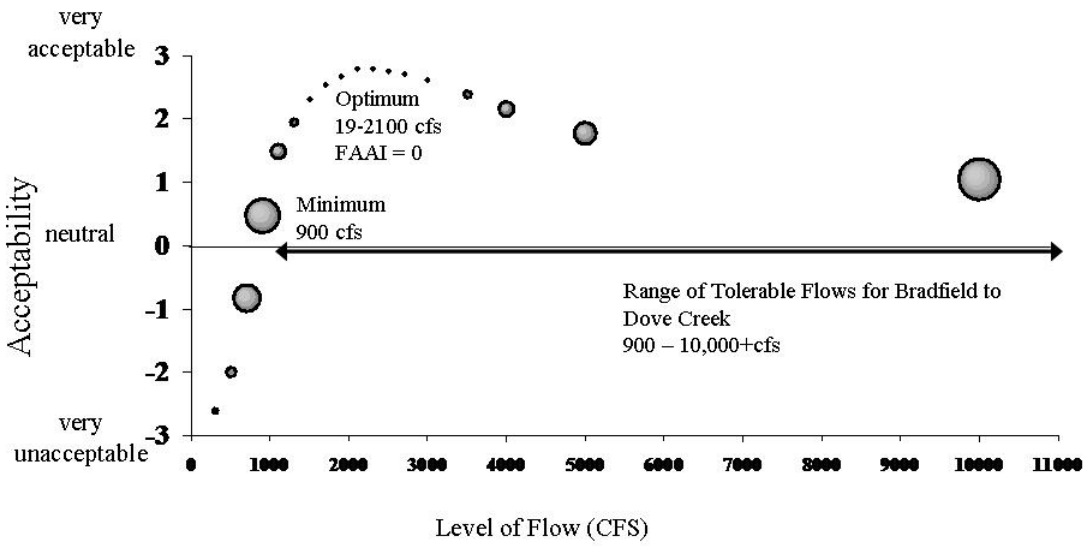


Table 1

Bradfield Launch to Dove Creek Pump Station
Mean Acceptability Scores and Flow Acceptability Agreement Index
(Flows represented are flow levels at USGS Dolores below McPhee Reservoir Gauge)

Specific Flow CFS	Mean Acceptability	FAAI
300	-2.62	0.05
500	-2.01	0.12
700	-0.84	0.30
900	0.47	0.38
1100	1.48	0.17
1300	1.94	0.09
1500	2.31	0.04
1700	2.54	0.01
1900	2.68	0.00
2100	2.79	0.00
2300	2.79	0.01
2500	2.76	0.03
2700	2.72	0.03
3000	2.61	0.03
3500	2.38	0.09
4000	2.16	0.15
5000	1.78	0.25
1000	1.05	0.45

Figure 2

Flow Acceptability Agreement Index Curve for Dove Creek Pump Station to Slickrock
(Flows represented are flow levels at USGS Dolores below McPhee Reservoir Gauge)

