RECLAMATION

Managing Water in the West

Annual Report of Operations For Flaming Gorge Dam Water Year 2011

U.S. Department of the Interior
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Annual Report of Operations for Flaming Gorge Dam

Water Year 2011

Introduction

This report details the operations of Flaming Gorge Dam during water year[1] 2011, and is produced pursuant to the February 2006 Record of Decision for the Operation of Flaming Gorge Dam (ROD; Reclamation 2006)[2], the Operation of Flaming Gorge Dam Final Environmental Impact Statement (FEIS; Reclamation 2005)[3] and 2005 Final Biological Opinion on the Operation of Flaming Gorge Dam (2005 BO; USFWS 2005)[4]. This is the sixth year of operations of Flaming Gorge Dam under the ROD and this report is the sixth annual report produced as described in the ROD.

Flaming Gorge Dam, located on the upper main-stem of the Green River in northeastern Utah about 200 miles east of Salt Lake City, is an authorized storage unit of the Colorado River Storage Project. The Green River system is part of the upper Colorado River basin in Utah, Colorado, and Wyoming. Below Flaming Gorge, the Green River supports populations of four endangered native fishes. Operation of Flaming Gorge Dam influences downstream flow and temperature regimes and the ecology of the Green River, including native fishes. Downstream of Flaming Gorge Dam the Green River is joined by the Yampa, White and Duchesne Rivers, portions of which have all been designated as critical habitat under provisions of the Endangered Species Act of 1973, (Muth, et al 2000).

The Upper Colorado River Endangered Fish Recovery Program (Recovery Program) was initiated in 1988 by the signing of a cooperative agreement amongst the states of Colorado, Wyoming, and Utah, the Secretary of Interior and the Administrator of the Western Area Power Administration (Western). The goal of the Recovery Program is to recover the endangered fish species while allowing for the continued operation and development of water resources in the Upper Colorado River Basin. The Recovery Program is the forum for discussion of endangered fish response to Flaming Gorge Dam operations and for identification of endangered fish research needs.

In 2000, the Recovery Program issued Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Gorge Dam, (Muth et al, 2000), (Flow Recommendations). The Flow Recommendations provide the basis for the proposed action described and analyzed in the FEIS. The ROD implements the proposed

[1] A water year begins on October 1 and ends on September 30.
[2] Record of Decision Operation of Flaming Gorge Dam Final Environmental Impact Statement (February 2006)
[3] Operation of Flaming Gorge Dam FINAL Environmental Impact Statement (September 2005)
[4] 2005 Final Biological Opinion on the Operation of Flaming Gorge Dam

action by modifying the operations of Flaming Gorge Dam, to the extent possible, to assist in the recovery of endangered fishes, and their critical habitat, downstream from the dam and, at the same time, maintains and continues all authorized purposes of the Colorado River Storage Project, (Reclamation 2006).

Operational Decision Process for Water Year 2011

The Flaming Gorge Technical Working Group (FGTWG) was established pursuant to the FEIS as recommended in the Flow Recommendations. The ROD clarified the purpose of the FGTWG to proposing specific flow and temperature targets for each year's operations based on current year hydrologic conditions and the conditions of the endangered fish. The FGTWG was also charged with integrating, to the extent possible, any flow requests received by Reclamation from the Recovery Program into the flow proposal so that Recovery Program research could also be facilitated. This process concurrently fulfills the informal consultation and coordination requirements of the ESA for the action agencies as committed to in the ROD.

Members of the FGTWG include biologists and hydrologists from Reclamation, the U.S. Fish and Wildlife Service (Service), and Western Area Power Administration (Western).

Each year, FGTWG's recommendation is presented to the Flaming Gorge Working Group, along with any flow requests or operational requests proposed by other federal or state agencies or stakeholders. The Flaming Gorge Working Group (Working Group) is open to the general public and was formed in 1993 to provide interested parties with an open forum to express their views and interests in the operations of Flaming Gorge Dam. The Working Group meets biannually at a minimum and functions as a means of providing information to, and gathering input from stakeholders and interested parties on dam operations, other resource concerns and research flows.

In 2011, the operational process developed in 2006 was used for making operational decisions at Flaming Gorge Dam. This process was developed based on descriptions provided in the FEIS (Section 1.5) and the ROD (Sections III, VI, and VII), (Reclamation, 2005, Reclamation 2006). A detailed description of this process can be found in Appendix A and a timeline of how this process was implemented in 2011 can be found in Appendix B. The implementation of the four steps of the process in 2011 is described below:

Step 1: Flow Requests for Research, and Other Federal, State and Stakeholder Input

Reclamation received, and provided to the FGTWG, a memorandum dated April 6, 2011 (Appendix C), from the Director of the Recovery Program providing the Recovery Program's research request for 2011 Green River spring flow. The Recovery Program's primary objective for the spring 2011 flow request contained two criteria. Criterion #1, that Flaming Gorge spring 2011 operations be timed to coincide with the presence of larval razorback sucker in Reach 2 habitats. Criterion #2 was contingent on having met Criterion #1, and

based on the range of potential hydrology scenarios. This secondary request was for Reclamation to release flows that maintain 18,600 cfs or greater for two weeks or more in Reach 2 if conditions remained in the wet-average, moderately wet or wet categories. If hydrologic conditions changed and became drier, the Recovery Program requested flows of 15,000 cfs or greater for 5 or 1 day under average or moderately dry conditions, respectively. Flows of these magnitudes would help reach their secondary objective, which was assessment of emigration rates of previously stocked razorback sucker from the Stirrup floodplain to the main stem of the Green River. Previous studies indicated a 30 centimeter (cm) water depth in passages between floodplains and the main river channel (e.g., levee breaches and outlet structures) is required for juvenile and adult Colorado pikeminnow and razorback sucker fish passage.

Western submitted a written request via email to Reclamation on March 14, 2011, supporting the Recovery Program research request and coordinating releases from Flaming Gorge to coincide with the presence of wild razorback sucker larvae. (Appendix D). Western outlined Kevin Bestgen's work regarding timing of spring peak releases. Western utilized the current scientific information and then further requested some additions and modifications from the Recovery Program request altering the peak flow timing, magnitude and duration.

On April 7, 2011, Reclamation received a base flow request from the Service dated April 1, 2011 (Appendix E). In the memorandum, the Service supported the Recovery Program's March 12 research request. The Service further requested that the calculated Reach 1 base flow targets be augmented as much as 40 percent higher than the average daily base flow for that reach of the Green River during the summer period through September 30. The intent of the request was to negatively impact nonnative fish species (particularly smallmouth bass) and provide benefits to endangered fish. The Service acknowledged that higher summer flows in Reach 1 might require balancing Flaming Gorge Dam flows during winter releases. The Service supported Reclamation reducing the duration of spring peak releases at Flaming Gorge Dam from two weeks to one week and, if necessary, reducing winter base flow releases.

On April 15, 2011, Reclamation received an Amendment from the Service to their earlier 2011 Green River Spring and Base Flows to Assist in Recovery of the Endangered Fishes (Appendix F). The Service further acknowledged the potential tradeoff between timing of releases for experiments and meeting the Reach 2 targets outlined in the ROD. The Service supported Reclamation following the Recovery Program's 2011 Spring Flow Request, and that doing so would meet Reclamation's responsibility to the ROD objectives in 2011.

Reclamation received comments from the public during the 2011 decision-making process. These comments are available to review in Appendix I. Reclamation received a February 7, 2011spring and base flow request from the Utah Division of Wildlife Resources (UDWR). UDWR requested a spring peak of 8,600 cfs in 2011, maintained for 5 to 7 days, to improve sport fish habitat and benefit the invertebrate community in the tail water portion of the Green River.

UDWR further requested releases from Flaming Gorge Dam during the winter of 2010-2011 mimic a natural hydrograph with minimal fluctuations, including an absence of a daily double peak pattern that would benefit hydropower production. UDWR indicated they were concerned with the ongoing, overwinter double-peak flow regime, including potential effects on invertebrate drift and trout feeding behavior, the negative perceptions of these flows among the angling public, and the socio-economic impacts to local businesses, fishing guides and outfitters.

Reclamation also received letters conveying similar requests for spring peaks on the order of 8,600 cfs from Trout Unlimited on February 3, 2011 and the Blue Ribbon Fisheries Advisory Council on February 13, 2011. Dinosaur National Monument (National Park Service, NPS) submitted a letter on March 3, 2011, which also supported such flows, but urged deferral of these flows for a period of one year such that a science plan could be developed to assess impacts to park resources.

Step 2: Development of Spring Proposal

The FGTWG met on March 9, 2011, to begin the development of a flow proposal for the spring of 2011. The intent of the flow proposal was to integrate the flow request from the Recovery Program into a flow regime consistent with the ROD. The flow proposal for 2011 described three possible flow regimes that were consistent with the ROD and FEIS (see Appendix G for details). Depending upon the outcome of hydrologic conditions during spring runoff, the intent was to achieve one of these proposed flow regimes.

Step 3: Solicitation of Comments

On April 26, 2011, Reclamation presented the 2011 FGWTG flow proposal (Appendix G) and Service base flow requests to the Working Group. The presentation at the Working Group meeting clearly described the FGTWG proposed flow regime for the Green River, the intended operation of Flaming Gorge Dam for the spring and summer of 2011, and received comments. Meeting minutes were recorded and written comments were solicited by Ed Vidmar, Chairperson of the Working Group.[5]

During the April 26, 2011, Working Group meeting, Western verbally requested the minimum 40 percent lower flows than the average daily base flow through September 30, 2011, with a redistribution of water from the summer into the winter period (November through February) in order to maximize hydropower production during periods of increased electrical demand. Western further requested that the winter period hourly release follow a daily double peak pattern, releasing greater amounts of water during the morning and afternoon electrical peak demand and conserving water during the evening and afternoon hours when demand decreases.

[5] Working Group Meeting notes are also available at http://www.usbr.gov/uc/water/crsp/wg/fg/fg_20110427.html and http://www.usbr.gov/uc/water/crsp/wg/fg/fg_20110826.html.

Step 4: Final Decision

Reclamation considered the spring and base flow requests of Western and the Service, and also the record-breaking hydrology in the Upper Green and Yampa River Basins. On May 16, 2011, Reclamation communicated with the Recovery Program regarding their spring 2011 Flow Request (Appendix H) and reassured them that it maintains its commitments in the 2006 Record of Decision, including the potential for refinement of the flow and temperature recommendations if relevant new information gained through adaptive management supports that possibility. However, based on the exceedingly wet hydrologic conditions, Reclamation determined that Flaming Gorge Dam operations during spring 2011 would be based on dam safety and, to the extent possible, time releases to diminish stage levels downstream of the Green and Yampa River confluence. Reclamation predicted that it was very likely that although operating exclusively to manage large volumes of water for dam safety and reservoir capacity reasons all Reach 2 and 3 ROD targets would be met during the wet hydrologic year.

Reclamation further determined the Service's base flow request could be achieved within normal operating parameters and decided to utilize the base flow flexibility and maintain high base flow releases through September 30. Reclamation also determined that it could implement Western's request for a double-peak pattern release during the winter period, as long as it was maintained within the ROD constraints, and existing hydrologic conditions and electrical demand.

Basin Hydrology and Operations

Progression of Inflow Forecasts

Snowpack conditions in the Upper Green River and Yampa River Basins varied significantly throughout the snow accumulation season (November 2010 through April 2011). The Upper Green River Basin snowpack condition was above average on January 1, 2011, at 127 percent of average.[6] On April 1, 2011, the snowpack condition in the Upper Green River Basin had decreased to 120 percent of average, but had increased to 159 percent of average by May 1, 2011. The Yampa River Basin snowpack condition was above average on January 1, 2011, at 146 percent of average. On April 1, 2011, the snowpack condition in the Yampa River Basin had increased to 131 percent of average, and had increased to 164 percent of average by May 1, 2011.

The Colorado Basin River Forecast Center (CBRFC), beginning in January every year and continuing through June, issues a monthly forecast of the total volume of anticipated unregulated inflow for the April through July period in thousands of acre-feet (kaf). The progression of Flaming Gorge Reservoir unregulated inflow and the Yampa River forecasts over the 2011 water supply season is shown in Table 1.

[6] Percent of average is based on the 1981-2010 period of record.

Table 1 – Progression of CBRFC Unregulated Inflow[7] Volume Forecasts for the April through July Water Supply Period

Forecast Issuance Month	Flaming Gorge Reservoir		Yampa River near Maybell, CO		Little Snake River near Lily, CO	
	Volume (1000 AF)	% of Average	Volume (1000 AF)	% of Average	Volume (1000 AF)	% of Average
January	1200	101	1280	137	435	131
February	1180	99	1280	137	435	131
March	1210	102	1350	144	470	141
April	1350	113	1550	166	580	175
May	1660	139	1930	206	790	238
June	1890	159	1790	191	780	234
July	1770	146	---	---	---	---
Actual	**1926**	**162**	**1988**	**213**	**893**	**269**

Summary of Flaming Gorge Operations

Releases from Flaming Gorge averaged 1,050 cfs from October 1, 2010 through December 1, 2010, when releases were increased to 1,100 cfs, and increased again on February 1, to 1,200 cfs through February 28th. The forecasts decreased in February and the releases were decreased from 1,200 cfs to 950 cfs beginning March 1, 2010. Hourly releases followed a single-peak pattern October and November, when the hourly release pattern was revised to a double-peak pattern from December through February. Releases were increased on April 1, 2011, from 950 cfs to steady releases at power plant capacity with two available units (3,060 cfs). Continued storms over both the Upper Green and Yampa River Basins increased the forecasts and Reclamation responded by increasing releases to power plant capacity releases with three available generating units (approximately 4,600 cfs) on April 26, 2011. The May final forecast increased again and Flaming Gorge Dam releases were increased to full power plant capacity and bypass tubes on May 4th through May 9th in order to evacuate storage space for spring runoff. Releases were decreased when Yampa River flows began rising with spring runoff in order to diminish stage levels downstream of the Green and Yampa River confluence, to the extent possible.

Flaming Gorge Dam releases under the ROD are increased to coincide with the immediate peak and post-peak of the Yampa River spring peak flows to create a spring peak in the Green River at Jensen. Spring runoff in the Yampa River Basin generally produces two distinct peaks (flows above 10,000 cfs) as low elevation snow melts first followed by the mid- and higher elevation snowmelt. However, because of record snowpack, operations at Flaming Gorge Dam during spring runoff 2011 were driven by dam safety and, to the extent possible, time releases to diminish stage levels downstream of the Green and Yampa River confluence. Coincidentally, these high flows did meet specified flow targets as well as research needs as was anticipated based on the underlying rationale of the ROD.

[7] Unregulated inflow is defined as the actual inflow to the reservoir corrected for change in storage and evaporation in reservoirs upstream. In the case of Flaming Gorge Reservoir, unregulated inflow accounts for change in storage and evaporation at Fontenelle Reservoir only.

Additionally, the wet hydrologic classification peak flow targets under the ROD were met in 2011.

Yampa River snowpack was 200 percent of average and spring runoff had the possibility for significant flooding downstream on the Green River. Runoff started early and flows measured at the USGS Yampa River at Deerlodge Park, CO stream gage (USGS 09260050) (Yampa River) increased above 10,000 cfs in mid-April and again in early-May. Weather patterns were favorable to effectively melt the record snowpack on the Yampa River and decrease potentially catastrophic hydrologic peaks. The weather maintained warm temperatures following by a cooling trend over the entire April-July period, which allowed the gradual melt of low, mid and high elevation snowpack in the Yampa River Basin.

Flaming Gorge releases were maintained at power plant capacity from May 9th through June 12th, when releases were increased to a total release of full power plant and bypass capacity (~8,600 cfs). Releases were maintained at full power plant and bypass capacity releases from June 12, 2011 to July 10, 2011, when releases were decreased at a down ramp rate of 1,000 cfs/day to power plant capacity releases (~4,600 cfs). Releases remained at power plant capacity (~4,600 cfs) until July 27, 2011, when releases were decreased at a down ramp rate of 1,000 cfs/day to an average daily release of 2,450 cfs.

Yampa River flows peaked at 26,700 cfs on June 9th as Flaming Gorge Dam ramped up to power plant and bypass capacity total releases of approximately 8,600 cfs. The Green River at Jensen, Utah peak was 31,300 cfs on June 11, 2011. Flows at Jensen were above 18,600 cfs for 58 days, and remained above 22,700 cfs for 34 days. Flows in Reach 2 remained above 26,400 cfs for 15 days.

Flaming Gorge Reservoir elevation increased a total of 13.5 feet (ft) from the minimum elevation of 6022.61 ft on May 16, 2011, to the annual maximum elevation of 6036.11ft on August 1, 2011.

Flaming Gorge Dam releases (blue line), and flows for the Yampa River (brown line) and Green River at Jensen (green line) are illustrated in Figure 1.

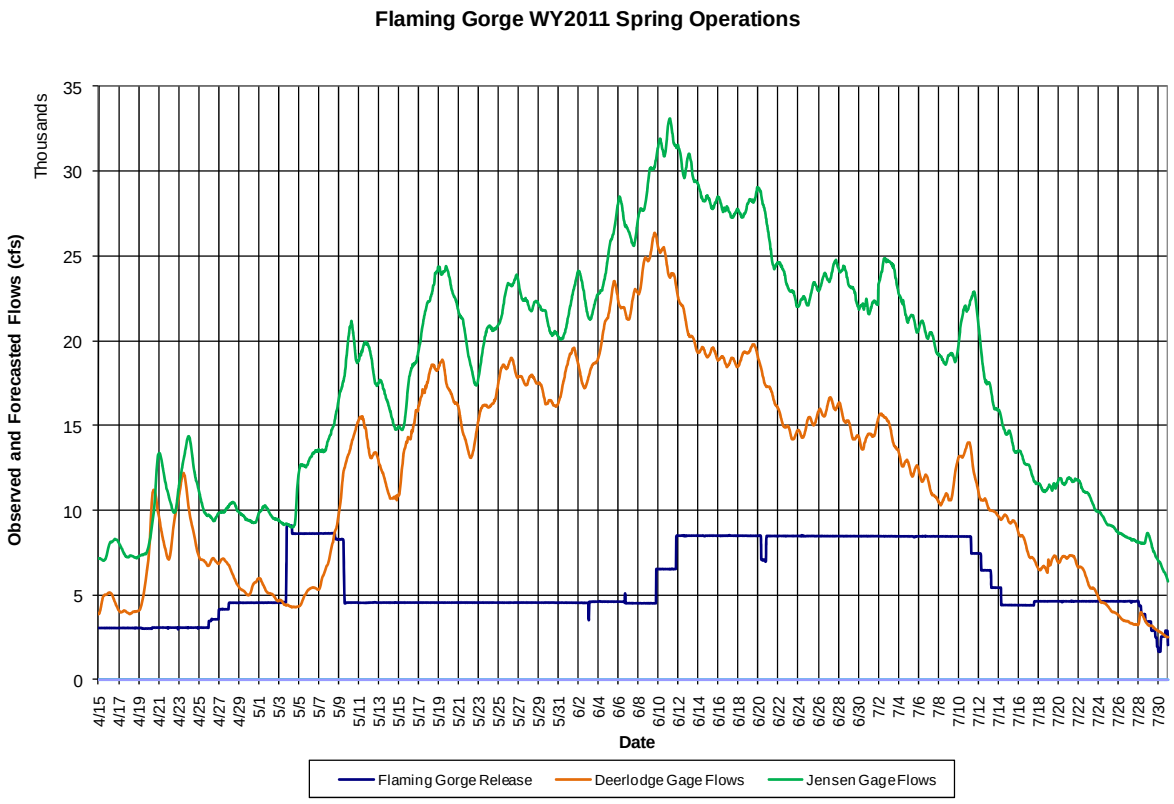

Figure 1 – 2011 Flaming Gorge Spring Releases and Flows Measured at Yampa River at Deerlodge and Green River at Jensen.

Spillway Inspection

The 2005 BO directs Reclamation to provide the results of its annual spillway inspections. During these inspections, inspectors operate gates 1 and 2 through a one-foot open and close cycle and note any unusual or excessive noise or vibration. The spillway inspection occurred on July 25, 2011, at reservoir elevation 6035.81 ft. Gate 1 and 2 are both opened one foot at an average rate of one foot per minute. The total volume released was approximately 2.75 acre-feet. Reclamation also conducted a physical inspection of the spillway tunnel on October 20, 2010, and again on June 15, 2011.

Flow Objectives Achieved in Water Year 2011

The ROD directs Reclamation to operate to achieve, to the extent possible, the Flow Recommendations as described in the FEIS, (Reclamation 2006). The Flow Recommendations divide the Green River below Flaming Gorge Dam into three river reaches. Reach 1 begins directly below the dam and extends to the confluence with the Yampa River. Reach 2 begins at the Yampa River confluence and continues to the White River confluence. Reach 3 is between the White River and Colorado River confluences, (Muth et. al 2000).

