RECLAMATION
Managing Water in the West

Flaming Gorge Technical Working Group

April 27, 2015 Hydrology Summary

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For the purposes of discussions related to implementing the ROD in 2015, an evaluation has been made of the current hydrologic conditions in the Upper Green River (*i.e*. above Flaming Gorge Dam) and Yampa River Basins. The evaluation centered on the historical unregulated inflow statistics for Flaming Gorge Dam during the period from 1963 through 2014. Based on these statistics and the April 17, 2015 midmonth forecast of 625,000 acre-feet for Flaming Gorge, the hydrologic classification will be moderately dry (70% to 90% exceedance) for spring 2015.

The combined April through July forecast of the Yampa River at Maybell and Little Snake at Lily is 680,000 acre-feet. This forecast would fall into the moderately dry hydrologic classification of the ROD.

Snow water equivalent (SWE) as of April 17, 2015, for the Upper Green River and Yampa/White River Basins are 75 and 67 percent of median, respectively. Flaming Gorge SWE is similar to 2012 and 1992, while Deerlodge SWE is similar to 2004 and 2007. The Tower snotel site, used as a reference point for Yampa snowpack and runoff, currently has 31.6 inches of SWE (64 percent of median). On April 24, Tower SNOTEL measured SWE inches of:

- 1987 = 38.5 in; FG 982 kaf unreg inflow; Yampa 745 kaf obs spring vol
- 2007 = 32.3 in; FG 370 kaf unreg inflow; Yampa 735 kaf obs spring vol
- 2012 = 28.4 in; FG 570 kaf unreg inflow; Yampa 449 kaf obs spring vol

The difference between the Tower SNOTEL figures and Yampa River observed spring volume differs significantly and needs to be considered when comparing any values.

Basin Hydrology

Green River Basin Hydrology

The April 17, 2015 April midmonth forecast of April through July unregulated inflow (current forecast) for Flaming Gorge Reservoir is 625,000 acre-feet (AF) (64% of 30-year average). This

forecast falls at approximately 79% exceedance based on the historic unregulated inflow record (1963-2014).

Figure 1 illustrates the Upper Green River SWE as of April 27 and compares it against water years 1992 and 2012. Figure 2 shows the current forecast in relation to the historic unregulated inflow volumes. Figure 3 illustrates Flaming Gorge Reservoir April midmonth forecast probability (percent exceedance).

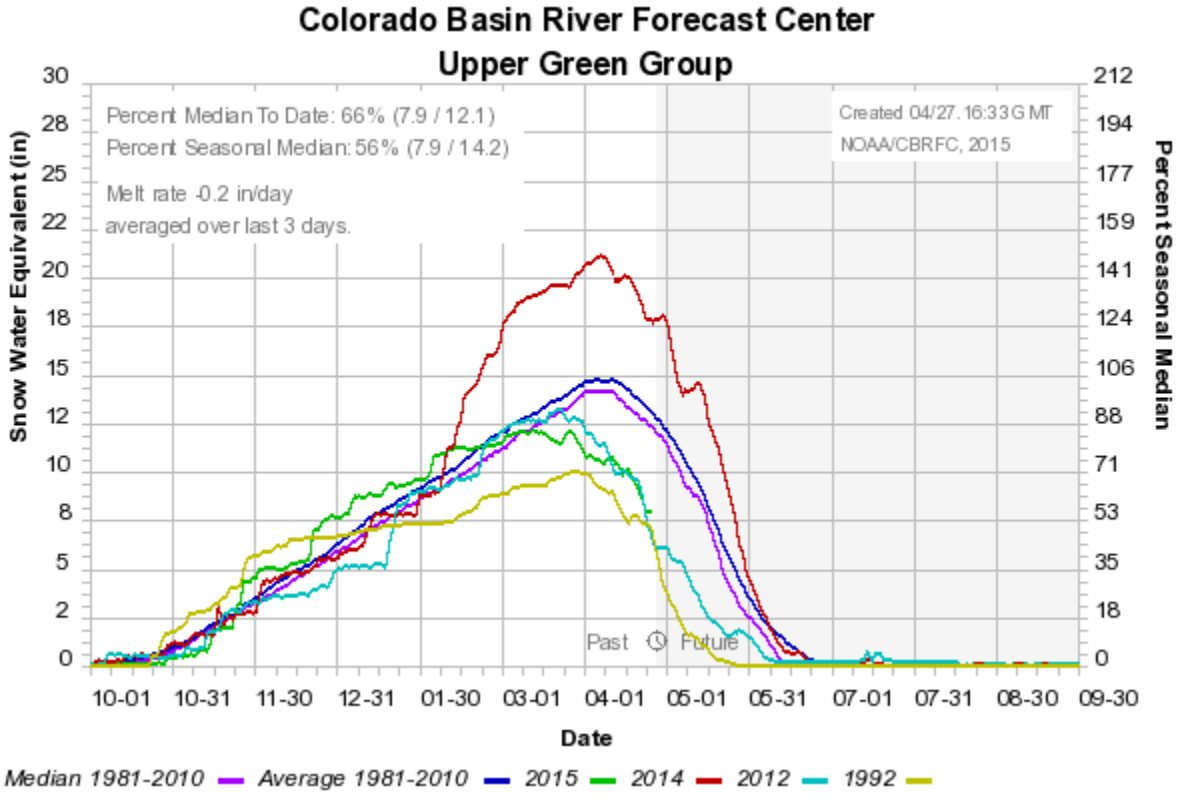

FIGURE 1. Upper Green River Basin Snotel Tracking. 1981-2010 percent of median compared against 2015 YTD Snow Water Equivalent (SWE) and 1992 and 2012 percent of average SWE