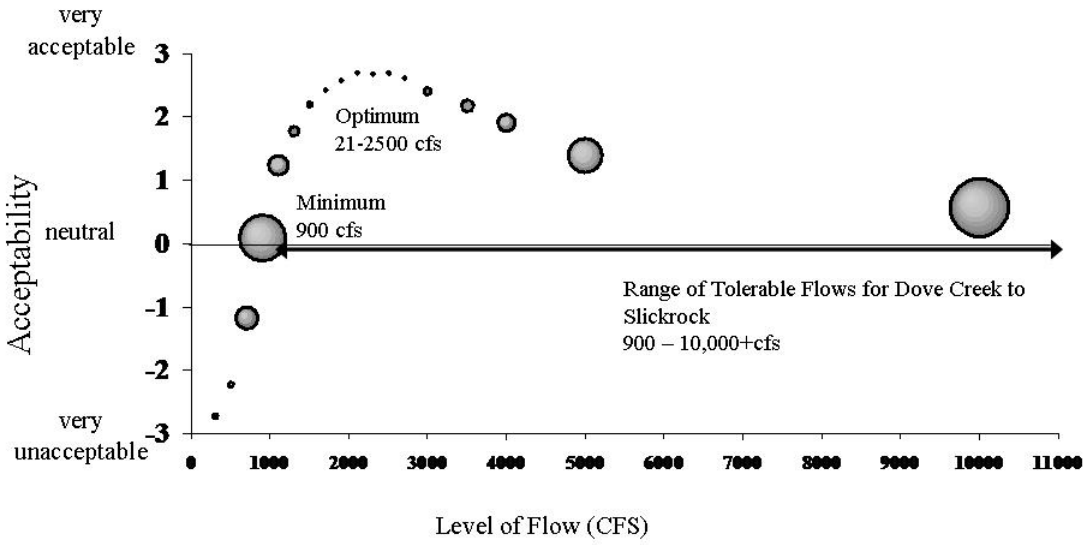


Table 2

Dove Creek Pump Station to Slickrock
Mean Acceptability Scores and Flow Acceptability Agreement Index
(Flows represented are flow levels at USGS Dolores below McPhee Reservoir Gauge)

Specific Flow CFS	Mean Acceptability	FAAI
300	-2.73	0.03
500	-2.24	0.07
700	-1.17	0.25
900	0.08	0.50
1100	1.24	0.21
1300	1.78	0.12
1500	2.2	0.05
1700	2.43	0.03
1900	2.58	0.03
2100	2.7	0.02
2300	2.67	0.02
2500	2.69	0.03
2700	2.61	0.05
3000	2.41	0.08
3500	2.17	0.14
4000	1.91	0.20
5000	1.39	0.37
1000	0.56	0.61

Figure 3

Flow Acceptability Agreement Index Curve for Slickrock to Bedrock
(Flows represented are flow levels at USGS Dolores below McPhee Reservoir Gauge)

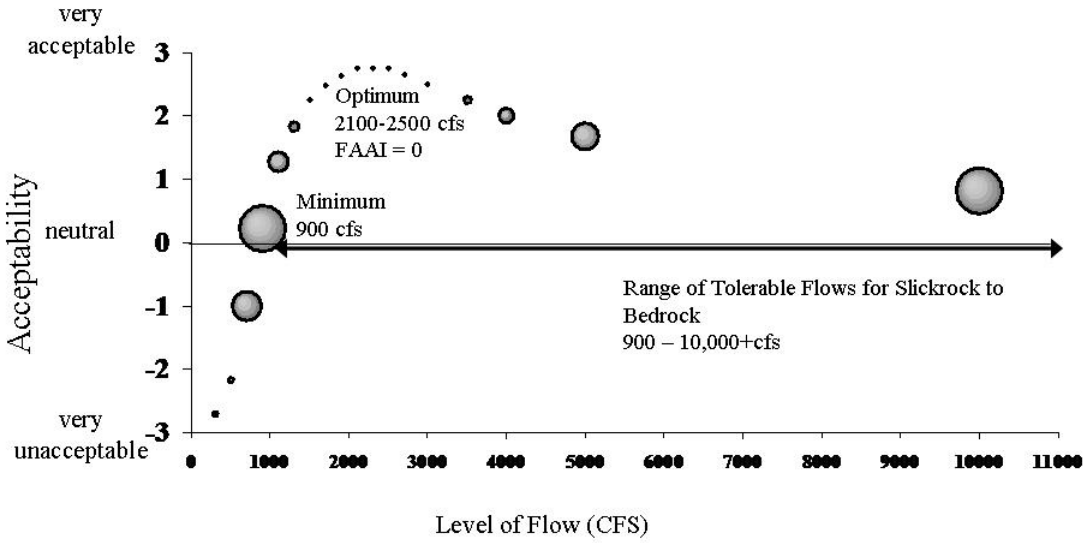


Table 3

Slickrock to Bedrock
Mean Acceptability Scores and Flow Acceptability Agreement Index
(Flows represented are flow levels at USGS Dolores below McPhee Reservoir Gauge)

Specific Flow CFS	Mean Acceptability	FAAI
300	-2.71	0.02
500	-2.17	0.06
700	-1	0.31
900	0.22	0.49
1100	1.27	0.21
1300	1.84	0.11
1500	2.26	0.02
1700	2.49	0.03
1900	2.64	0.00
2100	2.75	0.00
2300	2.75	0.01
2500	2.75	0.02
2700	2.65	0.03
3000	2.51	0.06
3500	2.25	0.10
4000	2.01	0.17
5000	1.68	0.30
1000	0.82	0.51