The Flow Recommendations use five different categories to classify both spring and base flow water year conditions and the Reach 1, 2, and 3 targets associated with that classification. Reach 1 targets are, for the most part, release patterns from Flaming Gorge Dam needed to achieve target peak and base flows identified in Reaches 2 and 3. Reach 2 targets are measured at Jensen, Utah and Reach 3 targets, measured at Green River, Utah, are largely dependent on flows targets for Reach 2 and runoff patterns of tributaries. The Flow Recommendations acknowledged that Reach 3 base flows will be subject to natural variation in tributary flows, and this variation should not be compensated for by Flaming Gorge Dam releases, (Muth et al 2000).

After the spring flow objectives in Reach 1 and Reach 2 have been achieved, flows should be gradually reduced to achieve base flow levels by no later than the date specified in the Flow Recommendations. Base flows in Reaches 1 and 2 should be managed to fall within the prescribed base flow ranges described in the Flow Recommendations based on the observed April through July unregulated inflow into Flaming Gorge Reservoir.

Pursuant to the Flow Recommendations, during the August through November base-flow period, the daily flows should be within ±40 percent of mean base flow. During the December through February base-flow period, the daily flows should be within ±25 percent of the mean base flow.

Additionally, the mean daily flows should not exceed 3 percent variation between consecutive days and daily fluctuations at Flaming Gorge Dam should produce no more than a 0.1-meter daily stage change at Jensen, Utah. On the basis of the stage-flow relationship near Jensen, the maximum stage change that could occur with this level of flow variability over the summer through autumn period would be about 0.4 meters. Flow variability during the winter (December through February) would produce a maximum stage change of about 0.2 meters. This recommendation is based on the fact that the average depth of backwaters occupied by Colorado pikeminnow larvae in Reach 2 is 0.3 m. By restricting within-day variation in flow, conditions critical for young of year fish in backwater habitats should be protected. (Muth et al 2000).

Table 2 –April – July Forecasts and Spring and Base Flow Hydrologic Classifications

Year	May 1st A-J Unreg Inflow Forecast (1000 AF)	Spring Hydrologic Classification	Observed A-J Unreg Inflow Forecast (1000 AF)	Base Flow Hydrologic Classification
2006	1,100	Average (Abv Median)	724	Moderately Dry
2007	500	Moderately Dry	370	Dry
2008	820	Average (Blw Median)	728	Moderately Dry
2009	890	Average (Blw Median)	1,197	Average (Abv Median)
2010	515	Moderately Dry	705	Moderately Dry
2011	1,660	Moderately Wet	1,925	Wet

Spring Flow Objectives

The spring hydrologic classification is based on the CBRFC May final forecast of April-July unregulated inflow volume into Flaming Gorge Reservoir. The May final forecast for water year 2011 was 1,660,000 acre-feet (AF) and resulting spring hydrologic classification was moderately wet.[8] The peak-flow magnitude for Reaches 1, 2, and 3 were 4,600 cfs, 20,300 cfs, and 24,000 cfs, respectively.

The Reaches 1, 2 and 3, Flow Recommendation spring objectives and the desired frequency of achievement are described in Tables 3, 4, and 5. Water year 2011 is the sixth year of operations under the ROD and thus is the sixth year for establishing the long-term frequencies of these spring flow objectives.

Table 3 – Reach 1 ROD Flow Objectives Achieved in 2011

Spring Peak Flow Objective	Desired Frequency of Achievement %	Achieved in 2011	Achievement Rate to Date (Cumulative Frequency %)*
Peak >= 8,600 cfs for at least 1 day	10 %	Yes	17 %
Peak >= power plant capacity for at least 1 day	100 %	Yes	100 %

*Based on six years of operation under the ROD (2006-2011)

[8] Hydrologic classifications are based on Pearson III percentile exceedance volumes for the period of record beginning in 1963 through the previous year hydrology. This calculation results in annual variations in exceedance ranges.

Table 4 – Reach 2 ROD Flow Objectives Achieved in 2011

Spring Peak Flow Objective	Desired Frequency Percent of Achievement	Achieved in 2011	Achievement Rate to Date (Cumulative Frequency %)*
Peak >= 26,400 cfs for at least 1 day	10 %	Yes	17 %
Peak >= 22,700 cfs for at least 2 weeks	10 %	Yes	17 %
Peak >= 18,600 cfs for at least 4 weeks	10 %	Yes	17 %
Peak >= 20,300 cfs for at least 1 day	30 %	Yes	33 %
Peak >= 18,600 cfs for at least 2 weeks	40 %	Yes	33 %
Peak >= 18,600 cfs for at least 1 day	50 %	Yes	83 %
Peak >= 8,300 cfs for at least 1 day	100 %	Yes	100 %
Peak >= 8,300 cfs for at least 1week	90 %	Yes	100 %
Peak >= 8,300 cfs for at least 2 days except in extreme dry years	98 %	Yes	100 %

*Based on six years of operation under the ROD (2006-2011)

Table 5 – Reach 3 ROD Flow Objectives Achieved in 2011

Spring Peak Flow Objective	Desired Frequency Percent of Achievement	Achieved in 2011	Achievement Rate to Date (Cumulative Frequency %)*
Peak >= 39,000 cfs for at least 1 day	10 %	Yes	17 %
Peak >= 24,000 cfs for at least 2 weeks	10 %	Yes	17 %
Peak >= 22,000 cfs for at least 4 weeks	10 %	Yes	17 %
Peak >= 24,000 cfs for at least 1 day	20 %	Yes	33 %
Peak >= 22,000 cfs for at least 2 weeks	40 %	Yes	33 %
Peak >= 22,000 cfs for at least 1 day	50 %	Yes	50 %
Peak >= 8,300 cfs for at least 1 day	100 %	Yes	100 %
Peak >= 8,300 cfs for at least 1week	90 %	Yes	100 %
Peak >= 8,300 cfs for at least 2 days except in extreme dry years	98 %	Yes	100 %

*Based on six years of operation under the ROD (2006-2011)

Base Flow Objectives

Base flows are classified based on the observed April-July unregulated inflow volume into Flaming Gorge and monthly base flow forecast from the CBRFC. The observed April-July unregulated inflow volume was 1,925,000 AF and resulting base flow hydrologic classification was wet. Reach 1 flows were reduced to base flows by July 30, 2011. The observed April-July unregulated inflow volume into Flaming Gorge Reservoir, August final forecast and average daily releases needed to achieve the May 1, 2012 elevation target of 6027 feet were used to calculate the Reach 1 daily average base flow of 2,150 cfs, which is within the base flow range for wet classification as shown in Figure 2.

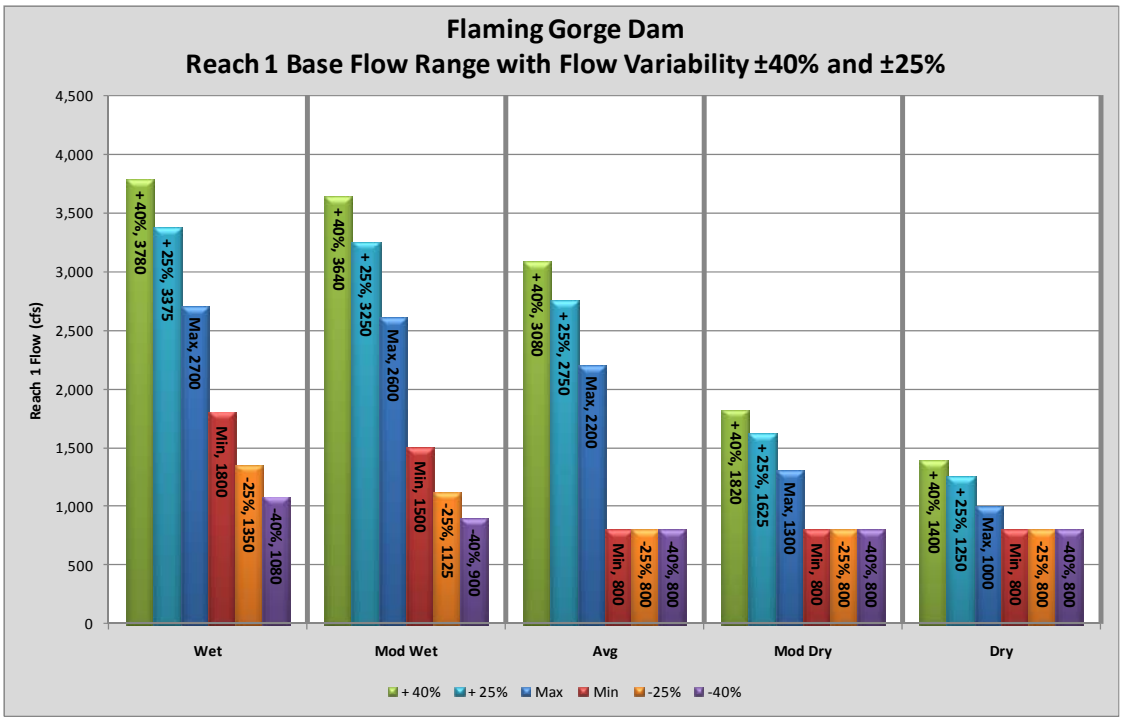

Figure 2 – Reach 1 Base Flow Ranges for each Hydrologic Classification as Outlined in the ROD.

Flaming Gorge Reservoir inflows decreased through the autumn and winter base flow period, and the base flow hydrologic classification moved into moderately wet. Observed August through November base flows in Reach 2 were within 40 percent of the established base flow for the moderately wet classification (*i.e.* between 1,440 cfs to 3,920 cfs as shown in Figure 3). Observed December through February base flows in Reach 2 were within 25 percent of the established base flow (*i.e.* between 1,800 cfs to 3,500 cfs). The daily fluctuations at Flaming Gorge Dam remained within the 0.1 meter daily stage change at Jensen, Utah parameters. The maximum daily stage change at Jensen was within the limits outlined in the Flow Recommendations.

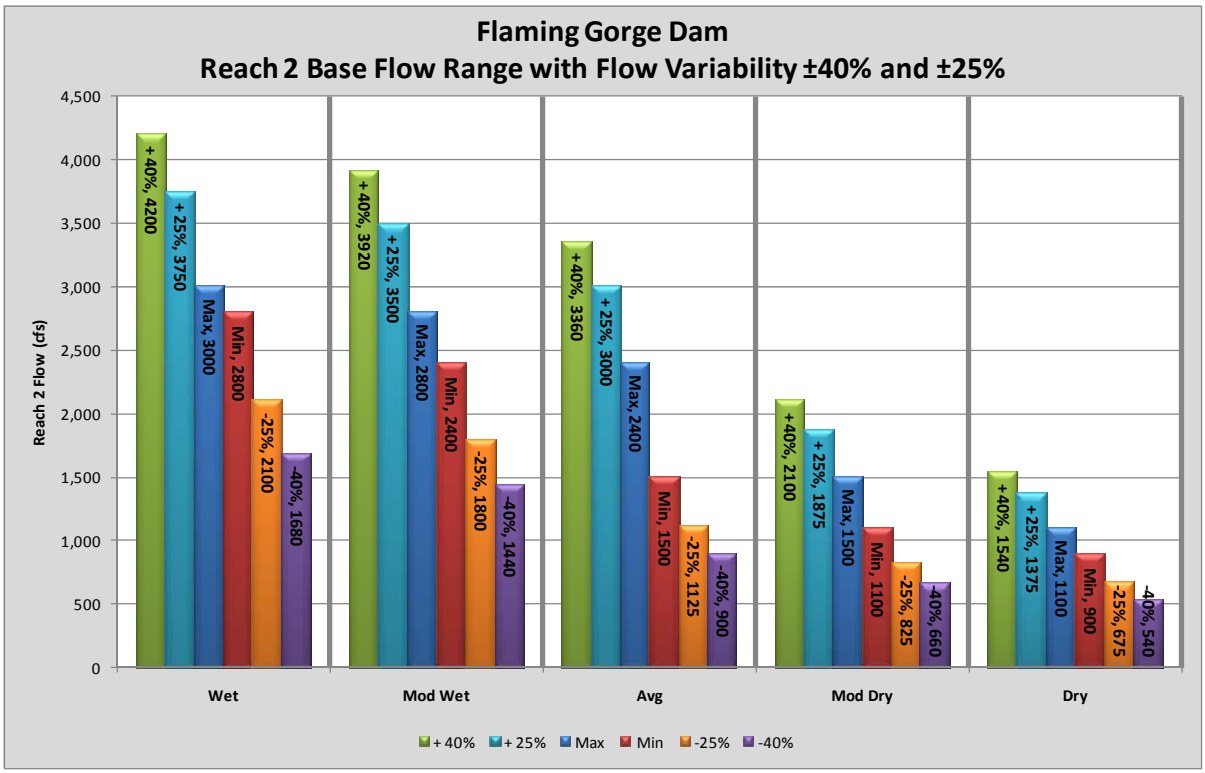

Figure 3 – Reach 2 Base Flow Ranges for each Hydrologic Classification as Outlined in the ROD.

Observed August through November base flows in Reach 3 were as measured at the USGS Green River at Green River, Utah stream gage were within 40 percent of the established base flow for the moderately wet classification (*i.e.* between 1,620 cfs to 6,580 cfs as shown in Figure 4). Observed December through February base flows in Reach 3 were within 25 percent of the established base flow (*i.e.* between 2,025 cfs to 5,875 cfs). The USGS reports that December base flows were affected by ice, and flows during that period fall below 2,025 cfs. These flows appear to be anomalous and not counted within the dataset of winter base flows.

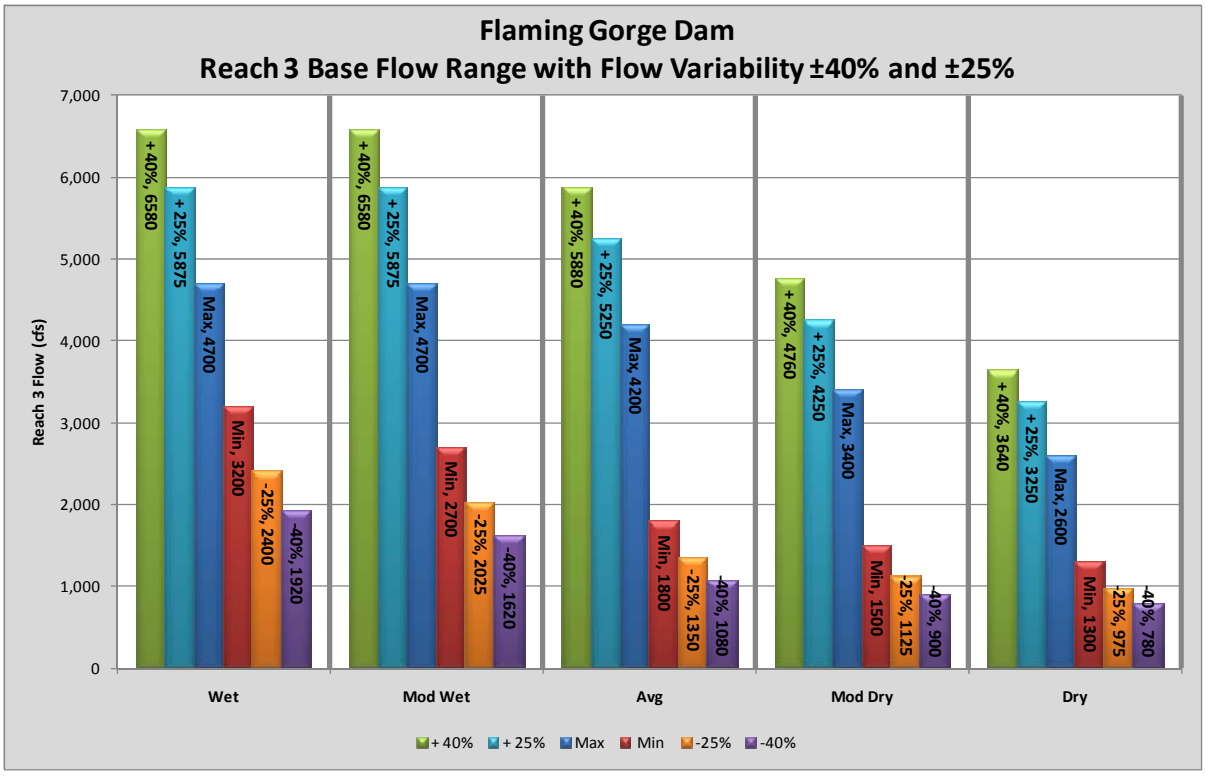

Figure 4 – Reach 3 Base Flow Ranges for each Hydrologic Classification as Outlined in the ROD.

Temperature Objectives Achieved in Water Year 2011

The Operational Plan for the Flaming Gorge Selective Withdrawal Structure (SWS) was completed by a subset of the FGTWG in June 2007, and is currently undergoing revisions. The SWS is a series of three gated intake structures that allow water to be drawn from different elevations in the reservoir. During summer months, water temperatures within the reservoir vary with depth and the adjustment of the SWS maintains some control over the water temperatures released into the Green River below Flaming Gorge Dam.

The Flow Recommendations indicate that warmer water would provide cues for adults migrating to spawning areas, aid reproductive success of fish in adulthood, enhance the likelihood of reproduction of certain fish in Lodore Canyon (Reach 1), and enhance growth of

early life stages of fishes in nursery habitat including those in Echo, Island, and Rainbow Parks (all in Reach 2). Improving conditions in Lodore Canyon also could result in expansion of endangered fish populations into lower Reach 1 and upper Reach 2. The timing of warm water releases is an important component of matching native fish life cycle reproduction and growth.

The operational plan provides guidelines in an attempt to meet the water temperature objectives below Flaming Gorge Dam that are contained within the 2006 ROD and described further in Table 6, below. Operational guidelines direct operators to achieve maximum gate elevation (40 ft below reservoir surface) by June 15 of each year in order to deliver outflow temperatures of 59-61 °F (15-16 °C; as measured at the Greendale Gage, USGS 09234500) during the summer months.

In WY 2011, the elevation target was achieved as scheduled but required several readjustments during the latter half of June and the first half of July to adjust for rapidly rising lake levels during that time period.

Unusually high snowpack levels in many parts of the upper Green River Basin during 2011 had prompted managers to maintain peak releases from the Flaming Gorge Dam power plant (approx. 4,600 cfs) through mid- to late July. During that period, effects of reservoir elevation, discharge and water temperature interacted to cause equipment thermal tolerances to be exceeded during SWS operation. Rising reservoir levels increased head pressure, generator output and equipment operating temperatures. This effect was exacerbated further by warming reservoir temperatures. As a result, selective withdrawal gates were lowered to 61 ft below the reservoir surface on July 21 in an effort to release cooler water and prevent equipment damage from overheating. Release temperatures at that point were 58 °F (14 °C) at the Greendale Gage and dam discharge was 4,608 cfs. SWS gates were elevated to 50 ft below the reservoir surface on August 16 once overheating risks subsided, and they remained at or near this level through December.

Average daily temperatures at Gates of Lodore (USGS 404417108524900) in 2011 intermittently equaled or exceeded Reach 1 objectives (18 °C; Figure 5) for 18 days between July 30th and September 2. Reach 2 objectives (difference between Yampa and Green rivers does not exceed 5 °C; Figure 6) were achieved during June through August 10th, after which no data from the Green River is available due to loss of the thermograph under high flow conditions. This loss was unfortunate, however equipment redundancy has since been increased through deployment of additional thermographs during September 2012.

Operations of the Flaming Gorge Dam SWS during 2011 failed to reach temperature objectives in Reach 1 of the Green River largely due to release of large volumes of cold water via bypass tubes through the mid-July, release of cool water to protect equipment, and high river discharge which limited downstream warming rates. During drier years, use of bypass tubes—if required at all—usually occurs prior to June 15 when SWS gates are raised to their maximum elevation. In such years, operation of the SWS in the absence of bypass releases normally results in attainment of target temperatures in Reach 1 by the first half of July. Use of bypass tubes in 2011 was required by dam safety guidelines to accommodate unusually high inflows and temperatures of these releases could not be mitigated by routine SWS operations. Risk of

equipment damage due to overheating also made it difficult to release warm water during mid-July through mid-August.

It should be noted that release of water averaging 61 °F (16 °C) occurred during August 19 through about September 9, which accounted for 11 of the 18 days whereby Reach 1 objectives were met or exceeded. These releases did not occur until after SWS gates were elevated to 50 ft below the reservoir surface on August 16, which coincides with guidelines for temperature objectives during moderately wet to wet years (see Table 2-1 in the Flaming Gorge Dam EIS; U.S. Department of Interior [DOI] 2005). While the Flaming Gorge Dam EIS (DOI 2005) and related documents acknowledge that it may be difficult to meet temperature objectives during wet years, results from 2011 suggest that likelihood of meeting at least Reach 1 objectives can be increased if dam release temperatures meet or exceed 61 °F (16 °C), which is consistent with modeling included the Flaming Gorge Dam EIS (see Figure 4-15 in DOI 2005).

Table 6. Temperature Objectives for the Green River below Flaming Gorge Dam

Temperature Objectives	Reach*	Desired Frequency %	Achieved in 2011
Temperatures >= 64° F (18° C) for 3-5 weeks from June (average-dry years) or August (moderately wet-wet years) to March 1	1	100%	No
Green River should be no more than 9° F (5° C) colder than the Yampa River during the base flow period	2	100%	Unknown

*Reach 1 is from the dam to the Yampa River confluence; Reach 2 is from the Yampa River to Sand Wash, UT.

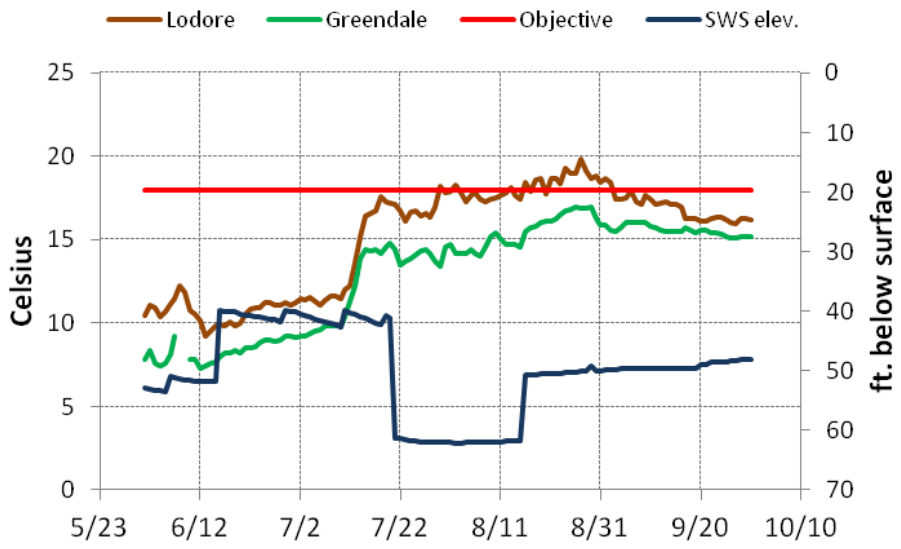

Figure 5. Reach 1 Green River Average Daily Temperatures & SWS Elevation
Recorded temperatures at the Gates of Lodore gage (USGS 404417108524900) (brown series), Greendale gage (USGS 09234500) (green series), Reach 1 temperature objective (red line), and SWS gate depth below reservoir surface (in blue, right hand axis), June-Sept 2011. SWS gate depths depicted are the average of 3 gates.

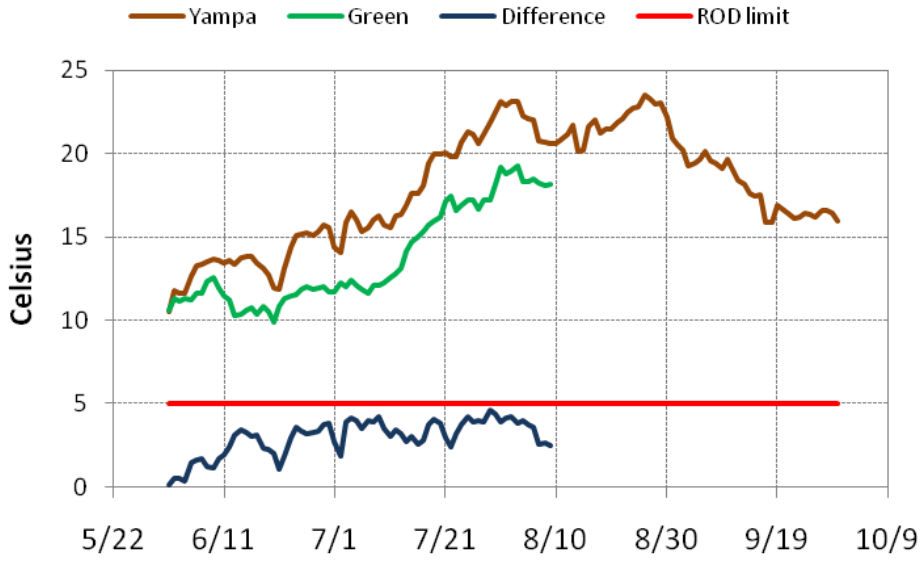

Figure 6. Green River Temperatures at the Yampa River Confluence
Temperatures are recorded at the Green River (USGS 404417108524900) (green series) and the Yampa River (USGS 09260050) (brown series), the difference between the two rivers (blue line), and the maximum temperature difference specified in the 2006 ROD (red series line), June-Sept 2011. Data for the Green River following August 10 are unavailable due to loss of the thermograph.

Conclusions and Recommendations

Reclamation operated Flaming Gorge Dam and Reservoir to comply with the commitments in the ROD and, to the extent possible, meet the goals and objectives of the Flow Recommendations. Reclamation operated Flaming Gorge Dam during spring 2011 for safe reservoir capacity and, to the extent possible, timing releases to diminish stage levels from the Yampa River in Reach 2. Reclamation did meet the spring peak and base flow objectives in the ROD for Reaches 1, 2 and 3. As a result of these operations, Reclamation did not meet the temperature objectives in the ROD. However, the FEIS recognized that in very wet years temperature targets would be difficult to meet because of the amount of cold water from the bypass tubes in the river necessary to keep reservoir storage in a safe operating range. Coordination was successful during extremely wet conditions.

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Appendix A

Flaming Gorge Decision Process
Intended Implementation under the 2006 Flaming Gorge Record of Decision

Overview – This document describes the four-step process the Bureau of Reclamation (Reclamation) will use to adaptively manage Flaming Gorge Dam operations and implement the 2006 Record of Decision for the Operation of Flaming Gorge Dam Final Environmental Impact Statement (ROD). These four steps are described in detail below:

1. Recovery Program
2. Flaming Gorge Technical Working Group (FGTWG)
3. Flaming Gorge Working Group (Working Group)
4. Reclamation Operational Plan

In 2000, the Upper Colorado River Endangered Fish Recovery Program (Recovery Program) issued Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Gorge Dam (flow recommendations). The Flow Recommendations provide the basis for the proposed action outlined in the 2005 final environmental impact statement (FEIS). The ROD implements the proposed action by modifying the operations of Flaming Gorge Dam, to the extent possible, to assist in the recovery of endangered fishes, and their critical habitat, downstream from the dam and, at the same time, maintains and continues all authorized purposes of the Colorado River Storage Project.[1]

Reclamation believes that the Recovery Program remains the appropriate forum for discussion of endangered fish response to Flaming Gorge Dam operations, endangered fish research needs, and refinements to the flow recommendations. The purpose of the FGTWG would be limited to proposing annual flow and temperature recommendations as outlined in the FEIS, including research requests by the Recovery Program. The Working Group remains the forum for public information/input.

1. Recovery Program – The ROD Environmental Commitment #2 defines the science role of the Recovery Program in the adaptive management process to include design and execution of studies that monitor implementation of the flow recommendations, and testing the outcomes of such studies. This includes conducting research to answer specific questions raised by previous studies, to fill information gaps identified in the Recovery Implementation Program Recovery Action Plan and related documents, and/or to address uncertainties associated with the flow recommendations. For example, effects of specific spring flow elevations on entrainment rates of larval endangered fish and their floodplain habitats is an uncertainty which prompted the Recovery Program to request periods of steady flows during the spring 2005 runoff season. A request for such flows or release temperatures is not

[1] Reclamation, 2006, Record of Decision on the Operation of Flaming Gorge Dam Final Environmental Impact Statement.

necessarily explicit in the flow recommendations, but is necessary to fulfill adaptive management research functions that should be made no later than February of each calendar year.

Beginning each summer, the Recovery Program should begin a process to develop any desired flow request for the Green River for the following year. Maintenance schedules for the dam and powerplant are a critical part of the proposal in order to assure release capability. Reclamation will clearly communicate equipment and maintenance issues to the Recovery Program during development of any Recovery Program request. This communication should include analysis of contingency plans for maintenance issues, system emergencies, equipment failures, or changes in hydrology. The Recovery Program should issue a finalized flow request by the end of February to Reclamation, the U.S. Fish and Wildlife Service (Service), and Western Area Power Administration (Western).

2. <u>Flaming Gorge Technical Working Group (FGTWG)</u> - The ROD clarified the purpose of the FGTWG as limited to proposing specific flow and temperature targets for each year's operations based on current year hydrologic conditions and the conditions of the endangered fish. The FGTWG was also charged with integrating, to the extent possible, any flow requests from the Recovery Program into the flow proposal so that Recovery Program research could also be facilitated. Members of the FGTWG include biologists and hydrologists from Reclamation, the Service, and Western. This group also serves as the informal consultation body for Endangered Species Act compliance as has occurred historically and as directed by the ROD.

An annual meeting of the FGTWG should be held in early March to develop a proposed flow and temperature regime for the upcoming spring and base flow season (Proposal). This Proposal should achieve the flow recommendations and/or the Recovery Program flow request for the current year within the current hydrologic conditions and Reclamation's operating parameters.

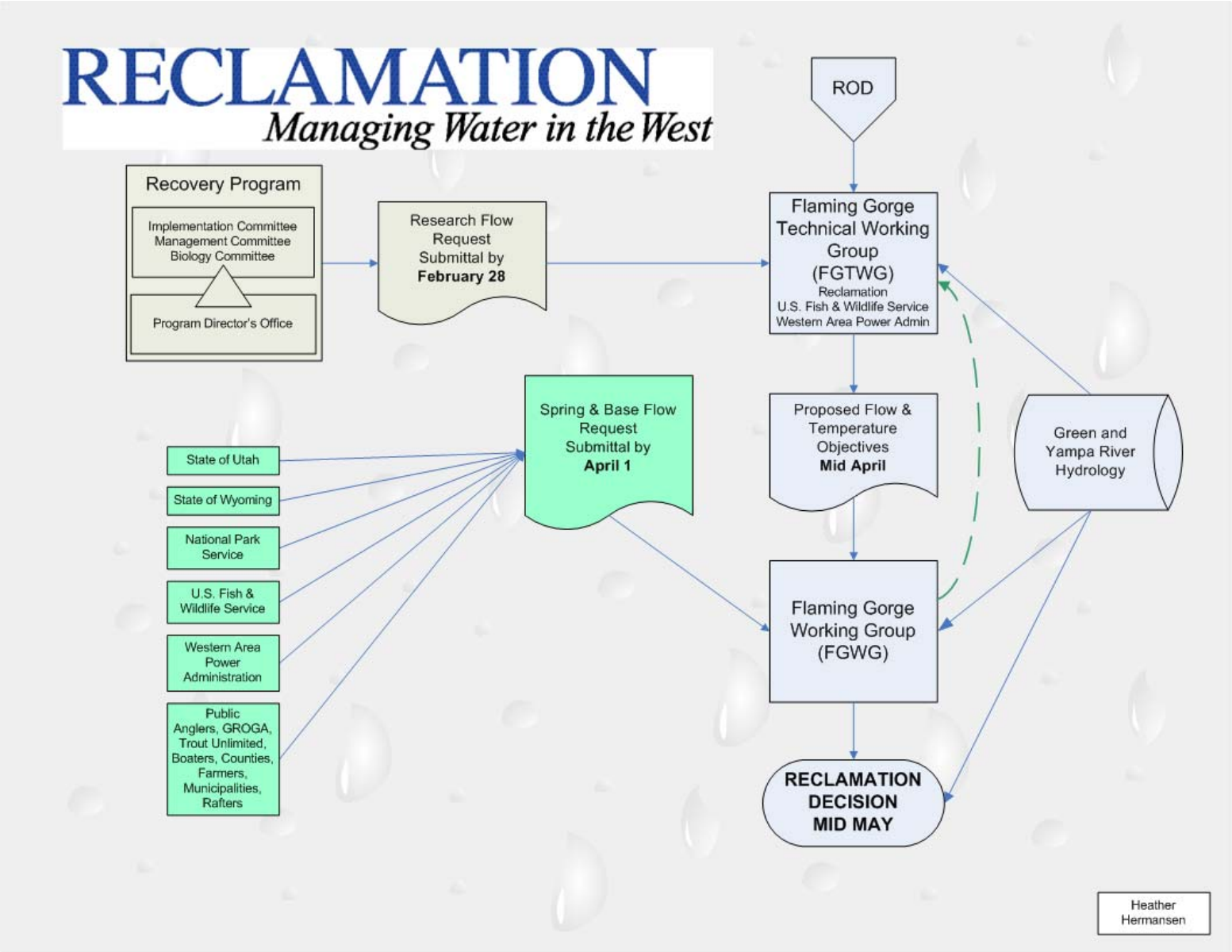
The FEIS specifically addresses and outlines the content of the Proposal. The Proposal describes the current hydrologic classification of the Green River and Yampa River Basins, including the most probable runoff patterns for the two basins. The Proposal also identifies the most likely Reach 2 flow magnitudes and durations that are to be targeted for the upcoming spring release. It further specifies that

> *Because hydrologic conditions often change during the April through July runoff period, the [Proposal] would contain a range of operating strategies that could be implemented under varying hydrologic conditions. Flow and duration targets for these alternate operating strategies would be limited to those described for one classification lower or two classifications higher than the classification for the current year (FEIS, Section 2.5.3.1).*

The FGTWG proposal should be finalized by early April in time to present to the Working Group.

3. <u>Flaming Gorge Working Group</u> – The Working Group was formed in 1993 to provide interested parties with an open forum to express their views and interests in the operations of Flaming Gorge Dam. The Working Group meets biannually (April and August) and functions as a means of providing information to and gathering input from stakeholders and interested parties on dam operations, other resource concerns and research flows. Reclamation presents the FGTWG Proposal to the Working Group during the April meeting and constitutes the public involvement and public outreach component of the adaptive management process as described in the FEIS (Sections 4.20, 4.21).

4. <u>Operational Plan</u> - Reclamation makes the final decision on how to operate Flaming Gorge Dam based on hydrologic conditions, the FGTWG flow proposal, and input from the public received via the Flaming Gorge Working Group.


RECLAMATION
Managing Water in the West
ROD
Recovery Program
Implementation Committee
Management Committee
Biology Committee
Program Director's Office
Research Flow Request Submittal by February 28
Flaming Gorge Technical Working Group (FGTWG)
Reclamation
U.S. Fish & Wildlife Service
Western Area Power Admin
Spring & Base Flow Request Submittal by April 1
Proposed Flow & Temperature Objectives Mid April
Green and Yampa River Hydrology
State of Utah
State of Wyoming
National Park Service
U.S. Fish & Wildlife Service
Western Area Power Administration
Public Anglers, GROGA, Trout Unlimited, Boaters, Counties, Farmers, Municipalities, Rafters
Flaming Gorge Working Group (FGWG)
RECLAMATION DECISION MID MAY
Heather Hermansen

Appendix B

Flaming Gorge Decision Process for 2011 Chronology of Events

Week of October 4th
Flaming Gorge releases decreased at a rate of 50 cfs/day from a daily average release of 1,800 cfs to 1,050 cfs. Hourly releases follow a single-peak pattern released at a rate of 1,050 cfs/day.

Week of October 25th
Flaming Gorge directed releases beginning November 1, 2010, to follow a research pattern requested by Western Area Power Administration (Western) in order to study invertebrate drift downstream. Releases returned to an average daily release rate of 1,050 cfs/day beginning November 1, 2010, with hourly releases following a double-peak pattern.

Week of November 8th
Western requested two additional days of releases to research invertebrate drift downstream. Flaming Gorge releases on November 15th and 16th were directed to follow research releases. Releases returned to an average daily release rate of 1,050 cfs/day beginning November 17, 2010, with hourly releases following a double-peak pattern.

Week of November 15th
The Flaming Gorge Technical Working Group (FGTWG) met on November 19, 2010, to discuss the drying hydrologic trend. Based on the discussion, the average daily base flow decreased from 1,400 cfs to 1,050 cfs. Reclamation committed to using the flexibility outlined in the ROD to manage releases through the winter months if conditions continued to trend dry.

Week of November 29th
Western requested reallocated water into December and January to assist in meeting electrical demand during the peak winter months. Releases increased from a daily average of 1,050 cfs to 1,100 cfs beginning December 1, 2010, with hourly releases following a double-peak pattern.

Week of January 24th
The January final forecast of April-July unregulated inflow volume for Flaming Gorge increased 472,000 acre-feet from 60 percent of average to 101 percent of average. In order to meet the elevation target of 6,027 feet on May 1, 2011, releases were increased from an average daily release rate of 1,100 cfs to 1,200 cfs beginning February 1, 2011, with hourly releases following a double-peak pattern.

Week of February 7th
The Flaming Gorge Working Group (Working Group) received correspondence from Utah Division of Wildlife Resources (UDWR) dated February 7, 2011, promote a spring flushing flow and avoid double-peaking patterns during winter releases.

Week of February 14th
The Working Group received correspondence from the Blue Ribbon Fisheries Advisory Council on February 13, 2011, in support of UDWR correspondence promoting a spring flushing flow and avoid double-peaking patterns during winter releases.

The Working Group received correspondence from Trout Unlimited on February 18, 2011, in support of UDWR correspondence promoting a spring flushing flow and avoid double-peaking patterns during winter releases.

Week of February 21st
The February final forecast of April-July unregulated inflow volume for both Fontenelle and Flaming Gorge decreased from the January forecast. In order to meet the elevation target of 6,027 feet on May 1, 2011, releases decreased from an average daily release of 1,200 cfs to 950 cfs beginning March 1, 2011, with hourly releases following a single-peak pattern.

Week of February 28th
UDWR requested modification of releases from Flaming Gorge Dam on April 18-19, 2011, to conduct the spring fishery assessment. Reclamation informed UDWR that Flaming Gorge Dam operations were responding to increasing hydrologic forecasts and would not be able to provide the lowered releases necessary for the spring fishing assessment.

Reclamation received correspondence on March 3, 2011, from the National Park Service in support of research and study related to the Upper Colorado River Endangered Fish Recovery Program (Recovery Program) request, and further asking for an additional year for researchers to acquire base level data prior to any spring flushing flows.

Week of March 7th
The FGTWG met on March 9, 2011, and discussed the wet hydrology in the Upper Green and Yampa River basins. The group then discussed the draft Proposed Flow and Temperature Objectives for 2011, with the draft containing previous year research requests from the Recovery Program. The Recovery Program worked with UDWR to submit a flushing flow request. The Recovery Program request follows their request and incorporates the synthesis report by Kevin Bestgen and Bruce Haines, which requests timing Flaming Gorge releases with larval emergence in Reach 2, along with the continuing studies requiring at least 15,000 cfs in Reach 2 for connection at Stirrup Floodplain.

On March 12, 2011, Reclamation received a memorandum from the Recovery Program containing its research request for 2011 Green River spring flows.

Week of March 14th

The March final forecast of April-July unregulated inflow volume for Flaming Gorge increased from the February forecast. In order to meet the elevation target of 6,027 feet on May 1, 2011, releases increased from an average daily release of 950 cfs to 1,050 cfs beginning April 1, 2011, with hourly releases following a single-peak pattern.

Week of March 28th

Storms over both the Upper Green and Yampa River Basins significantly increased the potential for high spring flows in 2011. It was anticipated that the Colorado Basin River Forecast Center (RFC) would increase the Flaming Gorge unregulated inflow forecast up to 10 percent from the March forecast. The RFC would likely increase the forecast for the Yampa River Basin 20 percent from the March forecast. Because of scheduled maintenance, Flaming Gorge had two units available until May 6, 2011. In anticipation of spring runoff, beginning April 4, 2011, releases increased from a daily average release of 950 cfs to steady releases at power plant capacity with two available units (3,060 cfs/day).

Week of April 4th

The FGTWG convened on April 8th to discuss the Proposed Flow and Temperature Objectives prior to presenting them at the April 26, 2011, Flaming Gorge Working Group (Working Group).

Reclamation received correspondence from the U.S. Fish and Wildlife Service (Service) on April 7, 2011, supporting the Recovery Program's research request.

Week of April 11th

The FGTWG convened on April 12th to discuss the upcoming Recovery Program research request for Flaming Gorge releases to coincide with the emergence of larval razorback sucker in Reach 2 of the Green River, along with maintaining five consecutive days at 15,000 cfs or greater for connection at the Stirrup Floodplain.

Reclamation received additional correspondence from the Service amending the correspondence received on April 7, 2011, clarifying that, while the Recovery Program's 2011 request may not meet the Reach 2 targets, the Service indicated that by implementing the Recovery Program research request, it would consider that Reclamation had met its responsibilities under the Record of Decision (ROD).

Week of April 18th

Storms continued over both the Upper Green and Yampa River Basins significantly increasing the potential for high spring flows in 2011. The RFC increased the forecast for inflows into Flaming Gorge Reservoir 13 percent from the April final forecast. Maintenance was completed and in order to evacuate space in anticipation of spring runoff, releases were

increased beginning April 26, 2011, to steady releases at power plant capacity with three available units (approximately 4,600 cfs).

The FGTWG convened on April 20th to discuss current hydrology and the necessity for Flaming Gorge to be operated for dam safety rather than Recovery Program research requests. It was anticipated that the requests would be met with the wet hydrology in the Green and Yampa River Basins.

Week of May 2nd

Storms continued over both the Upper Green and Yampa River Basins significantly increasing the potential for high spring flows in 2011. Snow water equivalent for the Green River Basin was 162 percent of average and the Yampa River Basin was 172 percent of average. The Upper Green River and Yampa River Basins were expected to receive continued precipitation.