Figure 4

Flow Acceptability Agreement Index Curve for Bedrock to Gateway
(Flows represented are flow levels at the USGS Dolores nr Bedrock Gauge)

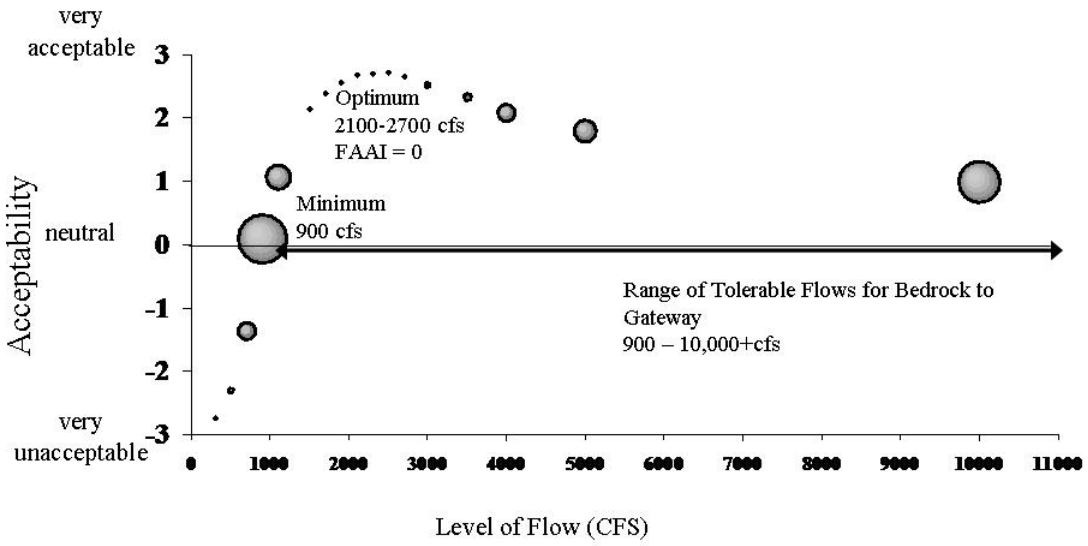


Table 4

Bedrock to Gateway
Mean Acceptability Scores and Flow Acceptability Agreement Index
(Flows represented are flow levels at the USGS Dolores nr Bedrock Gauge)

Specific Flow CFS	Mean Acceptability	FAAI
300	-2.75	0.02
500	-2.31	0.05
700	-1.37	0.19
900	0.08	0.51
1100	1.07	0.25
1300	1.76	0.10
1500	2.14	0.05
1700	2.39	0.02
1900	2.55	0.00
2100	2.67	0.00
2300	2.7	0.01
2500	2.71	0.02
2700	2.66	0.05
3000	2.53	0.07
3500	2.33	0.10
4000	2.08	0.18
5000	1.79	0.24
1000	0.99	0.43

Figure 5

Flow Acceptability Agreement Index Curve for Gateway to Colorado River
(Flows represented are flow levels at the USGS Dolores nr Bedrock Gauge)

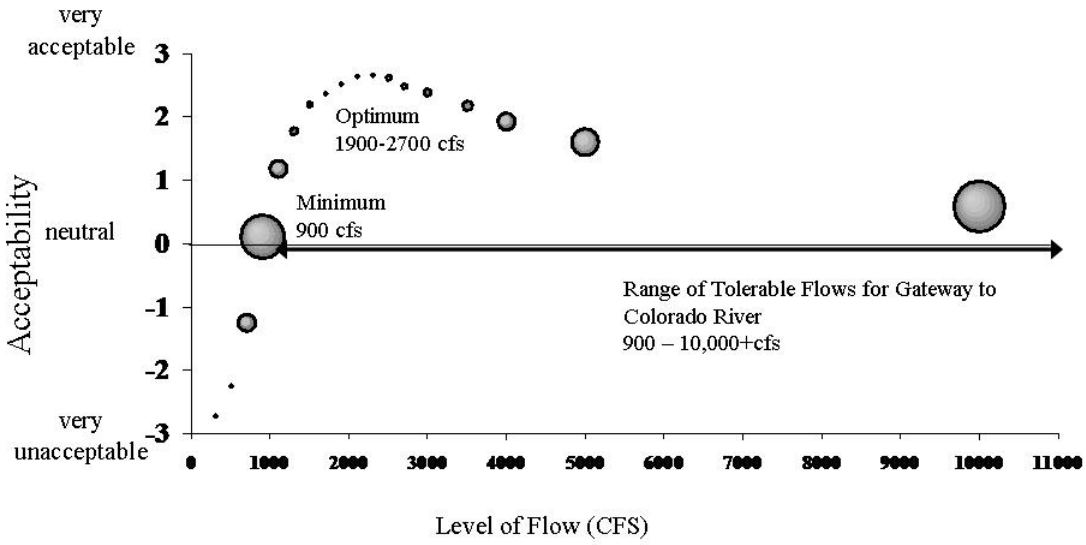


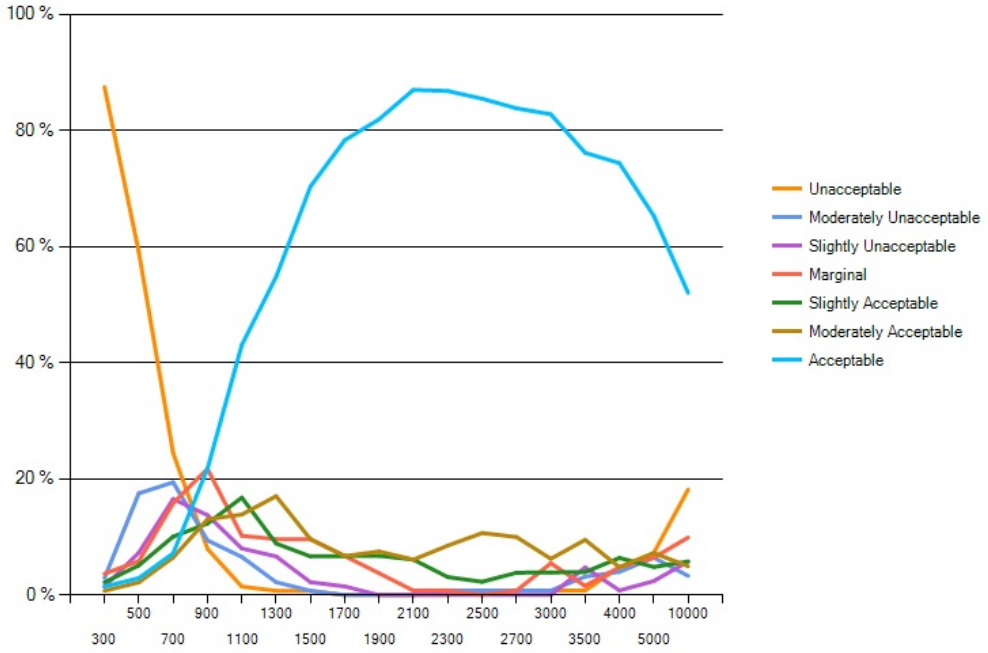
Table 5

Gateway to Colorado River
Mean Acceptability Scores and Flow Acceptability Agreement Index
(Flows represented are flow levels at the USGS Dolores nr Bedrock Gauge)