The May preliminary forecast from the River Forecast Center (RFC) for inflows into Flaming Gorge Reservoir was 146 percent of average (1,660 KAF). Evacuation of storage in anticipation of high spring runoff above and below Flaming Gorge Dam for safety was the highest priority. The outlet works (bypass tubes) were increased on May 3, 2011.

Vibrations from both river outlet hollow jet valves at the current elevation necessitated decreasing releases to maintain equipment safety. The river outlet hollow jet valves (bypass tubes) decreased to 70 percent capacity or approximately 1,860 cfs each, releasing a total from the hollow jet valves of approximately 3,720 cfs. Flaming Gorge total releases with power plant capacity and the hollow jet valves was 8,220 cfs.

Week of May 9th

Warm temperatures and rain over the Yampa River Basin increased flows with continued increases expected the next week. To reduce flows in the Green River below the confluence with the Yampa River, Flaming Gorge reduced releases to steady releases at power plant capacity on Monday, May 9, 2011.

Week of May 14th

Reclamation responded to the Recovery Program 2011 Green River Research Request on May 16, 2011. Reclamation recommitted to operations at Flaming Gorge Dam under the Record of Decision (ROD) and adaptive management in the Green River based on new information from the scientific community. However, based on the wet hydrologic conditions in the Green and Yampa Rivers, Reclamation asserted that operations at Flaming Gorge Dam during spring runoff were driven by dam safety and, to the extent possible, time releases to diminish stage levels downstream of the Green and Yampa River confluence. However, Reclamation projected that all the wet hydrologic classification targets pursuant to the ROD would likely be met.

Week of June 6th

The June final forecast increased to 1.89 million acre-feet or 159 percent of average; 75 percent of the total volume was expected by the end of July. Inflows increased and Flaming

Gorge Reservoir elevation was increasing rapidly. Evacuation of storage for safety in anticipation of continued high inflows into Flaming Gorge Reservoir was the highest priority. Accordingly, the outlet works increased 2,000 cfs on Thursday, June 9, 2011 to a total release from Flaming Gorge Dam of 6,600 cfs.

Inflows into Flaming Gorge Reservoir continued to increase and snow continued to fall in the Upper Green River Basin. Yampa River flows were expected to decrease starting June 11, with anticipated flows approximately 5,000 cfs lower. The Yampa River was contributing approximately 80% of the total flow in the Green River at Jensen, and snowpack was increasing in the Upper Green. In order to decrease the potential of much higher releases later in the season, Flaming Gorge outlet works increased an additional 2,000 cfs on Saturday, June 11, 2011, to a total release from Flaming Gorge Dam of approximately 8,600 cfs.

The combined Flaming Gorge Dam releases and Yampa River flows resulted in a peak flow of 31,300 cfs on June 11, 2011, as measured on the Green River at Jensen, Utah.

Week of June 13th

Flaming Gorge Reservoir had 527,000 acre-feet (AF) of space (86 percent of live capacity). The June final forecast estimated 1.89 million acre-feet (maf) of water into Flaming Gorge during the April-July period. Total volume into Flaming Gorge at that time was 707,000 AF, leaving approximately 1.2 maf or 63 percent of the total volume (1.18 maf) expected by the end of July. Releases were expected to remain high over the next few months and additional maintenance was necessary to ensure continuity of operations. The outlet works were decreased 1,500 cfs on Monday, June 20, 2011, between 0700 and 1800 to perform scheduled maintenance.

Week of July 4th

The Record of Decision targets had been met and analysis indicated the base flow and May 2012 elevation targets would be met. While forecasts predicted peak inflows into Flaming Gorge Reservoir decreasing, high inflows were forecasted to continue through August/September and elevation levels were expected to continue increasing. Therefore, beginning July 11, 2011, releases decreased from 8,450 cfs to an average daily release of 2,450 cfs, at a rate of 1,000 cfs.

Week of July 11th

Inflows remained higher than anticipated resulting in higher than anticipated elevation gains. Rather than decrease to an average daily release of 2,450 cfs, releases remained at power plant capacity beginning Thursday, July 14, 2011.

Week of July 25th

Inflows into Flaming Gorge and Fontenelle Reservoirs were forecasted to continue decreasing. The Record of Decision targets were met and analysis showed meeting the base flow and May 2012 elevation target. Beginning July 28, 2011, releases were decreased from power plant capacity of 4,600 cfs to an average daily release of 2,450 cfs, with hourly releases following a single-peak pattern.

Week of August 15th

Yampa River flows, measured as the sum of Little Snake at Lily and Yampa River at Maybell, were at 800 cfs and forecasted to reach approximately 500 cfs next week. The hourly pattern in place had been approved for Yampa flows from 2,000 cfs to 1,000 cfs. In order to comply with the commitments related to maintaining 0.1 meter stage change as measured at Jensen, Utah, the flow pattern at Flaming Gorge was revised on Tuesday, August 16, 2011. Releases remained at the current average daily release of 2,450 cfs, but followed an hourly release schedule that maintained 0.1 meter stage change as measured on the Green River at Jensen, Utah.

Week of September 5th

The Utah Division of Wildlife Resources (UDWR) requested modification of releases from Flaming Gorge Dam on September 12 and 13, 2011, to conduct the fall fishery assessment. Flaming Gorge Dam releases were operated at 1,600 cfs during the hours needed for the assessment.

Week of September 26th

The Flaming Gorge forecast continued to decrease for the months of October and November, and was expected to drop further in the coming months. Additionally, the Yampa River was expected to decrease to base flows averaging 300 cfs. Release requirements were to meet the May 1 elevation target of 6,027 feet and maintain 0.1 meter stage change as measured at the Jensen, Utah stream gage. In order to meet the release requirements, Flaming Gorge releases were decreased at a rate of 50 cfs/day from an average daily release rate of 2,450 cfs to 2,000 cfs by October 10th of water year 2012.

Appendix C

April 6, 2011 Memorandum from the Recovery Program Director containing the Research Request for 2011 Green River Spring Flows

Upper Colorado River Endangered Fish Recovery Program

Stephen D. Guertin, Chairman
Implementation Committee

Thomas E. Chart, Director
Recovery Program

U.S. Fish and Wildlife Service•P.O. Box 25486•Denver Federal Center•Denver, CO 80225•(303) 969-7322•Fax (303) 969-7327
FWS/CRRP
K3a1
Mail Stop 65115

APR 06 2011

Memorandum

To: Larry Walkoviak, Director, Upper Colorado Region, Bureau of Reclamation

Heather Hermansen, Chair, Flaming Gorge Technical Working Group, Bureau of Reclamation

From: Thomas Chart, Director, Upper Colorado River Endangered Fish Recovery Program

Subject: Recovery Program's Research Request for 2011 Green River Spring Flows

The Upper Colorado River Endangered Fish Recovery Program (Recovery Program) supports the Bureau of Reclamation's (Reclamation) operations at Flaming Gorge Dam in 2011 consistent with the 2005 biological opinion (U.S. Fish and Wildlife Service 2005) and 2006 record of decision (ROD; U.S. Department of Interior 2006). The primary objective of our request this year is intended to build on past research to benefit the razorback sucker population throughout the Green River by timing floodplain connection with the presence of wild-produced razorback sucker larvae. A secondary objective is to achieve a target flow at the Stirrup floodplain site as part of a specific project under the Utah Division of Wildlife Resources (UDWR) which will continue to investigate recruitment behavior of juvenile razorback sucker stocked from 2007-2009.

An important change from previous spring peak requests is a review of the considerations in Muth et al. (2000) which incorporates information the Recovery Program has gathered on razorback sucker early life history and historical operations at Flaming Gorge Dam (Hedrick et al. 2009; Bestgen and Haines 2010 in draft).

We are working under the assumption that flows in the Green and Yampa rivers will be average or wetter than average; however, we also address the possibility of drier hydrology. We consider this request a component of continued research into life history requirements of the endangered fish (particularly early life stages of razorback sucker), and an experiment using specific Flaming Gorge operations to better understand the relationship of using flows, timed with the abundance of wild razorback sucker larvae in Reach 2, to facilitate entrainment in high quality floodplain habitats with the objective of observing successful over-winter survival.

Colorado River Energy Distributors Association • Colorado Water Congress • National Park Service • State of Colorado
State of Utah • State of Wyoming • The Nature Conservancy • U.S. Bureau of Reclamation • U.S. Fish and Wildlife Service
Utah Water Users Association • Western Area Power Administration • Western Resource Advocates • Wyoming Water Association

CRITICAL UNCERTAINTIES

It has always been anticipated that the flow recommendations contained in Muth et al. (2000) and the ROD for Flaming Gorge (2006), would be revisited in an adaptive management framework. Specifically, the ROD (2006) described the uncertainty in the 18,600 cfs flow target and indicated that Reclamation would work with the Recovery Program to test the efficacy of that flow while trying to mitigate effects on various resources.

From the ROD (2006):

> *In particular, the hydrology analysis shows that the greatest potential for negative effects to several resources, including land use, recreation, mosquito control, and power generation are associated with one particular flow recommendation, specifically a spring peak release of at least 18,600 cubic feet per second (cfs) in Reach 2 for two weeks or more in at least one of four average hydrological years. Reclamation recognizes that the 2000 Flow and Temperature Recommendations represent the best available science and affirms its intent to meet those recommendations to the extent possible. At the same time, because of the potential economic effects of powerplant bypasses, Reclamation intends to work through the Upper Colorado Endangered Fish Recovery Program, along with the cooperating agencies on the EIS and the interested public, to assess the possibility of improving connectivity of floodplain habitats, identifying ways to improve entrainment of larval razorback suckers into floodplain habitats, maintain the river channel, restore natural variability of the river system, and meet other goals of the Flow and Temperature Recommendations at lower peak flow levels where feasible. Such additional knowledge gained through the adaptive management process may result in future refinement of the 2000 Flow and Temperature Recommendations that would maintain or improve conditions for the four endangered fish species while minimizing negative effects to the authorized purposes of Flaming Gorge Dam.*

In addition, under the Environmental Commitments of the ROD (2006), they state:

> *Reclamation will support the Recovery Program, in coordination with the U.S. Fish and Wildlife Service and Western, in developing and conducting Recovery Program studies associated with flood plain inundation. Such studies would include improving connectivity of floodplain habitats, identifying ways to improve entrainment of larval razorback suckers into floodplain habitats, maintain the river channel, restore natural variability of the river system, and analyze possibilities for meeting the goals of the Flow and Temperature Recommendations at lower peak flow levels where feasible.*

Thus, we believe it is important to utilize recent information which indicates the timing of the Flaming Gorge peak need to be adjusted to benefit drifting larval razorback suckers (Bestgen and Haines 2010 in draft; discussion below).

We also believe that it is important to test ability of various floodplain wetland types to successfully entrain and support larvae. It is undeniable that as flows increase entrainment increases substantially in both flow-through and single-breach wetland types (Hedrick et al. 2009; Bestgen and Haines 2010 in draft). The critical question is what flow levels are needed in Reach 2, when larvae are abundant, to result in a biological impact (survival of razorback suckers in rearing habitats).

This results in three critical uncertainties which we would like to test with these experimental flows from Flaming Gorge this year and in future years:

1. Can timing of the spring peak discharge from Flaming Gorge dam be altered to maximize overlap with the abundance of wild razorback sucker larvae in Reach 2 of the Green River?

2. Given changes in floodplain habitats since the flow recommendations were developed, what flows are necessary to result in successful entrainment of wild larvae in floodplains in Reach 2?

3. Are these wetlands successful in promoting survival of razorback suckers (both fall and over-winter survival)?

These and other floodplain-related uncertainties were recognized as high priorities in the Recovery Program's Green River Study Plan (Green River Study Plan *ad hoc* Committee 2007).

Primary Objective: Time Flaming Gorge releases to connect floodplains when wild produced razorback sucker larvae are present in the Green River.

As background, we review the anticipated effects (from Muth et al. 2000) of the spring flow targets (magnitude and duration; from Tables 5.4 – 5.6) and the examples of real-time and other year-specific information to be considered in annual patterns of releases (from Table 5.3). The anticipated effect of meeting flow targets in excess of 18,600 cfs at Jensen (Reach 2) as stated in Muth et al. 2000 is:

> *Significant inundation of floodplain habitat and off-channel habitats (e.g., tributary mouths and side channels) to establish river-floodplain connections and provide warm, food-rich environments for growth and conditioning of razorback suckers (especially young) and Colorado pikeminnow,* and, *Peak flows should coincide with peak and immediate post-peak spring flows in the Yampa River.*

In keeping with this anticipated effect, the authors identified, among other real-time triggers, the following piece of information that should be taken into account when timing the onset of spring Peak Flow operations:

> *Initial appearance of larval suckers in established reference sites in Reach 2(e.g., Cliff Creek).*

In the past, Reclamation and the Recovery Program have used the real-time razorback sucker larval collection information to influence spring operations, but this has generally occurred at the tail end of the spring releases coincident with the emergence of larvae. The Recovery Program recently contracted with Colorado State University to synthesize the long term body of razorback sucker larval collection information including timing of presence of larvae in nearshore habitat, relative abundance, larval entrainment into floodplain habitats, downstream transport of razorback sucker larvae, and environmental correlates of these processes. One of the objectives of this synthesis was to evaluate the ability to operate Flaming Gorge Dam (since the Service's 1992 Biological Opinion through more recent ROD operations) in order to meet the aforementioned anticipated effect of enabling entrainment of razorback sucker larvae into

floodplain wetlands. This synthesis was called for in the Recovery Program's Green River Study Plan, which was developed to evaluate implementation of Muth et al. 2000 and is a term and condition of the 2005 Biological Opinion.

In April 2010, the Recovery Program received a draft of that synthesis entitled: *Bestgen, K.R. and G.B. Haines (2010; in draft). Synthesis of floodplain wetland information: timing of razorback sucker reproduction in the Green River, Utah, related to streamflow, water temperature, and floodplain wetland availability.* Since that time, the draft report has undergone peer and Biology Committee review. The report has not yet been revised for final Recovery Program approval, but is expected to be completed in 2011. Importantly, the report presents a synthesis of long term monitoring data that may now be used to better inform our management actions, a foundational premise of the Recovery Program. One of the more significant conclusions from Bestgen and Haines (2010; in draft – see below) is that in the years after the 1992 Biological Opinion, matching the peak of the Yampa River with releases from Flaming Gorge Dam, a recovery strategy developed by the Service and implemented by the Reclamation, has resulted in floodplain connection in the Green River that occurs prematurely to the presence of endangered species life stage (larval razorback suckers) we are trying to benefit. The Recovery Program acknowledges that during the environmental impact statement process in 2004 and 2005, Reclamation incorporated new hydrologic models to assist in timing releases from Flaming Gorge to match Yampa River flows; and further, that the magnitude and duration of Flaming Gorge releases are one factor of several, including water quality and predation of nonnative aquatic species, that impact the reproduction and survival of wild razorback sucker. And whereas, the Recovery Program has consistently documented successful razorback sucker reproduction in the middle Green River since 1992, survival of wild- produced razorback sucker beyond the larval stage has not been documented. However, uncertainties exist related to the impact of increased survival of wild razorback sucker from timing releases of Flaming Gorge to more closely match the initial appearance, or potentially abundant appearance, of larvae in the middle Green River system. Therefore, agency efforts to work in concert towards recovery may benefit from exploring the shift in management action detailed later in this letter.

<u>Bestgen and Haines (2010; in draft) concluded (excerpted from a total of 35 conclusions)</u>:

- Abundance of razorback sucker larvae increased in the middle Green River perhaps beginning around 2000, and certainly after 2004, coincident with establishment of larger populations of stocked razorback suckers, indicating successful acclimation and reestablishment of some adults.

- Timing of spawning, hatching, and emergence of razorback suckers in the lower and middle Green River was dependent mostly on exceeding reasonably consistent thresholds of water temperature.

- Timing of first occurrence of razorback sucker larvae captured in light traps in the middle Green River was at or typically after peak flows had passed; peak abundance of larvae was well after flows declined.

- Higher Green River flows resulted in greater areas of floodplain wetland availability and greater entrainment rates.

- Flow releases from Flaming Gorge Dam and timing of occurrence of razorback sucker larvae are mismatched. This was because Flaming Gorge Dam releases in spring that were designed to enhance flood plain-river connections usually occurred too early and well before first appearance of the razorback sucker larvae that flows are supposed to benefit. Releases are also often well in advance of peak flows from the Yampa River, which is not consistent with flow recommendations.

- A flow release trigger that more consistently matches flows from Flaming Gorge Dam with those of the Yampa River, as well as with occurrence of razorback sucker larvae, is needed.

- First captures of larvae may be a better trigger to signal release of Flaming Gorge flows.

- Increasing the magnitude and duration of spring flow releases and delaying their onset to coincide with presence of razorback sucker larvae may be minimally sufficient conditions to enhance recruitment of razorback suckers in the middle Green River, Utah. Increased recruitment is required to achieve recovery of the species in the Upper Colorado River Basin.

Bestgen and Haines (2010; in draft) recommended (excerpted from a total of eight recommendations):

- Implement a schedule of altered timing of flow releases from Flaming Gorge Dam to coincide more closely with presence of razorback sucker larvae, or perhaps, presence of *abundant* larvae, in the middle Green River. Reliable real-time monitoring is already in place to guide timing of releases. In lieu of that, develop relationships based on physical attributes, mostly water temperature and time of year, which would predict timing of emergence of razorback sucker larvae.

- Investigate the feasibility of increased magnitude and duration of spring flow releases from Flaming Gorge Dam, after razorback sucker larvae are present, to maintain connections with floodplain wetlands and increase entrainment rates. Flow releases that simulate unregulated conditions should be used for a realistic test of effectiveness of increased flows to enhance recruitment. Subsequent effects on base flow levels, among other things, will also need to be considered.

The Recovery Program recognizes that flows greater than 13,000 cfs begin to connect the floodplain in some areas in Reach 2, but as stated in Muth et al. (2000) floodplain inundation increases significantly, particularly on the Ouray National Wildlife Refuge, as flows increase above 18,600 cfs.

Secondary Objective: Assist in meeting the objectives of Recovery Program Project No.C6 RZ-RECR: *Razorback emigration from the Stirrup floodplain*

The Recovery Program has determined that 15,000 cfs is needed to provide an adequate connection (30cm depth in the breach channel) at the Stirrup floodplain site for UDWR to continue their investigation into juvenile razorback sucker recruitment rates. As in past years, the Recovery Program therefore requests 15,000cfs for 5 consecutive days in Reach 2 to assist in meeting these project objectives. A flow of 15,000 cfs connects several other floodplain habitats. NOTE: a flow of 16,000 cfs would provide a better connection at the Stirrup and was recognized as an important connection flow for other floodplain habitats on the Ouray National Wildlife Refuge (Heitmeyer and Fredrickson 2005).

THE RECOVERY PROGRAM'S SPRING 2011 FLOW REQUEST:

At the March 9, 2011 Flaming Gorge Technical Work Group (FGTWG) meeting Reclamation provided the following information on forecasted conditions: March 1, 2011, forecast of April through July unregulated inflow (current forecast) for Flaming Gorge Reservoir is 1,210 thousand acre-feet (KAF) (102% of 30-year average); the current forecast for the Little Snake River and Yampa River combined (Little Snake at Lily plus Yampa at Maybell) is 1,820 KAF (134% of 30-year average). We provide this spring flow request with hopes that these conditions persist or get wetter. However, if conditions become drier the Recovery Program understands it will become increasingly difficult for Reclamation to meet our spring flow request.

Criterion #1. **The Recovery Program requests that Reclamation's spring 2011 operations be timed to coincide with the presence of larval razorback sucker in Reach 2 habitats.**

The Recovery Program can provide a real-time assessment of larval presence through Recovery Program Project No 22f. Based on information provided in Bestgen and Haines (2010; in draft), waiting for this biological trigger will likely cause Reclamation to make spring releases from Flaming Gorge Dam after the Yampa River has peaked necessitating releases in excess of power plant capacity in order to meet the flow magnitude thresholds. The Recovery Program requests that Reclamation limit their spring release magnitudes to full bypass flows up to 8,600 cfs. This is in deference to possible entrainment of nonnative burbot via the spillway. The Recovery Program fully recognizes the importance of using the spillway (releases in excess of 8,600cfs) in the future to assist in the recovery of the endangered fish, but we would rather proceed with caution until we have more information about the life history of burbot in Flaming Gorge Reservoir and associated risks of entrainment.

Criterion #2: Contingent on having met Criterion #1, and based on the hydrology scenarios below --

> Criterion #2a. If the hydrology remains **Wet-Average, Moderately Wet or Wet Categories** (<40% exceedance) we request that Reclamation release flows that maintain 18,600cfs or greater for two weeks or more in Reach 2.
>
> The Recovery Program considers achieving this flow magnitude and duration coincident with the presence of larval razorback sucker as fully meeting our Primary and Secondary Objectives. The Recovery Program is aware that if Yampa River flows drop below 10,000 cfs when the biological trigger occurs, achieving 18,600 cfs in Reach 2 will not be

possible (based on our request to cap Flaming Gorge releases at 8,600 cfs in 2011; see above). Maintaining flows as close to 18,600 cfs as possible will still provide some floodplain connection. Again, the primary objective of the experiment in 2011 is to provide floodplain connection when larval razorback sucker are present in the system.