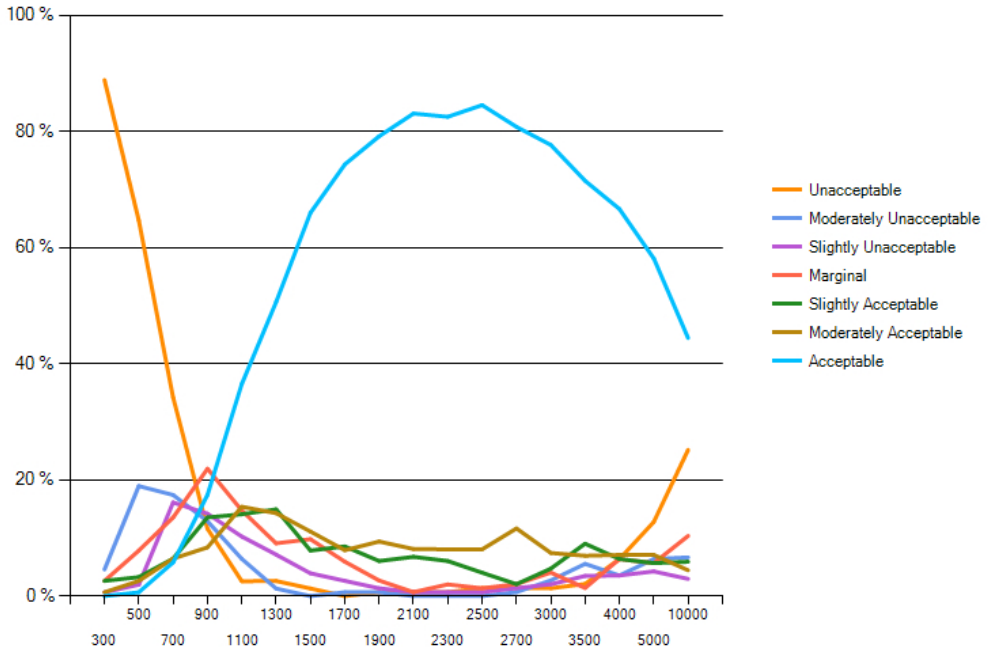
Specific Flow CFS	Mean Acceptability	FAAI
300	-2.74	0.02
500	-2.26	0.04
700	-1.26	0.19
900	0.1	0.46
1100	1.18	0.18
1300	1.78	0.10
1500	2.19	0.07
1700	2.37	0.05
1900	2.52	0.05
2100	2.63	0.04
2300	2.65	0.04
2500	2.61	0.05
2700	2.48	0.06
3000	2.38	0.08
3500	2.17	0.12
4000	1.93	0.19
5000	1.6	0.28
1000	0.58	0.56

Appendix B

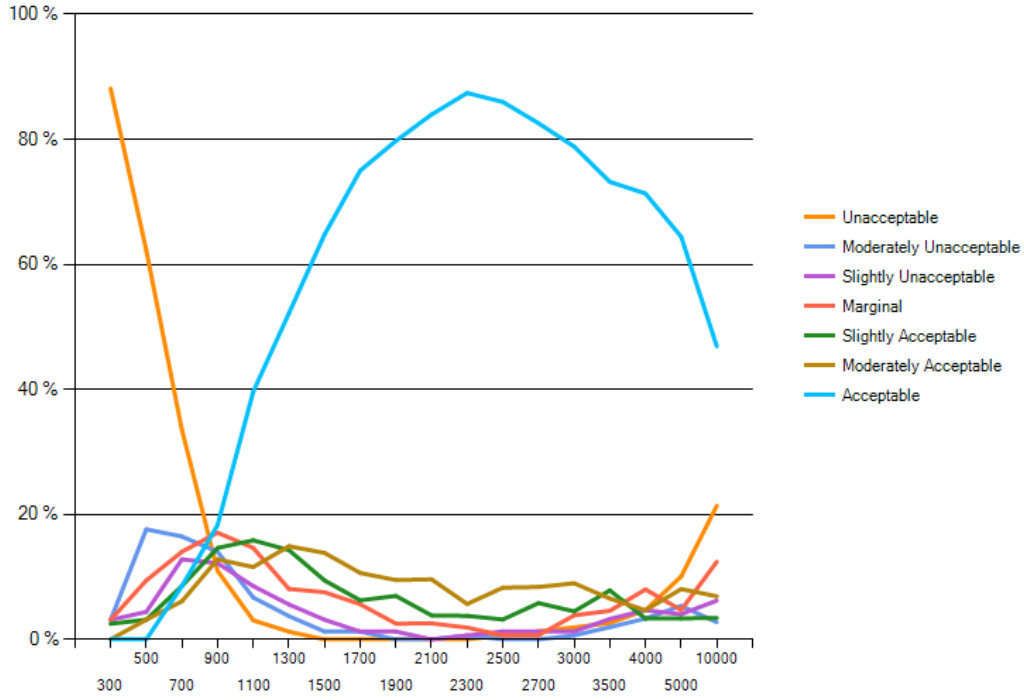
Plot 1
Aggregate Flow Evaluations
Bradfield Bridge to Dove Creek Pump Station
USGS Dolores below McPhee Reservoir Gauge.



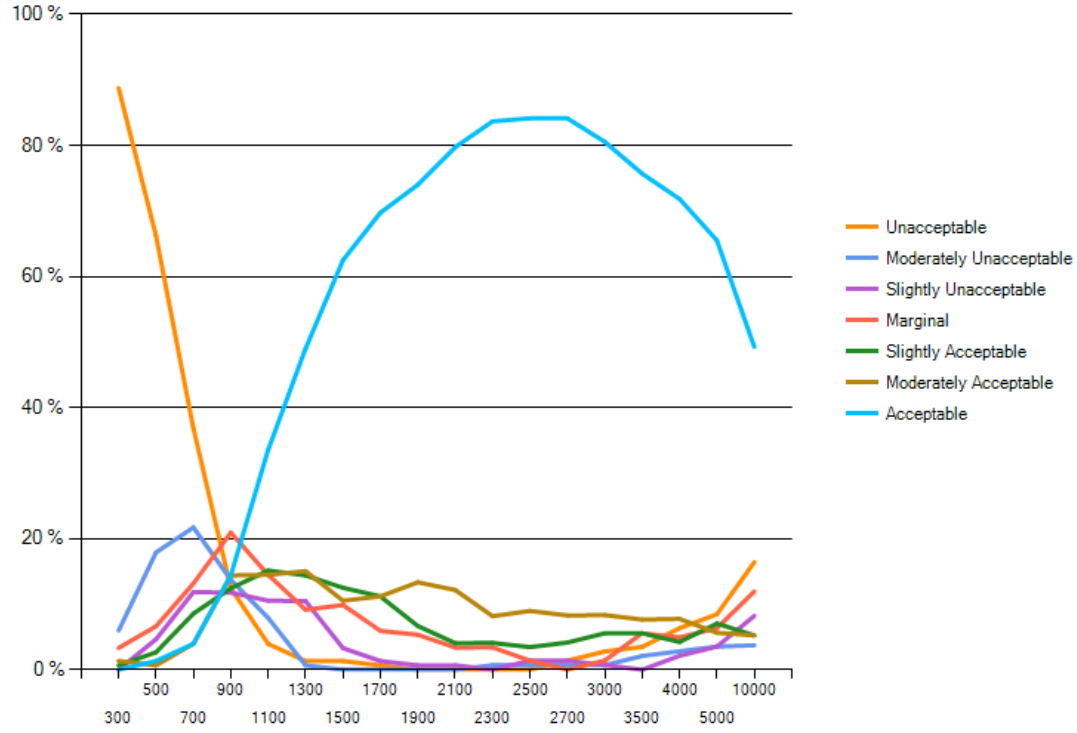
Plot 2
Aggregate Flow Evaluations
Dove Creek Pump Station to Slickrock USGS Dolores below McPhee Reservoir Gauge.