The Recovery Program therefore requests that the Service consider this tradeoff (operations in 2011 intended to focus on the intent of the Muth et al. (2000) spring flow recommendation at the possible expense of not fully achieving designated flow and duration targets) in their long term evaluation of Reclamation's operations/compliance under the Biological Opinion (USFWS 2005).

Criterion #2b. If the hydrology drops into the drier portion of the **Average Category** (40 - 70% exceedance) we request that Reclamation release flows that maintain 15,000 cfs or greater for at least 5 days. The Recovery Program considers achieving this flow magnitude and duration coincident with the presence of larval razorback sucker as partially meeting our Primary Objective and fully meeting our Secondary Objective.

Criterion #2c. If the hydrology drops into the **Moderately Dry Category** (>70% exceedance) we request that Reclamation release flows that achieve 15,000 cfs or greater for one day. The Recovery Program considers achieving this flow magnitude and duration coincident with the presence of larval razorback sucker as partially meeting both Primary and Secondary Objectives.

Recovery Program studies to assist in timing of releases and to evaluate the spring release (see Uncertainties 1-3; page 3).

The Recovery Program has the following studies in place to evaluate Reclamation's spring 2011 operations:

- Project 115: This long term fish community monitoring effort in Reaches 1 and 2 can be used to evaluate the effect of high spring releases on the resident fish community.

- Project 22f: Collections in long term sampling sites will be compared to years when Green River flows were dropping or had dropped prior to larval presence. This long term larval razorback sucker monitoring effort will be expanded in 2011 to sample for larval razorback sucker entrained into floodplain sites. Expanded sampling will include a minimum of two flow-through floodplains and two single-breach floodplains.

- C6-Baeser: Vernal-CRFP is scheduled to sample several Reach 2 floodplain habitats in the fall for presence Age-0 razorback sucker. Specific sampling locations will tier off results of the additional sampling for larvae identified under Project 22f. In addition, the Recovery Program will explore options of sampling these same habitats in Spring 2012 if Age-0 razorback sucker are detected in autumn 2011.

- Project 138 and 154: Small bodied fish sampling in main channel backwater; conducted in autumn. This sampling could detect an increase in young razorback suckers (if larvae

were swept on floodplain terraces and returned to the river or used floodplain depressions for a short period of time) in 2011.

- Project 160: A specific sampling effort to assess razorback sucker reproduction in the lower Green River.

- Projects 123a, 123b, 128: These nonnative fish removal projects and the Green River Colorado pikeminnow population estimation study call for multiple electrofishing trips in the main channel, which have accounted for many collections of stocked razorback sucker in recent years. We would not expect data collected in 2011 to contribute to an evaluation of 2011 operations, but these studies could detect juveniles from the 2011 cohort in outyears.

- The Recovery Program is developing a specific razorback sucker monitoring plan scheduled for completion in 2011. This plan will likely reference many of the aforementioned sampling efforts but will likely recommend additional sampling strategies that could assist in the evaluation of 2011 spring operations by tracking the 2011 cohort in outyears.

The Recovery Program can provide the following information to assist Reclamation with timing their spring release:

- Real time razorback sucker larval collection information (Project 22f), and a prediction of larval presence based on the Green River thermal regime and other environmental factors (Bestgen and Haines 2010 in draft).

Utah Division of Wildlife Resources Flushing Flow Request:

The Recovery Program has been in communication with the UDWR as they developed their spring release request (8,600 cfs for 5-7 days) to improve sport fish habitat and to benefit the invertebrate community in the Flaming Gorge tailrace. If timed to meet Criterion #1 (e.g., coincident with presence of razorback sucker larvae in Reach 2), we believe the UDWR flow request would be compatible with the Recovery Program's objectives this spring.

Base Flow Requests

Based on the current hydrologic forecasts the Recovery Program thinks it is prudent to focus on floodplain connection flows in 2011. We understand that spring operations could affect water availability for base flow operations. We reserve the right to address 2011 base flow operations at a later time.

In closing, the Recovery Program appreciates Reclamation's efforts in the past to achieve the flow and temperature recommendations and assist in recovery of the endangered fishes. We recognize that greater reliance on the biological trigger (presence of larval razorback sucker) may require considerably greater volumes of water during the spring in some years, but we believe this experiment is more in keeping with the intent of Muth et al. 2000 and is necessary to

assist in the recovery of the endangered fish. Thank you for considering this Recovery Program request for spring flows.

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cc: Malcolm Wilson, Chief, Water Resources Group, USBR, Salt Lake City, Utah
Beverley Heffernan, Environmental Resources Division, USBR, Salt Lake City, Utah
Julie Lyke, Deputy Assistant Regional Director – Ecological Service, USFWS
John Shield, Chair, UCREFRP - Management Committee, Wyoming State Engineer Office, Cheyenne, Wyoming
Melissa Trammell, Chair, UCREFRP - Biology Committee, National Park Service, Salt Lake City, Utah.

Appendix D

Western Area Power Administration

PROPOSED EXPERIMENTAL SPRING RELEASES FROM FLAMING GORGE RESERVOIR IN 2011

Western Area Power Administration

March 14, 2011

Information presented by the Bureau of Reclamation (Reclamation) at the Flaming Gorge Technical Work Group Meeting on March 10, 2011 indicated that the current forecast for 2011 is for an average year as defined in the Flaming Gorge Flow and Temperature Recommendations (Muth et al. 2000). The forecast indicates that unregulated inflow to Flaming Gorge Dam is 102% of the 30 year historical average and is at the 37% exceedance level. From a hydrologic standpoint, the most comparable recent year is 2009.

Western Area Power Administration (Western) has prepared this additional information and propose that it be used to modify and clarify the experimental spring releases described in a draft memo (Tom Chart, February 25, 2011) and approved by the RIP Biology Committee. This additional information seeks describe an experiment that addresses uncertainties related to razorback sucker survival and recruitment. We believe modifications to the Chart proposal will improve the chance of success from an operational and biological perspective as discussed below.

For average years, Muth et al. (2000) recommended spring peak flows as follows:

- For Reach 1, a spring peak magnitude ≥ 4,600 cfs, with a duration that is necessary to achieve the duration target in Reach 2;
- For Reach 2,
    - an instantaneous spring peak magnitude ≥ 18,600 cfs in 50% of average years,
    - ≥ 18,600 cfs with a 14 day duration in 25% of all average years;
    - ≥ 8,600 cfs for 7 days in 50% of average years.

Although not specified in Muth et al. (2000), these target magnitudes and durations would presumably be implemented according to the particular exceedance level of an average year, with the wettest 50% (i.e., years with exceedance levels between 50 and 30%) achieving the instantaneous peak target flow of ≥ 18,600 cfs, and the wettest 25% (i.e., years with exceedance levels between 40 and 30%) providing 14 days or more above 18,600 cfs. As discussed below, we would defer this specific duration target in order to achieve adequate floodplain connections during the peak of razorback sucker larval drift.

A recent draft synthesis of floodplain wetland information by Bestgen and Haines (2010) indicated that past attempts to meet the Muth et al. (2000) flow recommendations may have failed to achieve one of their primary intended objectives of entraining larval razorback suckers into floodplain wetland nursery habitats. The synthesis of Bestgen and Haines found that releases to match the peak of the Yampa River have often resulted in peak flows that precede rather than coincide with the peak of razorback sucker larval drift. They hypothesized that over the time period studied (1992-2008) entrainment has been insufficient to produce recruitment of razorback suckers in the middle Green River. Bestgen and Haines modeled various Flaming Gorge operational scenarios and compared the scenarios' abilities to provide entrainment flows during periods of larval drift.

Among other recommendations, Bestgen and Haines (2010) proposed that, rather than timing Flaming Gorge releases to coincide with the peak and immediate post-peak of Yampa River flows, releases should be timed to coincide with the peak of larval drift. On the basis of this recommendation, the Recovery Program submitted a 2011 spring flow request to the Bureau of Reclamation to achieve two objectives:

- Primary objective: Time Flaming Gorge releases to connect floodplains when wild produced razorback sucker larvae are present in the system.

- Secondary objective: Assist in meeting the objectives of Recovery Program Project No. C6 RZ-RECR: *Razorback Emigration from the Stirrup Floodplain*.

Details of the Recovery Program Director's Office request are as follows:

- Operations should be timed to coincide with the presence of larval razorback sucker in Reach 2 habitats;

- Flows of 18,600 cfs or greater should be achieved for two weeks or more in Reach 2 if the hydrology is wet-average, moderately wet or wet categories (i.e., <40% exceedance);

- Flows that maintain 15,000 cfs for at least 5 days should be provided in Reach 2 if the hydrology drops into the drier portion of the average category (i.e., 40 to 70% exceedance);

- Flows that achieve 15,000 cfs for one day should be provided in Reach 2 if the hydrology drops into the moderately dry or dry categories (i.e. >70% exceedance);

- Releases from Flaming Gorge should not exceed 8,600 cfs (full bypass).

The Recovery Program Director's Office recognized that once Yampa River flow drops below 10,000 cfs, achieving 18,600 cfs in Reach 2 will not be possible without releasing more than 8,600 cfs from Flaming Gorge.

The Recovery Program Director's Office request is couched as an experiment to test the effectiveness of using the biological trigger of razorback sucker larval drift for

determining the timing, magnitude, and duration of spring peak flows in the middle Green River. As an experiment, however, we feel that the specific request is tied too closely to particular details of the Muth et al. (2000) recommendations, and does not fully consider the findings presented in Bestgen and Haines (2010).

The Muth et al. (2000) spring peak flow magnitude recommendations were based on a floodplain inundation-to-flow relationship with existing levees in place (Figure 3.18 in Muth et al.). The recommended two-week duration was based on the need to intercept drifting larvae. Since the original recommendations were published, many of the inlets and outlets of the floodplain wetlands in the middle Green River have been modified such that connection now occurs in many of the wetlands at flows closer to 13,000 cfs rather than 18,600 cfs. Consequently, we do not believe the experiment must target a duration of 14 days at 18,600 cfs if the biological trigger is used.

Bestgen and Haines (2010) presented a solid case that entrainment rates into flow-through wetlands (i.e., those wetlands with at least two openings that allow water to flow through the wetland when the river is at high flow) are higher than in single-breach wetlands.[10] Entrainment into single-breach wetlands is highest when a riverine connection is first established until the time the wetland is filled. This pour-over event would entrain any larvae present near the wetland inlet. Once a single-breach wetland is filled, the estimated entrainment rate is very low unless there is an increase in stage or flows fluctuate up and down. On the basis of aerial photography collected in the spring of 2005, it appears that it took about three days for single-breach wetlands to fill as flows increased from 14,000 cfs to 18,500 cfs.

Despite the higher entrainment rates of flow-through wetlands as compared to single-breach wetlands, Bestgen and Haines point out several potential disadvantages for flow-through wetlands that limit their current functionality as nursery habitats that can contribute to recovery.

Single-breach wetlands may be more likely to provide overwinter habitat for fish than flow-through wetlands. Flow-through wetlands in the middle Green River may not have sufficiently deep areas to overwinter young fish especially in very cold years when ice cover is thick. Water depth is at least partly controlled by the elevation of outlet breaches, which determine the depth of water retained in those wetlands (Bestgen and Haines 2010). According to Bestgen and Haines (2010, p. 86):

> "We have good evidence to suggest that entrainment rates were highest in flow-through wetlands such as Thunder Ranch. However, the capacity of flow-through wetlands, including Thunder Ranch, to overwinter fish may be suspect. For example, in 2006 nearly 600,000 razorback sucker larvae were released just upstream of the Thunder Ranch wetland breaches, and we know that large numbers, perhaps most,

[10] Bestgen and Haines estimated entrainment rates into floodplain wetlands, but there were no data available to determine the rates that entrained larvae were exported to the river through wetland outlets. Thus, retention of entrained larvae in flow-through wetlands is not known.

> were entrained. However, inspection of the Thunder Ranch wetland in autumn 2006 did not reveal presence of razorback suckers (Hedrick et al. 2009)."

As they state on page 87: "while flow-through sites will entrain more razorback sucker larvae, if the floodplain cannot sustain those fish over-winter, the floodplain wetland will not contribute to recovery of the species." In contrast to flow-through wetlands, single-breach wetlands may entrain less water and fewer larvae, but there are several such as Stirrup and L-7 that are deep enough to successfully overwinter fish (Bestgen and Haines 2010).

Flow-through wetlands are more prone to sedimentation than are single-breach wetlands. The same process that results in higher entrainment rates, results in an influx and deposition of sediment in flow-through wetlands. As stated in Bestgen and Haines (2010):

> "Managers at Ouray National Wildlife Refuge considered wetland sedimentation a serious enough issue that they will no longer allow wetlands to fill in a flow-through fashion. Instead, flood plain wetlands will backfill via a downstream breach(es) as they naturally do, albeit aided in some situations by reduced heights of levee breaches (Heitmeyer and Fredrickson, 2005)."

Over time, sedimentation can result in increasingly shallow wetlands, and ultimately compromises the ability of wetlands to overwinter fish. Sedimentation of floodplain wetlands was identified in LaGory et al. (2003) as a primary information need for the Recovery Program.

Modifications and Additions to the Chart Experiment of February 25, 2011, to Address Uncertainties Related to Razorback Sucker Recruitment

Addressing uncertainties related to recovery of razorback suckers in the Green River is a vital concern of the Recovery Program. We propose an alternative approach to achieving the Recovery Program Director's Office objectives that is supported by the Bestgen and Haines (2010) synthesis and other information gathered by the Recovery Program. Our approach is intended to maximize the potential for success, as measured by the recruitment of razorback suckers, given the existing configuration of flow-through and single-breach wetlands and existing operational constraints at Flaming Gorge Dam. Characteristics of our proposed additions are as follows:

- <u>Peak flow timing</u>: Time peak flow releases from Flaming Gorge Dam to coincide with the estimated peak of razorback sucker larval drift. This would meet the Recovery Program's primary objective, and is consistent with their request, but it should be noted that their proposal only requests that operations provide connecting flows at the onset of larvae, not the peak in drift as we request..

- <u>Peak flow magnitude</u>: Provide sufficient flow to achieve a target of at least 15,000 cfs. This magnitude is potentially lower than the Recovery Program's request depending on contributions from the Yampa River.

- Peak-flow duration: Flows above 15,000 cfs should be maintained for 5 consecutive days or longer to meet the needs of Recovery Program Project No. C6 RZ-RECR. This would meet the Recovery Program's secondary objective. This duration should be sufficient to fill single-breach wetlands. Depending on hydrology, the Recovery Program requested a peak flow of 14 days above 18,600 cfs.

- Pre-peak flows: Prior to the estimated peak in larval drift, maintain relatively low releases to avoid filling single-breach wetlands prematurely. This may be difficult to achieve if the Yampa River alone provides over 12,000 cfs of flow. The Recovery Program's request did not specify a pre-peak flow request.

- Post-peak releases: Once single-breach wetlands are filled, fluctuate releases to the extent possible (e.g., 2,000 cfs/day) to provide continued opportunities for entrainment to single-breach wetlands. The Recovery Program's request did not specify post-peak fluctuations.

Past operations at Flaming Gorge Dam to achieve the flow recommendations of Muth et al. (2000), and to meet the requirements of the Flaming Gorge Dam EIS record of decision, have attempted to match peak releases with the peak and immediate post-peak of the Yampa River. Delaying a peak release to coincide with the peak in larval drift runs the risk of being unable to achieve floodplain inundation and larval entrainment for adequate periods of time. If the peak in larval drift and the peak in Yampa River flows are greatly offset, it could be difficult to achieve 18,600 cfs even with bypass flows. With observed Yampa River flows in 2010, and depending on the timing of larval drift, it appears that the Recovery Program's Objectives 1 and 2 could have been accomplished with a sustained release of 4,200 cfs or less between May 28 and June 16. Based on the data presented in Bestgen and Haines (2010), the peak of larval drift occurred in this time window in 12 out of 16 of the years between 1993 and 2008. Over this same time period, nine days would have required a bypass of 6,600 cfs or 8,600 cfs to achieve a target of 18,600 cfs.

Proposed Studies to Address Uncertainties

The Recovery Program's letter identifies existing studies that would be implemented to assess the success of peak flow operations in 2011. These studies would be used to determine there is a pulse in razorback sucker numbers that represents the 2011 cohort in subsequent years. While this is a valid hypothesis to test, none of these studies specifically evaluate the success of operations in entraining larvae in different wetland types and sustaining them through the winter.

A key uncertainty identified in Bestgen and Haines relates to the relative performance of single-breach and flow-through wetlands. Because operations are likely to affect these wetland types differently, it is critical that this uncertainty is addressed. We do not believe that it is sufficient to examine only the relative strength of the 2011 cohort. To address uncertainty related to wetland type, the following hypotheses should be evaluated:

- The number of larvae entrained in single-breach wetlands in 2011 is the same as in flow-through wetlands.

- Single-breach wetlands retain more water and overwinter habitat than flow-through wetlands.

- The number of young-of-the-year razorback suckers in single-breach wetlands is the same as in flow-through wetlands in the fall of 2011.

- The number of young-of-the-year razorback suckers in single-breach wetlands is the same as in flow-through wetlands in the spring of 2012.

We propose that a minimum of two flow-through and two single breach wetlands be chosen for study. There are only four flow-through wetlands for potential study including Thunder Ranch, Stewart Lake, Bonanza Bridge, and Above Brennan, all of which connect at flows below 15,000 cfs. There are six single-breach wetlands that connect at flows below 15,000 cfs including Horseshoe Bend, Stirrup, Baeser Bend, Johnson Bottom, Leota, and Old Charley Wash. In selecting study wetlands, the ability to provide overwinter habitat for razorback suckers should be an overriding factor for consideration.

We believe that these proposed additions/modifications have a greater chance of success when added to the Recovery Program Director's Office spring flow request because (1) it will add to the likelihood of achieving the required inundation thresholds when the peak of larval drift occurs, (2) it capitalizes on more of the findings in the Bestgen and Haines (2010) draft synthesis, and (3) tests key hypotheses that will be important for improving recovery of razorback suckers.

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Appendix E

April 1, 2011 Memorandum from the U.S. Fish and Wildlife Service for the 2011 Green River Spring and Base Flows to Assist in Recovery of Endangered Fishes

United States Department of the Interior
FISH AND WILDLIFE SERVICE
UTAH FIELD OFFICE
2369 WEST ORTON CIRCLE, SUITE 50
WEST VALLEY CITY, UTAH 84119

April 1, 2011

In Reply Refer To:
FWS/R6
ES/UT
08-FA-0180

Memorandum

To: Director, Upper Colorado Region, Bureau of Reclamation
Chair, Flaming Gorge Technical Working Group, Bureau of Reclamation

From: Field Supervisor, Utah Field Office, U.S. Fish and Wildlife Service

Subject: 2011 Green River Spring and Base Flows to Assist in Recovery of the Endangered Fishes

This letter describes our recommendations for 2011 spring peak and summer base flows in Reach 2 of the Green River. Our intent is to work with other Flaming Gorge Technical Working Group (FGTWG) members to ensure consistency with the 2005 biological opinion (BO; U.S. Fish and Wildlife Service 2005) and 2006 record of decision (ROD; U.S. Department of Interior 2006), which call for flows to protect and assist in recovery of endangered fishes. The following suggestions are subject to forecasted and real-time April – July hydrologic conditions in the upper Green River drainage, with recognition that trade-offs of spring and base flows should be considered and used to adjust operations as deemed appropriate. We hope these recommendations are helpful for the FGTWG in development of recommendations for Flaming Gorge Dam operations.

Spring-peak research flow

We support the Upper Colorado River Endangered Fish Recovery Program's (Recovery Program) 2011 Spring Flow Request, as explained in their March 12, 2011 letter. We believe their primary objective, to time Flaming Gorge releases and resultant floodplain connection with the presence of wild produced razorback sucker larvae, is consistent with the intent of the Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Gorge Dam (Flow Recommendations; Muth et al. 2000), the 2005 BO, and the 2006 ROD. Specifically, the objectives and criteria presented in their letter are consistent with the common goal of the Flow

Recommendations, the BO, and the ROD: to use the best available science to guide Flaming Gorge operations and recovery actions in an adaptive management framework.

This experimental flow release is supported by the most recent scientific research into endangered fish ecology and floodplain management (Bestgen and Haines 2010; in draft). As the Recovery Program described in their letter, the Bestgen and Haines draft report synthesized long term data, evaluated the ability to operate Flaming Gorge Dam for the purpose of entraining wild razorback larvae into floodplain habitats, and created a set of conclusions and recommendations to guide future management. Utilizing up-to-date research and monitoring (such as the Bestgen and Haines draft report) to support an adaptive management process was called for in the Flow Recommendations, section 5.6:

> "the collection of additional data on endangered fishes and their habitats should focus on the evaluation and possible modification of our recommendations by following an adaptive-management process" (Muth et al. 2000, p. 5-39);

as was using biological information to guide the onset of spring peak flow:

> "Examples of real-time and other year-specific information to be considered in determining annual patterns of releases . . .
>
> - Initial appearance of larval suckers in established reference sites in Reach 2 (e.g., Cliff Creek)" (Muth et al. 2000, p. 5-9, Table 5.3).