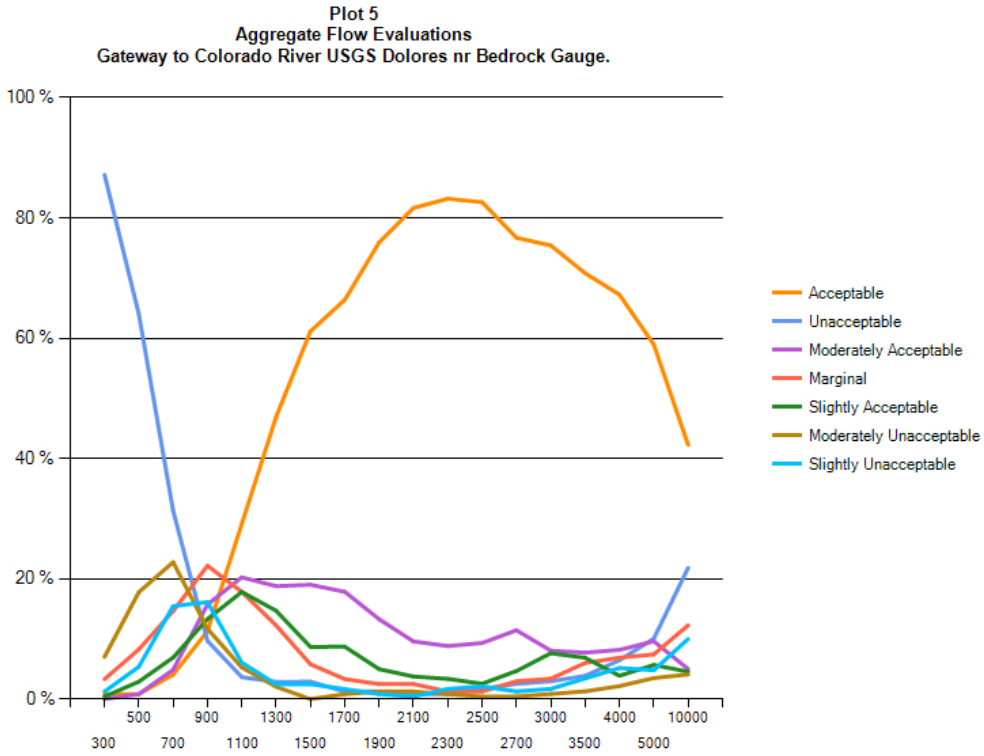


Plot 3
Aggregate Flow Evaluations
Slickrock to Bedrock USGS Dolores below McPhee Reservoir Gauge.



Plot 4
Aggregate Flow Evaluations
Bedrock to Gateway USGS Dolores nr Bedrock Gauge.




Plot 5
Aggregate Flow Evaluations
Gateway to Colorado River USGS Dolores nr Bedrock Gauge.
100 %
80 %
60 %
40 %
20 %
0 %
300
500
700
900
1100
1300
1500
1700
1900
2100
2300
2500
2700
3000
3500
4000
5000
10000
Acceptable
Unacceptable
Moderately Acceptable
Marginal
Slightly Acceptable
Moderately Unacceptable
Slightly Unacceptable

Appendix C

A subset of FERC regulated hydropower projects at which discrete usable boating days have been scheduled and/or provided as mitigation for impacts to whitewater boating, and/or analyzed as part of a whitewater flow study.

River	Project Name	State	FERC Project #
COOSA RIVER	JORDAN DAM	AL	00618
COOSA RIVER	MITCHELL	AL	00082
BUTTE CREEK	FORKS OF BUTTE	CA	06896
FEATHER RIVER	FEATHER RIVER	CA	02100
KERN RIVER	BOREL	CA	00382
KERN RIVER	ISABELLA	CA	08377
KERN RIVER	KERN CANYON	CA	00178
KERN RIVER	KERN RIVER NO 1	CA	01930
KERN RIVER	KERN RIVER NO 3	CA	02290
KINGS RIVER	PINE FLAT	CA	02741
MIDDLE FORK AMERICAN R	MIDDLE FORK AMERICAN RIVER	CA	02079
MIDDLE FORK STANISLAUS RIVER	BEARDSLEY/DONNELLS	CA	02005
N FK KINGS R	HAAS-KINGS RIVER	CA	01988
NORTH FORK FEATHER RIVER	POE	CA	02107
NORTH FORK FEATHER RIVER	ROCK CREEK-CRESTA	CA	01962
NORTH FORK FEATHER RIVER	UPPER NORTH FORK FEATHER RIVER	CA	02105
NORTH FORK MOKELUMNE RIVER	MOKELUMNE RIVER	CA	00137
PIRU CREEK	SANTA FELICIA	CA	02153
PIT RIVER	MCCLOUD-PIT	CA	02106
PIT RIVER	PIT 3, 4, & 5	CA	00233
PIT RIVER	PIT NO. 1	CA	02687
SAN JOAQUIN R	KERCKHOFF	CA	00096
SAN JOAQUIN RIVER	BIG CREEK NO 3	CA	00120
SAN JOAQUIN RIVER	BIG CREEK NO 4	CA	02017
SAN JOAQUIN RIVER	BIG CREEK NO.1 & NO.2	CA	02175
SOUTH FORK AMERICAN R	UPPER AMERICAN RIVER	CA	02101
SOUTH FORK AMERICAN RIVER	CHILI BAR	CA	02155
SOUTH FORK FEATHER RIVER	SOUTH FEATHER POWER	CA	02088
SOUTH FORK OF THE AMERICAN RIVER	EL DORADO	CA	00184
SOUTH YUBA RIVER	DRUM-SPAULDING	CA	02310
SOUTH YUBA RIVER	YUBA-BEAR	CA	02266
STANISLAUS R MIDDLE FORK	SAND BAR	CA	02975
STANISLAUS RIVER	SPRING GAP-STANISLAUS	CA	02130
WEST BRANCH FEATHER RIVER	DESABLA-CENTERVILLE	CA	00803
TALLULAH RIVER	NORTH GEORGIA	GA	02354