Similarly, the 2005 BO calls for adaptive management in implementing the proposed action (operations of Flaming Gorge Dam) (U.S. Fish and Wildlife Service 2005, p. 16) and set forth this process as a conservation measure:

> "The adaptive management process will rely on the Recovery Program for monitoring and research studies to test the outcomes of implementing the proposed action and proposing refinements to dam operations" (U.S. Fish and Wildlife Service 2005, p. 17)

and

> "[Bureau of] Reclamation, Western [Area Power Administration], and the [U.S. Fish and Wildlife] Service will use any new information collected in these studies to determine the need for management actions or modification of operations as determined appropriate" (U.S. Fish and Wildlife Service 2005, p. 17)

Therefore, we believe that the Recovery Program's 2011 Spring Flow Request is consistent with the 2005 BO and we support the Bureau of Reclamation's (BOR) implementation of this request. We recognize that BOR's targeting of a biological trigger (presence of larval razorback sucker) in 2011 rather than a hydrological one (Yampa River flows) deviates from past operations and may require greater volumes of water. However, we conclude that this is consistent with the intent of the Flow Recommendations and will assist in the recovery of the endangered fish.

Additionally, we support the Recovery Program's secondary objectives (Criteria 2a, 2b, and 2c in the Recovery Program's request letter) for flow volumes and durations that will assist in meeting the necessary river stages to entrain larval razorback sucker into floodplain habitats.

Base flow operations (through September 30th)

Because of projected wetter than average year conditions, we believe that spring peak duration and flows should be the primary focus for 2011 and that base flow augmentation is secondary in importance. However, we still recognize that base flows are important for a variety of ecological reasons. We propose the following approach to base flow operations in 2011, which is very similar to our suggested approach in 2010. Biological data collected last year indicated that Colorado pikeminnow collections continue to improve.

We understand that in accordance with the ROD and the BO, BOR will select a Reach 1 base flow target commensurate with the April – July hydrologic condition. The BOR selects a Reach 1 target that creates a flow condition in Reach 2 that falls within the appropriate base flow range when coupled with projected Yampa River base flows (Muth et al. 2000). For reasons mentioned below, we request that BOR release higher flows than the scheduled base flow target through September 30, 2010, with the understanding that BOR may need to release less than the base flow target through the remainder of the base flow period to balance annual operations.

Specifically, we request that BOR augment the Reach 1 calculated base flow target by as much as 40%. For example, if BOR determines that a release of 2,000 cfs is necessary to comply with the ROD and BO, then we request that up to 2,800 cfs be released through Sept 30, 2011. This augmentation is in accordance with the Reach 2 summer - autumn seasonal flow variability recognized in the Flow Recommendations. We recognize there is substantial uncertainty for summer base flow operations in 2011 and request that the FGTWG reconvene as spring flows recede to revisit this issue, similar to the process undertaken in 2010.

We believe that the Flow Recommendations intended for the seasonal variability to assist in the recovery of the species and accommodate natural variability, but not to allow for manipulation that targets a specific operational pattern. Our 2011 base flow proposal, which complies with the ROD and the BO, is consistent with the intent of the flow recommendations, is based on information gathered by the Recovery Program, and responds to current biological conditions in the Green River system.

Our rationale for requesting elevated base flows through September 30 is similar to our request in 2008, 2009, and 2010, and is intended to accomplish two goals:

1) provide improved nursery conditions for age-0 (young-of-year) Colorado pikeminnow in Reach 2; and
2) delay spawning time and decrease growth of the age-0 cohort of nonnative smallmouth bass in Reaches 1 and 2.

Goal 1: Improve nursery conditions for age-0 Colorado pikeminnow

Since 2000, there were a wide range of base flow conditions in Reach 2. Many of the lower base flow years coincided with low age-0 Colorado pikeminnow catch rates as determined each autumn via Recovery Program Project 138[1] – Interagency Standardized Monitoring Program (Table 1). For example, during the summers of 2001, 2002, 2003, 2006, and 2007 base flows in Reach 2 dropped below 1,000 cfs for varying periods of time and age-0 Colorado pikeminnow catch rates were in the single digits (Badame et al. 2010, p. 8).

Contrastingly, in 2009 and 2010, Reach 2 experienced average base flows that exceeded 2,000 cfs for the second and third consecutive year, and for only the second and third time in the most recent eleven year period. Those same years, Utah Division of Wildlife Resources (UDWR) biologists reported the highest catches of age-0 pikeminnow since 1991 (Badame et al. 2010, p. 8; Table 1). We understand that there are many variables that could contribute to the increased catch of age-0 CPM, such as numbers of spawning adults, densities of nonnative fish throughout the larval drift zone, densities of nonnatives in backwaters, productivity of backwaters, and sampling efficiency. However, we believe that the higher base flows (approximately 2,400 to 2,600 cfs) in Reach 2 in 2008, 2009, and 2010 likely played an important role in this increase.

Year	# of age-0 Colorado pikeminnow collected	Average flow between July 15 and September 30	Years base flows dropped below 1000 cfs
2000	31	1423	
2001	8	1073	X
2002	0	876	X
2003	2	1101	X
2004	60	1367	
2005	8	1958	
2006	5	1213	X
2007	3	1122	X
2008	18	2376	
2009	325	2610	
2010	454	2244	

Table 1. Age-0 Colorado pikeminnow (CPM) standardized catch and corresponding flow conditions in Reach 2 as measured by the USGS at their Jensen, Utah gage

Most above-average Colorado pikeminnow recruitment events in the middle and lower Green River occur when summer flows ranged from about 1,800 to 2,700 cfs (Bestgen 1997; in Muth et al. 2000). The relationship between base flow elevations and quality of

[1] Can be found online at : http://www.coloradoriverrecovery.org/documents-publications/work-plan-documents/arpts/2010/rsch/138.pdf

nursery habitat is an information need identified in the Green River Study Plan (Green River Study Plan ad hoc group 2007) and is currently being investigated through a Recovery Program project entitled "Historical assessment of factors affecting young Colorado pikeminnow abundance and physical habitat availability in the Green River, Utah."

Goal 2: Delay smallmouth bass spawning time and decrease growth

Information continues to indicate that higher and cooler base flows delay smallmouth bass spawning and reduce growth of the age-0 smallmouth bass cohort. This information was gathered on the Yampa River and on the Green River in Reaches 1 and 2.

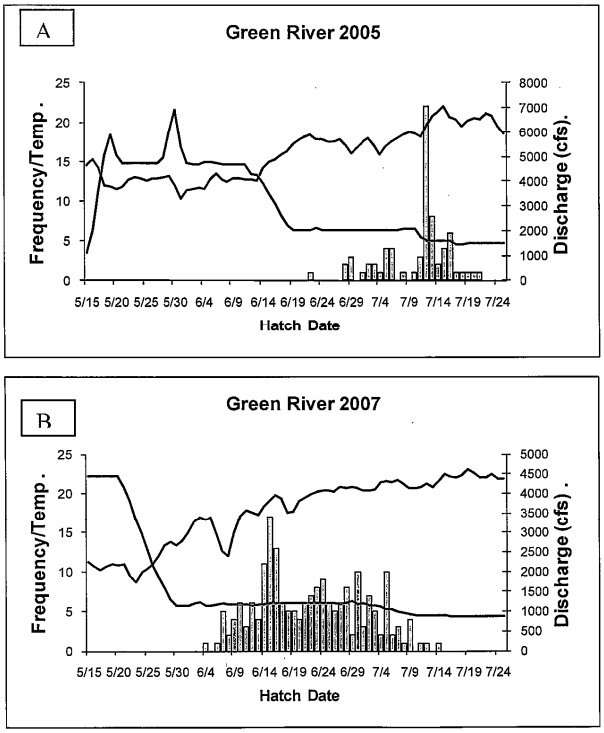

Figure 1. A comparison of flow (green), temperature (purple), and smallmouth bass hatching dates (bars) in Lodore Canyon (Green River - Reach 1). A) 2005 conditions included higher base flows and cooler temps; B) 2007 conditions included lower base flows and warmer temps. Figures excerpted from Recovery Program Project #115 2009 Annual Report (preliminary information)[2]

[2] Available online at: http://coloradoriverrecovery.org/documents-publications/work-plan-documents/arpts/2009/nna/115.pdf

The effect of flow and temperature on the onset of smallmouth bass spawning is clearly demonstrated with data collected in Lodore Canyon, Green River (Figure 1). During a relatively wet and cool year (2005), smallmouth bass spawning occurred nearly 3 weeks later than during a drier, warmer year (2007). The same relationship was observed in related investigations on the Yampa River.

Also, preliminary information from Yampa River studies (Recovery Program Project #140) indicate that age-0 smallmouth bass measured in September 2005 were on average 30 millimeters smaller than those collected in September 2007. Thus, high flows and associated cool temperatures appear to not only delay spawning but also slow the growth rates of age-0 smallmouth bass which in turn decreases their likelihood for overwinter survival (Shuter at al. 1980).

UDWR's Flushing Flow Request

Our office was in communication with the UDWR as they developed their spring release request (8,600 cfs for 5-7 days) to improve sport fish habitat and to benefit the invertebrate community in the Flaming Gorge tailrace. We believe that if this release is timed concurrently with the presence of razorback sucker larvae in Reach 2 (following the Recovery Program's 2011 Spring Flow Request), the UDWR flow request would be consistent with regulatory requirements and would support recovery actions for endangered fish. Therefore, if the release is consistent with the ROD, we support UDWR's request.

Conclusion

In summary, we request that BOR operate Flaming Gorge Dam in 2011 as follows:

- Time spring flow releases to the correspond with the presence of wild produced razorback sucker larvae in order to improve entrainment success;
- Release spring flow levels in accordance with the Recovery Program's criteria 2a, 2b, and 2c;
- Enhance summer base flows at the expense of winter base flows to continue to improve Colorado pikeminnow nursery conditions, support age-0 Colorado pikeminnow, and disadvantage smallmouth bass; and
- Implement the UDWR's flushing flow request in conjunction with ROD requirements and recovery actions for endangered fish.

We believe that data gathered by the Recovery Program supports our proposed operations in 2011. We hope that hydrology conditions in the Upper Green and Yampa River drainages continue to be above average and will supply sufficient water to meet these needs. We understand that hydrologic conditions are ever-changing and the BOR may need to adjust operations accordingly.

We thank BOR for the opportunity to provide this input and look forward to participating in the Flaming Gorge Technical Working Group process. If you have any questions or concerns, please contact Kevin McAbee or Paul Abate at 801-975-3330.

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Appendix F

April 15, 2011, Memorandum from the U.S. Fish & Wildlife Service as an Amendment to 2011 Green River Spring and Base Flows to Assist in Recovery of the Endangered Fishes

United States Department of the Interior
FISH AND WILDLIFE SERVICE
UTAH FIELD OFFICE
2369 WEST ORTON CIRCLE, SUITE 50
WEST VALLEY CITY, UTAH 84119

April 15, 2011

In Reply Refer To:
FWS/R6
ES/UT
08-FA-0180

Memorandum

To: Director, Upper Colorado Region, Bureau of Reclamation
Chair, Flaming Gorge Technical Working Group, Bureau of Reclamation

From: Field Supervisor, Utah Field Office, U.S. Fish and Wildlife Service

Subject: Amendment to 2011 Green River Spring and Base Flows to Assist in Recovery of the Endangered Fishes

We submitted our spring and base flow request to your office, as part of the Flaming Gorge Technical Working Group process, on April 7, 2011. In that letter, we explained that release requests for 2011 deviate slightly from previous protocols. Your office wished to receive additional clarification on the regulatory implications of this type of release. The following discussion provides the additional information you requested.

In the 2006 Flaming Gorge Record of Decision (ROD), the Bureau of Reclamation (Reclamation) committed to "implement the proposed action of the EIS and, at the same time, maintain and continue all authorized purposes of the Colorado River Storage Project" (pg. 1). This decision includes the potential for refinement of the flow and temperature recommendations if relevant new information gained through adaptive management supports that possibility (pg. 2).

Reclamation's modeling process is summarized in the ROD and states that:

> *"The 2000 Flow and Temperature Recommendations for each reach are not integrated in such a way that a particular release from Flaming Gorge Dam could equally achieve the recommendations for all reaches simultaneously. The intent is to first meet the 2000 Flow and Temperature Recommendations for Reach 2 by timing releases to supplement the larger Yampa River spring peak flows and then, if necessary, make adjustments to releases. (ROD, pg. 3)"*

We are aware that Reclamation continues to support the Upper Colorado River Endangered Fish Recovery Program's (Recovery Program) research and adaptive management process currently ongoing in the Green River. The primary criteria of the Recovery Program's 2011 Spring Flow Request recommends altering the timing of releases from Flaming Gorge Reservoir for an experiment that would allow for better understanding of the relationship between timed river flows, the abundance of wild

razorback sucker larvae, and the rate of larval entrainment. The second criteria in the Recovery Program's 2011 Spring Peak Flow Request was to meet the target outlined in the 2000 Flow and Temperature Recommendations for Reach 2 of at least 18,600 cfs for a minimum of two weeks. The requested timing of releases for the experiments may preclude achieving the 2000 Flow and Temperature Recommendations as modeled and outlined in the ROD.

In our April 7, 2011, letter, we stated that we support the Recovery Program's 2011 Spring Flow Request. After additional analysis, we further recognize that timing releases from Flaming Gorge Dam consistent with the Recovery Program's 2011 Spring Flow Request may require the hydrologic tradeoff of not meeting the 2000 Flow and Temperature Recommendations for Reach 2. Nevertheless, we support Reclamation following the Recovery Program's 2011 Spring Flow Request, and consider that doing so will meet Reclamation's responsibility to the ROD objectives in 2011.

We thank BOR for the opportunity to provide this input and look forward to participating in the Flaming Gorge Technical Working Group process. If you have any questions or concerns, please contact Kevin McAbee or Paul Abate at 801-975-3330.

Appendix G

Flaming Gorge Technical Working Group – Proposed Flow and Temperature Objectives for 2011

Flaming Gorge Technical Working Group
Proposed Flow and Temperature Objectives for 2011

Current Hydrologic Classification

For the purposes of implementing the 2006 Flaming Gorge Record of Decision (ROD) in 2011, an evaluation has been made of the current hydrologic conditions in the Upper Green River (*i.e.* above Flaming Gorge Dam). The evaluation centered on the historical unregulated inflow statistics for Flaming Gorge Dam during the period from 1963 through 2010. Based on these statistics and the May 1, 2011, forecast of 1,660,000 acre-feet for Flaming Gorge, the spring 2011 hydrologic classification is moderately wet (10% to 30% exceedance). Appendix A illustrates the May 1, 2011, final forecast for Flaming Gorge Reservoir in relation to the hydrologic categories described in the Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Gorge Dam (Muth, et al, 2000) (Flow Recommendations).

Green River Basin Hydrology

The May 1, 2011, forecast of the April through July unregulated inflow (current forecast) for Flaming Gorge Reservoir is 1,660 thousand acre-feet (KAF) (139% of 30-year average). This forecast falls at 14% exceedance based on the historic unregulated inflow record (1963-2010). Figure 1 shows the current forecast in relation to the historic unregulated inflow volumes.

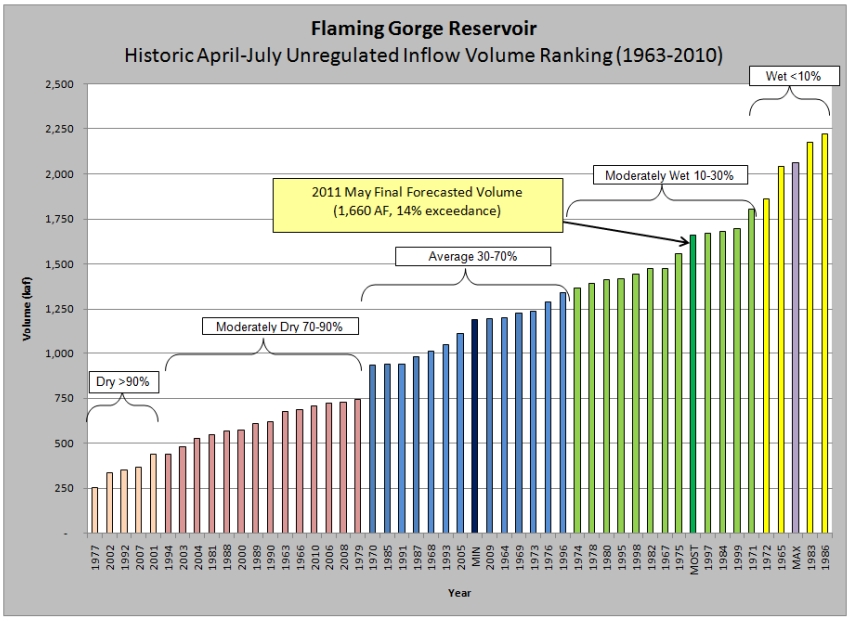


FIGURE 1—Flaming Gorge Reservoir May final forecast and ranked historic unregulated April through July inflow volume for years 1963-2010.

Flaming Gorge Reservoir currently has a water surface elevation of approximately 6024.61 feet above sea level. There is approximately 3.146 million acre-feet of live storage (84% storage capacity) in Flaming Gorge and approximately 0.606 million acre-feet of space.

Yampa River Basin Hydrology

The current forecast for the Little Snake River and Yampa River combined (Little Snake at Lily plus Yampa at Maybell) is 2,720 KAF (200% of 30-year average). This forecast falls at above 5% exceedance based on a ranking of the historic record (1922-2010). Figure 2 below shows the current forecast in relation to historic flow volumes.

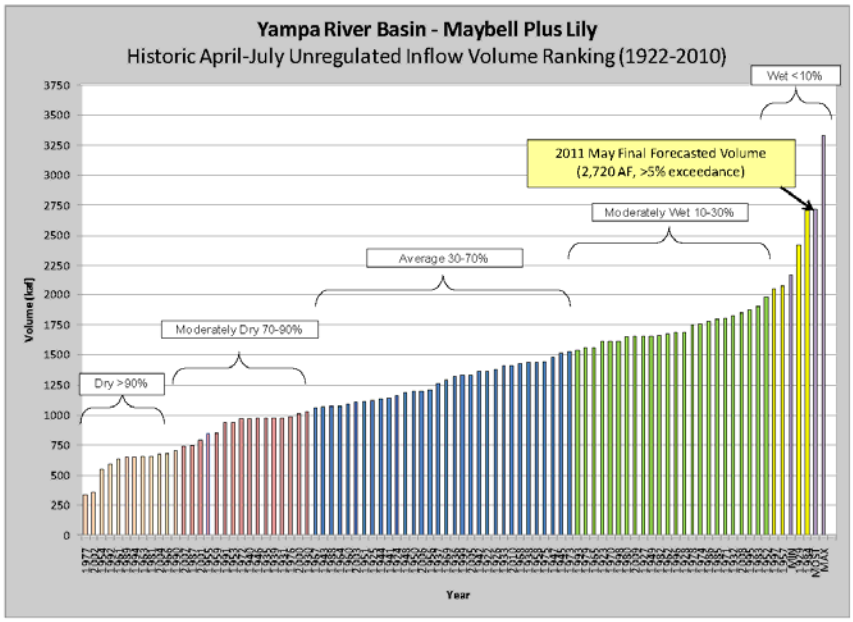


FIGURE 2—Yampa River Basin (Maybell plus Lily) current forecast and ranked historic unregulated April through July inflow volume for years 1922-2010.

Flooding is expected in the Yampa River Basin this spring, with the current forecast higher than all historic observed Yampa River flows. Current snowpack in both basins are similar to 1983 and 1984. The Yampa River at Deerlodge Park flows in 1984 reached a daily average of 32,300 cfs on May 18, 1984, and maintained 28 days above 18,600 cfs beginning on May 13, 1984.

Probabilities of Flow Events for Spring 2011

Flaming Gorge Reservoir is in the moderately wet hydrologic classification for the first time after signing the ROD in 2006. The Yampa River Basin is in the wet hydrologic classification. An analysis was completed to assist in the determination of appropriate flow objectives for spring and summer 2011. The ten most similar historic years for the Yampa River Basin (Maybell plus Lily) compared to the current forecast (Table 1) were analyzed assuming a normal distribution. Table 2 presents the percent exceedance of cumulative days greater than or equal to various flow levels at Yampa River (Maybell plus Lily).

Table 1
Yampa River (Maybell plus Lily) – April through July Unregulated Volume
Ten Similar Years to the May 1, 2011 Final Forecast
Thousand Acre-Feet (KAF)

Year	April-July Unreg Inflow Volume (KAF)
1971	1,802
1932	1,826
2008	1,847
1995	1,869
1983	1,905
1952	1,982
1997	2,052
1957	2,072
MIN	2,170
1929	2,418
1984	2,710
MOST	2,720
MAX	3,335

Table 2
Spring 2011 – Days above Specific Flow Thresholds in the Yampa River (Maybell plus Lily)
Based on the May 1, 2011, Final Forecast
Percent Exceedance (%)

May Final Forecast	% Exceed	Days above 10,000 cfs	Days above 11,000 cfs	Days above 12,000 cfs	Days above 13,000 cfs	Days above 14,000 cfs	Days above 15,000 cfs	Days above 16,000 cfs
YAMPA	25%	50	44	38	34	31	25	18
	50%	45	37	34	27	22	17	14
	75%	39	34	27	22	19	14	9
	90%	36	27	17	15	13	11	7

Record of Decision Spring Flow Objectives

If the April through July unregulated inflow into Flaming Gorge Reservoir remains in the range from 1,320 KAF to 1,410 KAF the hydrological classification would be moderately wet. The ROD spring flow objectives for moderately wet years are:

Moderately Wet Spring Flow Objectives

Reach	Spring Peak Magnitude (cfs)	Spring Peak Duration
Reach 1	≥ 4,600 cfs	that necessary to achieve duration target in Reach 2
Reach 2	≥ 20,300 cfs	1 day in moderately wet years
	≥ 18,600 cfs	2 weeks (i.e. 14 days) in moderately wet years

Flow Recommendations and FEIS

If conditions become even wetter and the Flaming Gorge Reservoir unregulated inflow forecast for April through July increases above 1,761 KAF, the hydrological classification would be wet. ROD spring flow objectives for wet years are:

Wet Spring Flow Objectives

Reach	Spring Peak Magnitude (cfs)	Spring Peak Duration
Reach 1	≥ 8,600 cfs	That necessary to achieve duration target in Reach 2
Reach 2	≥ 26,400 cfs	One day in wet years
	≥ 22,700 cfs	Two weeks (i.e., 14 days) in wet years
	≥ 18,600 cfs	Four weeks (i.e., 28 days) in wet years

Flow Recommendations and FEIS

If the April through July unregulated inflow forecast into Flaming Gorge Reservoir decreases below 1,320 KAF and falls in the range from 777 KAF to 1,320 KAF the hydrological classification would be average. The ROD spring flow objectives for average years are:

Average Spring Flow Objectives

Reach	Spring Peak Magnitude (cfs)	Spring Peak Duration
Reach 1	≥ 4,600 cfs	That necessary to achieve duration target in Reach 2
Reach 2	≥ 18,600 cfs in 50% of average years	Two weeks (i.e. 14 days) in 25% of all average years
	≥ 8,300 cfs in 50% of average years	One week (i.e. 7 days) in 50% of average years

Flow Recommendations and FEIS

In the event conditions become drier and the Flaming Gorge Reservoir unregulated inflow forecast for April through July falls below 777 KAF, the hydrological classification would be moderately dry. ROD spring flow objectives for moderately dry years are:

Moderately Dry Spring Flow Objectives

Reach	Spring Peak Magnitude (cfs)	Spring Peak Duration
Reach 1	≥ 4,600 cfs	That necessary to achieve duration target in Reach 2
Reach 2	≥ 8,300 cfs	1 week (i.e. 7 days)

Flow Recommendations and FEIS

Recovery Program Research Request

Reclamation and the Flaming Gorge Technical Working Group received a memorandum dated April 6, 2011, from Tom Chart, Director of the Upper Colorado River Endangered Fish Recovery Program (Recovery Program). In 2011, the Recovery Program request has a primary and secondary objective. The primary objective recommends altering the timing of releases from Flaming Gorge Reservoir for an experiment that would allow for better understanding of the relationship between timed river flows, the abundance of wild razorback sucker larvae, and the rate of larval entrainment. The second criterion of the primary objective is to meet the target outlined in the 2000 Flow and Temperature Recommendations for Reach 2 of at least 18,600 cfs for a minimum of two weeks. The secondary objective is to continue the assessment of emigration rates of razorback sucker stocked in the Stirrup floodplain to the main stem of the Green River.

The primary objective request from the Recovery Program is to time the initial onset of Reach 1 releases with real-time information on the initial appearance of larval suckers in established reference sites in Reach 2 (*e.g.*, Cliff Creek). The secondary objective request is for a spring peak flow is 15,000 cfs or greater for a minimum of five consecutive days in

Reach 2 of the Green River. The secondary objective is contingent on meeting the primary objective. The Recovery Program recognizes that flows above 8,600 cfs in Reach 1 may entrain burbot, and recommends limiting Reach 1 flows to 8,600 cfs in order to limit the potential of entrainment in the Green River below Flaming Gorge Dam.

The Recovery Program lists studies and continued monitoring to assess the effects of the flow and temperature recommendations on the fish community in the Green River and the research request in 2011. The Recovery Program will continue to coordinate with the U.S. Fish and Wildlife Service's Utah Field Station on all future research flow requests, and specifically as the Service develops their 2011 base flow request to assist in the recovery of the endangered fish.

Proposed Flow Objectives for Spring 2011

The 2005 Operations of Flaming Gorge Dam Final Environmental Impact Statement (FEIS) specifically addresses the content of this operating plan in Section 2.5.3.1. The operating plan is to describe the current hydrologic classification of the Green River and Yampa River Basins, including the most probable runoff patterns for the two basins. This information has been provided above. The operating plan is also to identify the most likely Reach 2 flow magnitudes and durations that are to be targeted for the upcoming spring release. It further specifies that "[b]ecause hydrologic conditions often change during the April through July runoff period, the operations plan would contain a range of operating strategies that could be implemented under varying hydrologic conditions. Flow and duration targets for these alternate operating strategies would be limited to those described for one classification lower or two classifications higher than the classification for the current year."

The potential classifications for 2011 are as follows:

<u>Moderately Wet Classification</u>

The current forecast of 1,660 KAF into Flaming Gorge reservoir is in the moderately wet classification. The 2,720 KAF for the Yampa River Basin would fall into the wet category of the Flow Recommendations. The following proposed flow objectives apply to a moderately wet hydrologic classification as determined by the May 1, 2011 final forecasted unregulated inflows for the April through July period into Flaming Gorge Reservoir. Proposed Reach 1 flows should be managed to achieve a peak of 4,600 cfs or greater in order to accommodate the Recovery Program spring peak research request, timed coincident with the initial appearance of larval suckers in established reference sites. Further, flows in Reach 1 should be managed in order to achieve a one-day peak flow of 20,300 cfs in Reach 2 and 18,600 cfs in Reach 2 for at least two weeks. The spring peak research request of 15,000 cfs for a minimum of five days would be met under the moderately wet hydrologic classification. Once the spring peak research flows have been achieved in Reach 2, Reach 1 flows should be gradually reduced at a rate of 1,000 cfs/day to base flow levels ranging between 1,500 to 2,600 cfs.

Flows in Reach 1 may be managed above 4,600 cfs with the objective of achieving flows of 18,600 cfs or greater during emergence of larval suckers for a minimum of 14 days. In the event this scenario occurs, Reach 1 flows should subsequently be gradually reduced at a rate of 1,000 cfs/day to base flow levels.

Average Classification

If Flaming Gorge forecasted inflows decrease below 1,320 KAF, the spring flow proposal would fall into the average hydrologic classification. In accordance with the operational flexibility outlined in the ROD to achieve objectives one or two classification higher than the actual classification established, if the Flaming Gorge Reservoir forecast falls below 1,320 KAF and the Yampa River Basin forecast remains at or above 1,250 KAF, it is proposed that flows would be managed under the ROD spring flows objectives for moderately wet hydrologic conditions outlined above.

If Flaming Gorge Reservoir forecast falls below 777 KAF and the Yampa River Basin forecast falls below 1,250 KAF, it is proposed that flows in Reach 1 would be managed up to 4,600 cfs to achieve 8,600 cfs in Reach 2 for at least one week. Reach 1 flows should be reduced at a rate of 500 cfs/day to base flow levels in ranging between 800 to 2,200 cfs.

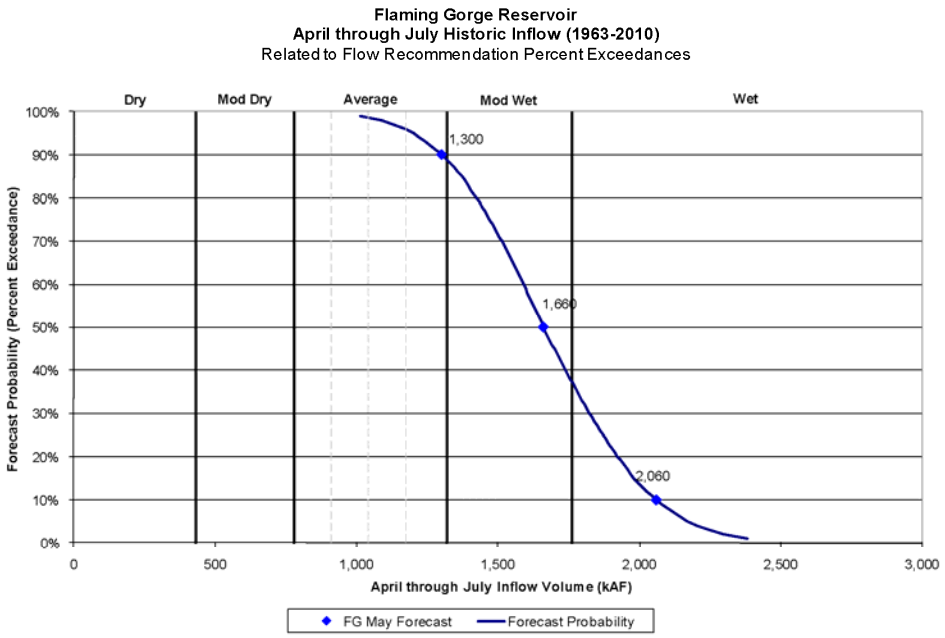
Proposed Base Flow and Temperature Objectives for Summer 2011

After the spring flow objectives in Reach 1 and Reach 2 have been achieved, flows should be gradually reduced to achieve base flow levels by no later than August 1, 2011. Base flows in Reaches 1 and 2 should be managed to fall within the prescribed base flow ranges described in the Flow Recommendations based on the observed April through July unregulated inflow into Flaming Gorge Reservoir. Pursuant to the Flow Recommendations, during the August through November base-flow period, the daily flows should be within ±40% of mean base flow. During the December through February base-flow period, the daily flows should be within ±25% of the mean base flow. Additionally, the mean daily flows should not exceed 3% variation between consecutive days and daily fluctuations at Flaming Gorge Dam should produce no more than a 0.1 meter daily stage change at Jensen, Utah.

Additionally, the temperature of flows should be managed to be at least 18° C for 2 to 5 weeks in Upper Lodore Canyon during the beginning of the base flow period. Water temperatures in the Green River should also be managed to be no more than 5° C colder than those of the Yampa River at the confluence of the Green and Yampa Rivers for the summer period of 2011 (June through August).

APPENDIX A

May 1, 2011 Final Forecasted April through July Inflow Volumes for Flaming Gorge Reservoir, Yampa River (Maybell plus Lily) and Jensen, Utah (sum of Flaming Gorge and Yampa)



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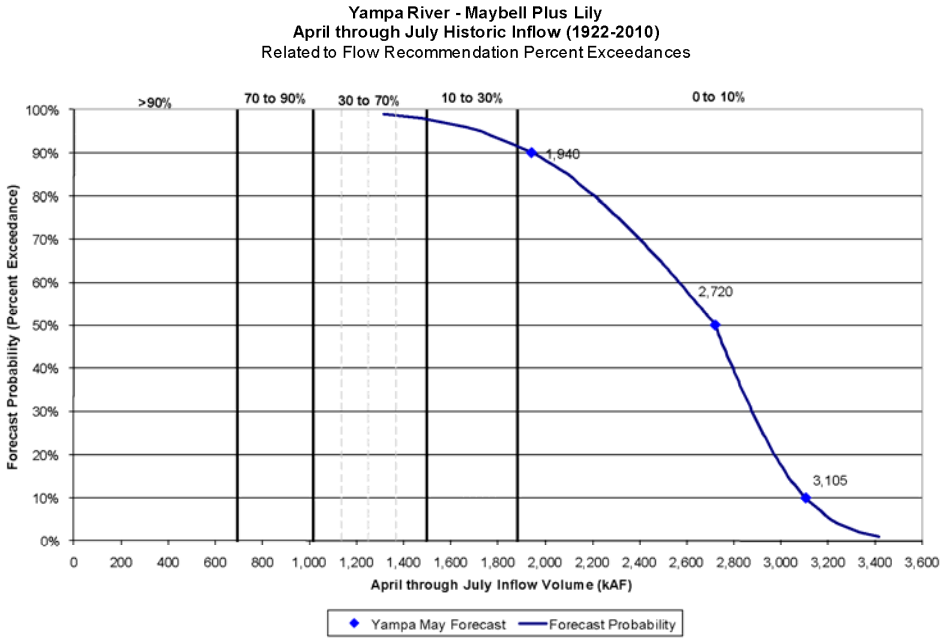
APPENDIX A

May 1, 2011 Final Forecasted April through July Inflow Volumes for Flaming Gorge Reservoir, Yampa River (Maybell plus Lily) and Jensen, Utah (sum of Flaming Gorge and Yampa)



Appendix H

May 16, 2011, Memorandum from Reclamation to the Recovery Program in Response to their Research Request for 2011 Green River Spring Flows

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Regional Office
125 South State Street, Room 6107
Salt Lake City, UT 84138-1102

IN REPLY REFER TO:
UC-436
WTR-3.10

MAY 16 2011

MEMORANDUM

To: Director, Upper Colorado River Endangered Fish Recovery Program, U.S. Fish and Wildlife Service, P.O. Box 25486, Denver Federal Center, Denver, CO 80225
Attn: Thomas Chart

From: Larry Walkoviak
Regional Director

Subject: Upper Colorado River Endangered Fish Recovery Program's (Recovery Program) Research Request for 2011 Green River Spring Flows (2011 Research Request)

Thank you for your Memorandum dated April 6, 2011, regarding the Recovery Program's research request for 2011 Research Request. The Bureau of Reclamation supports all of the Recovery Program's efforts, including the habitat maintenance, monitoring, and continued research to assist in the recovery of four endangered aquatic species in the Upper Colorado River system.

Reclamation also maintains its commitment in the 2006 Record of Decision (ROD) to implement the proposed action of the operation of Flaming Gorge Dam's Environmental Impact Statement, at the same time, maintain, and continue all authorized purposes of the Colorado River Storage Project. This decision included the potential for refinement of the flow and temperature recommendations if relevant new information gained through adaptive management supports that possibility. The 2011 Research Request utilizes this commitment for adaptive management in the Green River based on new information from the scientific community.

Winter and spring 2011 have provided both the Upper Green and Yampa river basins with record snowpack. The Yampa river basin contains unprecedented snowpack, with forecasted flows at 197 percent of average. All peak forecasts for the Yampa River at Deerlodge are above flood stage. Likewise, the Upper Green river basin May final forecast increased 310,000 acre-feet or 26 percent over the April final forecast. The projected May-July volume into Flaming Gorge Reservoir is 146 percent of average.

In view of these conditions, Reclamation operations at Flaming Gorge Dam during spring peak runoff this year are driven by dam safety and efforts to alleviate flooding downstream to the extent possible. However, given the wet forecasts, it is likely that all of the wet hydrologic classification targets pursuant to the ROD will be met.

Thank you in advance for your assistance and information your organization will provide to assist in developing and managing the Upper Colorado River system. We look forward to working with you next year in all of our efforts to assist in the recovery of endangered fish species. If you have any questions, please contact Ms. Heather Hermansen at 801-524-3883.

Appendix I

Comment Letters Received through the Flaming Gorge Working Group Process

ORIGINAL

State of Utah
DEPARTMENT OF NATURAL RESOURCES
MICHAEL R. STYLER
Executive Director
Division of Wildlife Resources
JAMES F. KARPOWITZ
Division Director

...RBERT
...overnor
GREG BELL
Lieutenant Governor

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Heather Patno
Co-chair, Flaming Gorge Working Group
Upper Colorado Region, Bureau of Reclamation
125 South State Street
Salt Lake City, UT 84138

Ed Vidmar
Co-chair, Flaming Gorge Working Group
Provo Area Office, Bureau of Reclamation
302 East 1860 South
Provo, UT 84606

Re: 2011 Green River flows

Dear Ms. Patno and Mr. Vidmar,

Flows released from Flaming Gorge Dam have had profound effects on the Green River aquatic ecosystem, both positive and negative. Results include the creation of a world class sport fishery in the tailrace and the decline of a suite of native fishes currently classified as endangered. Studies undertaken to explore the causes of native species declines have resulted in specific recommendations for flows in the Green River, including seasonal flow patterns (Muth et al. 2000). While much research has been conducted on the endangered fish, less attention has been given to the effects of flows on sportfish in the tailwater portion of the river below Flaming Gorge Dam.

Current (post-dam) spring flows released from Flaming Gorge Dam are generally 4,600 cubic feet per second (cfs) or power-plant capacity, though peaks have ranged from 3,900 to 13,700 cfs. This is reduced from pre-dam peaks, which ranged from 7,000 to 19,600 cfs. In only five years since the 1962 impoundment of the Green River (1983, 1984, 1986, 1997, and 1999) have post-dam spring flows approached or exceeded bypass flows of 8,600 cfs (power-plant capacity at ~4,600 cfs and full use of the bypass tubes at 4,000 cfs combined), as measured at the USGS Greendale gage (#09234500) located immediately below the dam. Although the effects of these high flows were not well-documented, some evidence exists that these flows were beneficial to the system.

The Bureau of Land Management/Utah State University National Aquatic Monitoring Center (aka The BugLab) has monitored aquatic invertebrate and macrophyte trends at seven sites located between the dam and Swinging Bridge in Browns Park (16.2 mi. downstream of the dam) on a quarterly basis since 1993. Following the spring flow of 1997, which peaked around 8,600 cfs and exceeded 8,000 cfs for approximately four days, Vinson (1998) documented measurable post-flood changes in the invertebrate community, including increases in taxa richness in all habitat types, a 50% decrease in aquatic plant biomass, and movement of streambed sediments as measured by bathymetric mapping. Aquatic plant biomass increased slightly over the next couple of years, until a 1999 flood decreased plant biomass again by 50% (M. Vinson, pers. comm. April 29, 2010).

Spring peak flows between 2000 and 2010, as measured at the Greendale gage, were near 4,600 cfs, excluding 2005 and 2006 when the bypass tubes were opened briefly and flows reached 6,900 cfs and 6,800 cfs, respectively. After 1999, invertebrate taxa richness increased to a high in 2007, and then declined to near-1999 levels thru 2010. Total invertebrate abundance has

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telephone (801) 538-4700 • facsimile (801) 538-4709 • TTY (801) 538-7458 • *www.wildlife.utah.gov*

NOTICE IF YOU DETACH ENCLOSURES PLEASE INSERT CODE NO._____

declined since 2000, hovering at pre-flood levels from 2007 to 2010. Concurrently, aquatic plant biomass was greater in three of the last four years (2007, 2008, and 2010) than any other year since 1995 (Vinson 2010).

The Utah Division of Wildlife Resources (Division) is formally requesting a spring peak of 8,600 cfs in 2011, maintained for 5 to 7 days, to improve sportfish habitat and benefit the invertebrate community in the tailwater portion of the Green River. We have reached this recommendation based on the positive results of the 1997 and 1999 spring peak flows and the recent decline in invertebrate taxa, presumably due to the lack of a recent flushing flow of this magnitude. Timing of spring flows is not as critical in the tailwater reaches as in the lower portions of the Green River near Jensen, Utah. Therefore we request that this flow be timed to best assist in the recovery of the endangered fish downstream. We will rely on the Upper Colorado River Endangered Fish Recovery Program to address this timing issue in a separate letter.

In the event this request is implemented, Division biologists, in coordination with the BugLab, will monitor the effects of the spring flow, including (but not limited to) aquatic invertebrate and macrophyte sampling, photo point monitoring, and fish population surveys. We do not expect adult fish escapement since we are not requesting the use of the spillway; however, we will report any reservoir fish escapement verified through electrofishing to the Recovery Program.

The Division concurs with flow recommendations in Muth et al. (2000), and is therefore requesting flows that follow a natural hydrograph. Although Muth et al. (2000) primarily made recommendations for flow magnitude, timing of flows is also an important consideration for a more natural hydrograph. Thus, in addition to higher than normal spring flows, we are also requesting stable base flows during the remainder of the year, including stable winter flows as requested by the Division in a previous letter (Re: 2010 Green River base flows, dated August 23, 2010). While we acknowledge the need to study the effects of double peaking on the tailrace, the Division is very concerned with the ongoing, overwinter double-peak flow regime, including potential effects on invertebrate drift and trout feeding behavior, the negative perceptions of these flows among the angling public, and the socio-economic impacts to local businesses, fishing guides and outfitters whose livelihood depends on recreational use of this resource.

We appreciate your careful consideration of this request. If you have any questions, please contact Matt McKell or Ryan Mosley at 435-885-3164 or Trina Hedrick at 435-781-5314.