BEAR RIVER	BEAR RIVER	ID	00020
DEAD RIVER	FLAGSTAFF STORAGE	ME	02612
KENNEBEC RIVER	INDIAN POND	ME	02142
MAGALLOWAY RIVER	AZISCOHOS [?]	ME	04026
RAPID RIVER	UPPER & MIDDLE DAMS STORAGE	ME	11834
S BR PENOBSCOTT R	CANADA FALLS	ME	
W BR PENOBSCOT R	PENOBSCOT	ME	02458
W BR PENOBSCOT R	RIPOGENUS	ME	02572
SWAN RIVER	BIGFORK	MT	02652
WEST ROSEBUD CREEK	MYSTIC LAKE	MT	02301
PIGEON RIVER	WALTERS	NC	00432
TUCKASEGEE RIVER	DILLSBORO	NC	02602
WEST FORK TUCKASEGEE RIVER	WEST FORK	NC	02686
NANTAHALA RIVER	NANTAHALA	NC	02692
EF TUCKASEGEE	EAST FORK	NC	02698
ANDROSCOGGIN RIVER	PONTOOK	NH	02861
PEMIGEWASSET RIVER	AYERS ISLAND	NH	02456
HOOSIC RIVER	HOOSIC	NY	02616
MONGAUP RIVER	RIO	NY	09690
MOOSE RIVER	MOOSE RIVER	NY	04349
RAQUETTE RIVER	[STONE VALLEY REACH]	NY	
RAQUETTE RIVER	PIERCEFIELD	NY	07387
SACANDAGA RIVER	STEWARTS BRIDGE	NY	02047
SALMON R	SALMON RIVER	NY	11408
SARANAC RIVER	SARANAC RIVER	NY	02738
BEAVER RIVER	BEAVER FALLS	NY	02593
BEAVER RIVER	BEAVER RIVER	NY	02645
BLACK RIVER	GLEN PARK	NY	04796
BEAVER RIVER	LOWER BEAVER FALLS	NY	02823
BLACK RIVER	WATERTOWN	NY	02442
KLAMATH RIVER	KLAMATH	OR	02082
SOUTH FORK ROGUE RIVER	PROSPECT NO 3	OR	02337
SUSQUEHANNA RIVER	HOLTWOOD	PA	01881
SALUDA RIVER	SALUDA	SC	00516
WATEREE RIVER	CATAWBA-WATEREE	SC	02232
LITTLE TENNESSEE RIVER	TAPOCO	TN	02169
DEERFIELD RIVER	DEERFIELD RIVER	VT	02323
LITTLE RIVER	WATERBURY	VT	02090
LAKE CHELAN	LAKE CHELAN	WA	00637
SPOKANE RIVER	SPOKANE RIVER	WA	02545
SULLIVAN CREEK	SULLIVAN LAKE (STORAGE)	WA	02225
SULTAN RIVER	HENRY M JACKSON (SULTAN)	WA	02157
TIETON RIVER	TIETON DAM	WA	03701
BLACK RIVER	HATFIELD	WI	10805
CHIPPEWA RIVER	JIM FALLS	WI	02491
GAULEY RIVER	SUMMERSVILLE	WV	10813