Respectfully,

ACTING DIRECTOR

James Karpowitz, Director
Utah Division of Wildlife Resources

cc: Clayton Palmer, Western Area Power Administration
Kevin Clegg, Green River Outfitters and Guides Association
Casey Snider, Trout Unlimited
Robert King, Utah Division Water Resources
Walt Donaldson, Utah Division Wildlife Resources
Kevin Christopherson, Utah Division Wildlife Resources

Literature Cited:

Muth, R. T., L. W. Crist, K. E. LaGory, J. W. Hayse, K. R. Bestgen, T. P. Ryan, J. K. Lyons, and R. A. Valdez. 2000. Flow and temperature recommendations for endangered fishes in the Green River downstream of Flaming Gorge Dam. Upper Colorado River Endangered Fish Recovery Program Project FG-53. Final Report, September 2000.

Vinson, M. 1998. Aquatic macroinvertebrate assemblages downstream from Flaming Gorge Dam. National Aquatic Monitoring Center, Utah State University, Logan, Utah. June 1998.

Vinson, M. 2010. Results update: Green River downstream from Flaming Gorge Dam aquatic ecosystem monitoring results, September 2010. Utah State University, Logan, Utah, and U.S. Geological Survey, Ashland, Wisconsin. Quarterly project update, October 18, 2010.

Blue Ribbon Fisheries Advisory Council

9294 Wild Clover Lane
West Jordan, Utah 84081

February 13, 2011

Ms. Heather Patno
Co-Chair, Flaming Gorge Working Group
Upper Colorado Region, Bureau of Reclamation
125 South State Street
Salt Lake City, Utah 84138

Mr. Ed Vidmar
Co-Chair, Flaming Gorge Working Group
Provo Area Office, Bureau of Reclamation
302 East 1860 South
Provo, Utah 84606

RE: Green River Flows for 2011

Dear Ms. Patno and Mr. Vidmar,

The Governor's Blue Ribbon Fisheries Advisory Council was created in 2001 to identify, enhance, protect, and to promote the quality fisheries of our State for economic and recreational benefit.

The Green River below Flaming Gorge Dam was a natural fit to be recognized as a blue ribbon fishery in Utah. Anglers and recreationalists come from across the country and around the globe to fish this exceptional water. In addition, this fishery brings tens of millions of dollars in economic benefit to the State and the local economy. We recognize the value of this water and will be spending some of our money on a study to determine the amount of economic benefit it has on the State and local economies.

The value of this fishery is highly dependent on how the flows are managed at the dam. Our greatest concern and that of the angling public is the peaking flows. These peaking flows can have a significant impact on the bug population in the river; an impact on the bug population will certainly translate into an impact on the fish and the fishing quality. We strongly request that the concerns of the angling public and the impacts to the economy be taken into consideration with any flow changes. We would like to see a more stable regimen of flows throughout the year. We have commented on these flows before in a letter dated November 28, 2006.

We also understand the Utah Division of Wildlife Resources has requested a spring peak flow to improve habitat and to help "spark" the bug population and also assist the threatened and endangered fish downstream. We support the Utah Division of Wildlife Resources request. Please reference their letter of February 7, 2011.

Respectfully Yours,

George Sommer
Chair,
The Blue Ribbon Fisheries Advisory Council
advprtsys@msn.com
801-541-7419

cc: Jim Karpowitz, Utah Division of Wildlife Resources
Walt Donaldson, Utah Division of Wildlife Resources
Kevin Christopherson, Utah Division of Wildlife Resources
Clayton Palmer, Western Area Power
Kevin Clegg, Green River Outfitters and Guides Association
Casey Snider, Trout Unlimited
Robert King, Utah Division of Water Resources
Blue Ribbon Fisheries Advisory Council

ORIGINAL

TROUT UNLIMITED

February 3, 2011

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Heather Patno
Co-chair, Flaming Gorge Working Group
Upper Colorado Region, Bureau of Reclamation
125 South State Street
Salt Lake City, UT 84138

Ed Vidmar
Co-chair, Flaming Gorge Working Group
Provo Area Office, Bureau of Reclamation
302 East 1860 South
Provo, UT 84606

Dear Ms. Patno and Mr. Vidmar:

Trout Unlimited (TU) writes this letter to detail our concerns regarding potential flow operations below Flaming Gorge Dam in the Spring of 2011. Our concerns center on potential Bureau of Reclamation (BOR) plans to extend the double-peaking flows from Flaming Gorge Dam that were initiated in the fall of 2010. On behalf of TU's 140,000 members nationwide, including subtantial membership in the tri-state Utah, Wyoming, Colorado area that call the Green River below Flaming Gorge "home water," we write to express deep concern over extending the double-peaking period,, and encourage the BOR to reaffirm its commitment to scheduled flow patterns that were discussed and agreed to at a meeting on September 21, 2010.

At the September meeting, TU, the BOR, the Western Area Power Administration (WAPA), and other interested parties met to discuss concerns over double-peaking flows, and to establish a flow release schedule. Following the meeting, stakeholders concerned about double-peaking impacts felt that agreement was reached regarding the following short-term 2011 water year operations: **double-peaking would occur November thru January, but releases would return to base (or stable) flow operations February thru April (until the next meeting) to accommodate the start of the high recreation season on the Green below Flaming Gorge.**

Recent discussions between WAPA and the BOR suggest that the agency plans to ignore stakeholder discussions last fall and extend the double-peaking period. Such a decision would be contrary to the informal agreement—or at least the understanding—reached with TU, the Utah Division of Wildlife Resources (UDWR), the Green River Guides and Outfitters Association (GROGA), and other members of the local community. A large part of this community deeply depends on the Green River – and dam operations – for their livelihoods.

TU, the UDWR, and GROGA have long argued that double-peaking poses not only a safety risk to wading anglers but a serious threat to the invertebrates, fish, and the overall health of the river below the Gorge. Impairing those resources in turn not only threatens the fishery but also a thriving tourism industry that attracts anglers from all over the country. Many of our members travel to Dutch John to fish the Green every year, and others rely on the river on a daily basis to put food on the table.

TU works with the BOR on tailwaters all over the west and understands the inherent complexities associated with river management, especially in a multi-dam system like the Colorado/Green River system. However, there is historic precedent for managing Flaming Gorge Dam to protect the tailwater fishery. Since the early 1970s the BOR has provided minimum flows and periodically structured flow regimes to benefit the fishery, fish spawninng, and boating. Discussions last fall captured this spirit of cooperation, especially in light of the fact that double-peaking operations were scheduled for a substantial portion of the winter months.

Trout Unlimited is the nation's oldest and largest coldwater fisheries conservation organization, boasting more than 140,000 members. TU's mission is to conserve, protect and restore North America's coldwater fisheries and their watersheds. Learn more at www.tu.org

BOR has the responsibility and the mandate to manage the water releases and flows out of Flaming Gorge in a way that takes into account *all* of the stakeholders who use and value this important resource. Structuring annual operations to provide some double-peaking while at the same time avoiding such operations when most harmful to the world-class fishery is reasonable. Much like planning – when snow pack and water year dynamics dictate – for periodic flushing flows is also a reasonable operational dynamic in light of the incredible fishery benefits provided by such operations.

TU respectfully requests that the BOR confirm in writing agency plans for dam releases over the coming months and, if that involves double-peaking flows in February thru April, how that can be reconciled with fall 2010 stakeholder discussions and BOR commitments to the Dutch John recreational community last fall.

We look forward to continuing a dialog with the BOR and other stakeholders on the double-peaking and flushing flow issues. Please don't hesitate to contact me with any questions or comments regarding this letter.,

Sincerely yours,

Casey Snider
Northeastern Utah Field Coordinator
Trout Unlimited
Sportsmen's Conservation Project
P.O. Box 345
Dutch Johnt, UT
84023

Trout Unlimited is the nation's oldest and largest coldwater fisheries conservation organization, boasting more than 140,000 members. TU's mission is to conserve, protect and restore North America's coldwater fisheries and their watersheds. Learn more at www.tu.org

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Governor
GREGORY S. BELL
Lieutenant Governor

State of Utah
DEPARTMENT OF NATURAL RESOURCES
MICHAEL R. STYLER
Executive Director
Division of Wildlife Resources
JAMES F. KARPOWITZ
Division Director

February 28, 2011

Heather Patno
Bureau of Reclamation
Hydraulic Engineer
125 South State Street
Salt Lake City, UT 84138-1102

Dear Heather:

We have tentatively scheduled our spring 2011 tailwater fishery assessment (electrofishing), contingent on flows being approved for the operation. Our following flow request is similar to previous years:

DATE	FLOW (cfs)	TIME (MDST)	OBJECTIVE
April 18-19	1600	1900-0200	Electrofishing
April 19	1600	1600-2300	Electrofishing

All times are in Mountain Daylight Savings Time and not hour-ending. We may need to schedule a make-up electrofishing flow in the event that we are unable to complete the sampling during the scheduled two nights.

Please consider this request in light of all other constraints and respond at your earliest convenience. Contact me if you have any questions and once again we appreciate your continued support with our fishery monitoring efforts.

Sincerely,

Ryan Mosley
Flaming Gorge Project Leader
PO Box 145
Dutch John, UT 84023
Office (435)885-3164
Cell (435)790-4097

1594 West North Temple, Suite 2110, PO Box 146301, Salt Lake City, UT 84114-6301
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ORIGINAL

United States Department of the Interior

NATIONAL PARK SERVICE
Dinosaur National Monument
4545 Highway 40
Dinosaur, CO 81610

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Memorandum

March 3, 2011

To: Larry Walkoviak, Director, Upper Colorado Region, Bureau of Reclamation

Heather Patno, Chair, Flaming Gorge Technical Working Group, Bureau of Reclamation cy 436

From: Mary Risser, Superintendent, Dinosaur National Monument, National Park Service 400
Mary Risser

Subject: State of Utah and Upper Colorado River Endangered Fish Recovery Program Requests for 2011 Green River Spring Flows 430

We have recently received copies of letters from the State of Utah and the Upper Colorado River Endangered Fish Recovery Program to the Bureau of Reclamation, both of which request spring peak flows from Flaming Gorge dam at power plant capacity plus full bypass (approximately 8,600 cfs) to be maintained for five to seven (or more) days in 2011. The Recovery Program letter goes further to request that flows be timed to coincide with the appearance of larval razorback sucker (*Xyrauchen texanus*) in specified Reach 2 habitats. While we support the flow request in concept, we would prefer to see implementation of this release next year for reasons we will elaborate below.

A release of 8,600 cfs from Flaming Gorge dam (FGD) is equivalent in magnitude to several of the experimental high flow releases from Glen Canyon dam with respect to proportional increase above power plant capacity. A flow of this magnitude represents a substantial departure from recent Flaming Gorge operations and presents an opportunity to mobilize the bed and winnow accumulated algae, silt, and sand from coarse substrates, which in turn will create opportunities for improvements in food web dynamics and other aspects of fish habitat for both the tailrace sport fishery and more importantly (from the National Park Service perspective) native fisheries, including endangered species, in Reaches 1 and 2 of the Green River.

The timing considerations laid out in the Recovery Program letter are of particular interest to the NPS, as they reflect new information produced by the on-going monitoring/studies conducted as part of the adaptive management process, which Reclamation committed to in the 2006 Record of Decision, Operation of Flaming Gorge Dam, Final Environmental Impact Statement (section VII-Environmental Commitments). We believe new data support using presence of larval razorback sucker in specified Reach 2 habitats as a biologically based trigger for FGD peak flow releases. Implementing this strategy

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may do a better job of avoiding jeopardy for this species than the current use of *anticipated* Yampa River peak flows as an environmentally based trigger.

Reclamation also committed in the 2006 Record of Decision to work with the NPS to monitor and assess effects of FGD operations on threatened Ute ladies'-tresses (*Spiranthes diluvialis*) populations. To date, the only monitoring data collected since 2006 occurred in 2010 as a cost-share project jointly funded by Reclamation and the NPS. The available data set is therefore insufficient to assess trend since the new F*low and Temperature Recommendations* (Muth, et al., 2000) have been implemented. Peak flows of the proposed magnitude certainly have implications for *Spiranthes'* distribution and abundance, but cumulative impacts cannot be assessed without more regular monitoring. Our recent letter to Reclamation (dated February 4, 2011) conveyed a report on the 2010 monitoring effort and offered the possibility of a jointly funded monitoring program that would generate sufficient data to assess cumulative impacts of FGD operations over time.

Recent studies conducted in Dinosaur National Monument (Manners, et al., 2010, in progress) add to the growing body of evidence suggesting that tamarisk invasion has caused adverse geomorphic changes to spawning and nursery habitat utilized by Colorado pikeminnow (*Ptychocheilus lucius*) in the lower Yampa River and in Reach 2 of the Green River. It is now clear that the flood of record (1984) on the Yampa River (peak = 33,200 cfs), while leaving a substantial depositional record, failed to reset the system and that colonization by tamarisk over time has stabilized depositional surfaces by "armoring" them and eventually disconnecting them from the active channel. Analysis shows channel narrowing, side channel in-filling, and conversion of aquatic habitat to terrestrial habitat. While non-native fish may constitute a more immediate concern for endangered fish recovery, it is now clear that issues of compromised habitat present a non-static and growing concern for the long term.

This renders the experimental tamarisk removal/control reaches established by the NPS and its research partners in Lodore Canyon (Reach 1) as valuable assets in the race to acquire knowledge that will inform our long term river and endangered species management strategies. We urge Reclamation to work with the NPS and its research partners over the next year to develop a robust plan for revisiting established cross sections and collecting good information on hydraulics, sediment transport, geomorphology and aquatic and riparian ecology. To do less would be inconsistent with Reclamation's intention, articulated in the 2006 Record of Decision:

> "Such studies would include improving connectivity of floodplain habitats, identifying ways to improve entrainment of larval razorback suckers into flood plain habitats, maintain the river channel, restore natural variability of the river system, and analyze possibilities for meeting the goals of the *Flow and Temperature Recommendations* at lower peak flow levels where feasible."

It is impossible to analyze possibilities without first collecting data. An adaptive management process also requires data. Planning an efficient and effective scientific data collection effort in this environment takes time and funding. A year does not seem like an unreasonable planning time line to take best advantage of the opportunity to study the effects of such a rare occurrence (i.e, bypass flows).

We concur with the assessment of the Recovery Program that it is imprudent at this time to consider any FGD operations that might result in entrainment of invasive burbot (*Lota lota*) from Flaming Gorge reservoir into the Green River below the dam. We urge that studies be developed and implemented as quickly as possible, however, to determine the level of risk and appropriate mitigations for using both bypass and spillway options for implementing the Recovery Program's 2000 *Flow and*

Temperature Recommendations. Postponing the proposed peak release by one year may provide enough time to make progress on addressing the potential risk from burbot entrainment.

Waiting one year will also provide time for the BLM (Vernal Office) to complete a large invasive teasel (*Dipsacus* spp.) management project along the Green River in Reach 1. This project was initiated in 2009 and will be completed in 2011. The NPS shares concerns expressed by personnel involved with weed management from BLM and Uintah County, Utah that a peak release of 8,600 cfs will cause teasel seeds to be entrained in Reach 1 and then deposited downstream, if the proposed release occurs prior to completion of BLM management efforts. Teasel is a new invading plant species in our area and it is very difficult to manage, once established. If allowed to spread, it could have a significant economic impact on downstream agricultural water users and will increase the level of NPS effort required to manage incipient infestations in Lodore Canyon.

Lastly, we would like to request that consideration be given to extending magnitude (after burbot and teasel risks are mitigated) and duration of peak flow releases. The 2000 *Flow and Temperature Recommendations* specify:

> "**at least** 18,600 cubic feet per second (cfs) in Reach 2 for two weeks **or more** in at least one of four average hydrological years." (emphasis added)

It seems that Reclamation has defaulted to these values as maxima, with respect to FGD operations, although it seems that the intent (from the language) was to think of these values as the minima for this particular flow recommendation. The NPS is concerned with many values associated with the river resources of Dinosaur National Monument. Some of these require that we advocate for increases in variation and magnitude of peak releases to ensure that we are able to meet our mandates for long term stewardship of the resources for which the monument was established. Because the commitment in the 2006 Record of Decision is consistent with NPS objectives, we would certainly support the use of **at least** 18,600 cubic feet per second (cfs) in Reach 2 for two weeks **or more**, when appropriate hydrologic criteria are met.

Manners, R.B., J.C. Schmidt and J.M. Wheaton. 2010. Geomorphic effectiveness of a woody shrub—field characterization of stand structure and quantification of flow field alterations indicate that scale matters. In progress. Poster presented at the American Geophysical Union Fall Meeting, San Francisco, CA.

Manners, R.B., J.C. Schmidt and M. Scott. 2010. Rate and style of channel change on the Yampa River, Dinosaur National Monument. In progress. Poster presented to the Desert Fish Council Meeting, Moab, Utah.

Muth, R.T., L.W. Crist, K.E. LaGory, J.W. Hayse, K.R. Bestgen, T.P. Ryan, J.K. Lyons, and R.A. Valdez. 2000. Flow and temperature recommendations for endangered fishes in the Green River downstream of Flaming Gorge Dam. Final Report to Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado.

Appendix J

Reclamation Responses to Comment Letters Received through the Flaming Gorge Working Group Process

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Regional Office
125 South State Street, Room 6107
Salt Lake City, UT 84138-1102

IN REPLY REFER TO:

UC-436
WTR-3.10

MAR 22 2011

Mr. James Karpowitz, Director
Utah Division of Wildlife Resources
1594 West North Temple, Suite 2110
P.O. Box 146301
Salt Lake City, UT 84114-6301

Subject: 2011 Green River Flows Below Flaming Gorge Dam

Dear Mr. Karpowitz:

Thank you for your letter dated February 7, 2011, regarding flows on the Green River below Flaming Gorge Dam. We understand your request to the Bureau of Reclamation through the Flaming Gorge Working Group process is for a spring peak with a magnitude of 8,600 cfs in 2011, maintained for 5 to 7 days. We also acknowledge that you request that this flow be timed to best assist the recovery of endangered fish downstream of Flaming Gorge.

When the Upper Colorado River Endangered Fish Recovery Program (Recovery Program) has identified specific research to study on the Green River in its Recovery Implementation Plan, and the research may require flows outside of the 2006 Record of Decision on the operation of Flaming Gorge Dam, Reclamation expects a formal request for research flows from the Recovery Program through the Flaming Gorge Technical Working Group, normally by February 28, 2011. It is our understanding that, while this date has passed, the Recovery Program will submit a request for experimental flows for the benefit of endangered fish this year. Any request received from the Recovery Program will be used in our regular process and assist us in determining Flaming Gorge spring releases to support the Recovery Program and respond to our commitments under the 2006 Record of Decision. It is our current understanding that the Recovery Program requests and potential releases may result in benefits to the issues you raise in your request.

Thank you again for your participation in the process. If you have any questions, please contact Heather Patno at 801-524-3883 or Ed Vidmar at 801-379-1182.

Sincerely,

Larry Walkoviak
Regional Director

cc: See next page.

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Colorado Regional Office
125 South State Street, Room 6107
Salt Lake City, UT 84138-1102

IN REPLY REFER TO:
UC-732
WTR-3.10

APR 1 2 2011

Ms. Mary Risser
Superintendent
Dinosaur National Monument
National Park Service
4545 Highway 40
Dinosaur, CO 81610

Subject: 2011 Green River Flows Below Flaming Gorge Dam

Dear Ms. Risser:

Thank you for your letter dated March 3, 2011, regarding flows on the Green River below Flaming Gorge Dam during spring 2011, their impacts to riparian resources in Dinosaur National Monument, and the need for monitoring of those impacts. As you know, the Bureau of Reclamation is committed to meeting the flow and temperature objectives outlined in the 2006 Record of Decision (ROD), which are designed to aid in the recovery of the four endangered fish species found in the Green River below Flaming Gorge Dam. To date, we have received letters from several agencies and organizations urging Reclamation to operate Flaming Gorge Dam during the spring runoff period to meet needs for recreational and endangered fish resources, including letters from the State of Utah (February 9, 2011), and the Upper Colorado River Endangered Fish Recovery Program (April 6, 2011).

Reclamation will consider your request as it develops its Flaming Gorge Dam operational plan for spring 2011 to meet the requirements specified in the 2006 ROD along with request letters submitted by the aforementioned agencies, current hydrological forecasts, and input from other agencies and members of the public. To the latter end, we encourage you to attend the next Flaming Gorge Working Group meeting (7:00 PM MT, April 26th, 2011, at the Western Park Convention Center, 302 East 200 South, Vernal, UT). At this meeting you will have the opportunity to outline your issues and concerns about spring flows directly with Reclamation representatives. Your input at that meeting, along with the letter you have already provided us with, will be carefully considered during the formulation of our operational plans for Flaming Gorge Dam during the peak runoff season. We expect to reach a decision on these operations during the first week of May 2011.

I would also like to take this opportunity to thank you and your staff for recently sharing with us (February 4, 2011) the final report on status and trends of Ute ladies' tresses within Dinosaur National Monument. This monitoring, as you point out in your letter, is a project Reclamation committed to in the 2006 ROD. We appreciate the opportunity to work with you to complete that project, and hope to see you at the April 26th Flaming Gorge Working Group Meeting in Vernal.

If you have questions about that meeting, please contact Heather Hermansen at 801-524-3883 or Ed Vidmar at 801-379-1182.

FOR Sincerely,
ANAMARIE GOLD

Larry Walkoviak
Regional Director

bc: UC-436, UC-700, UC-732, PRO-400