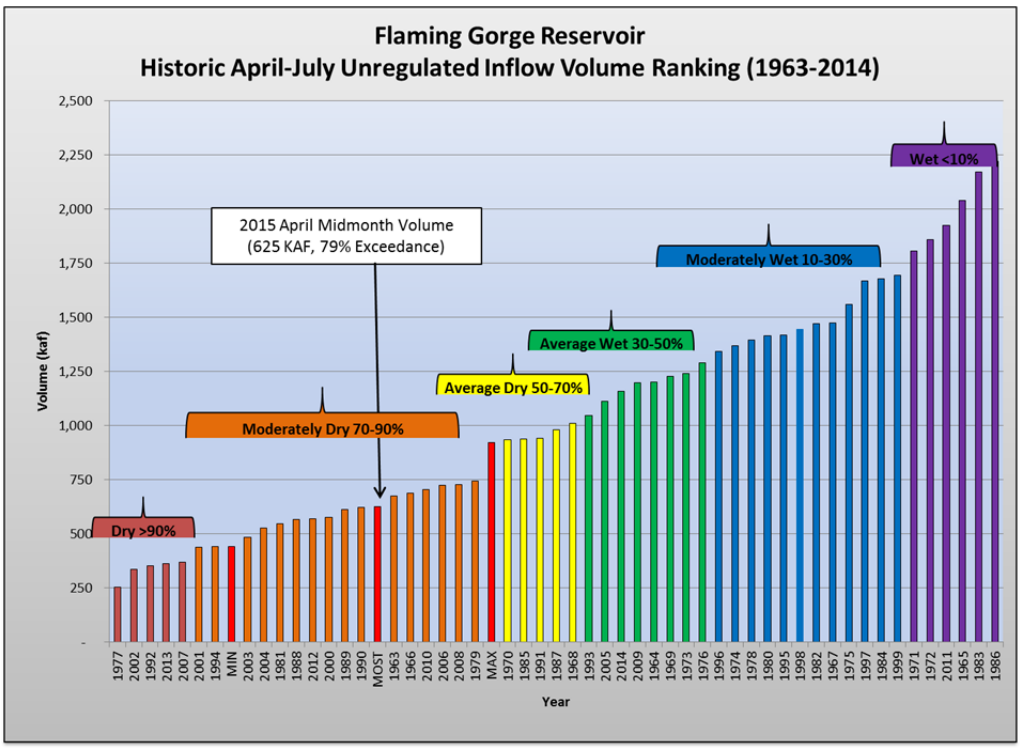

FIGURE 2. Flaming Gorge Reservoir April midmonth forecast and ranked historic April-July unregulated inflow volume for years 1963-2014

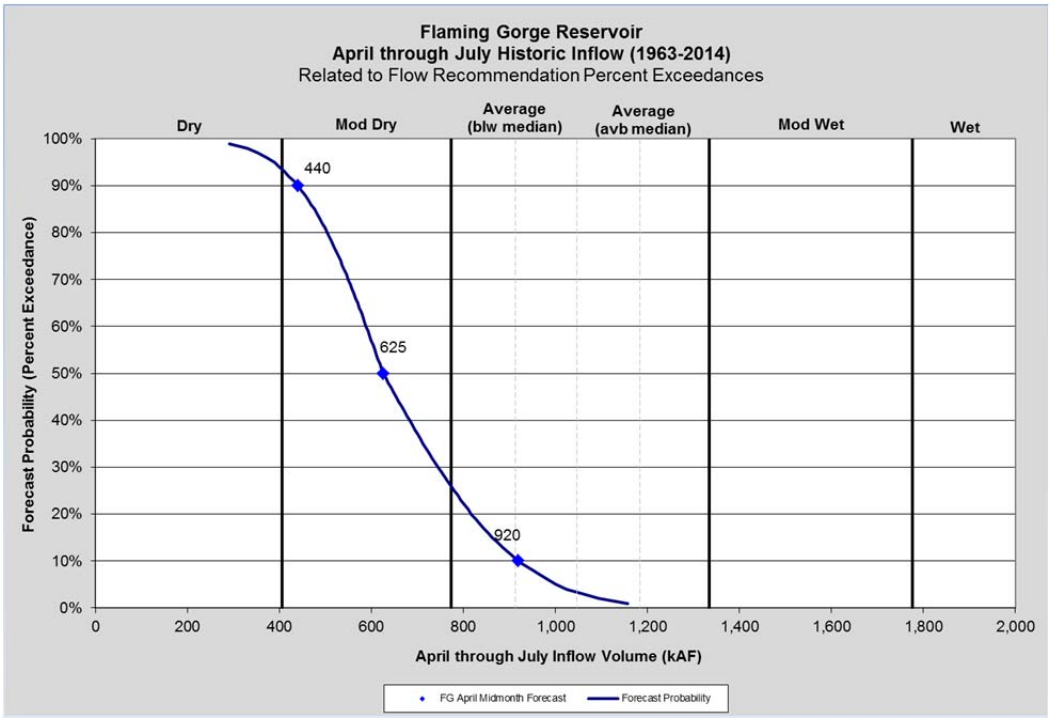

FIGURE 3. Flaming Gorge Reservoir April midmonth forecast probability (percent exceedance) and historic April-July unregulated inflow volume for years 1963-2014

Yampa River Basin Hydrology

The combined current forecast for the Little Snake at Lily plus Yampa River at Maybell is 680,000 AF (59% of 30-year average). This forecast falls at approximately 89% exceedance based on a ranking of the historic record (1922-2014).

Figure 4 illustrates the Yampa River at Deerlodge Park SWE as of April 17, 2015 and compares it against water years 2002 and 2012. Figure 5 below shows the current forecast in relation to historic flow volumes. Figure 6 illustrates the Yampa River at Maybell plus Lily April midmonth forecast probability (percent exceedance).

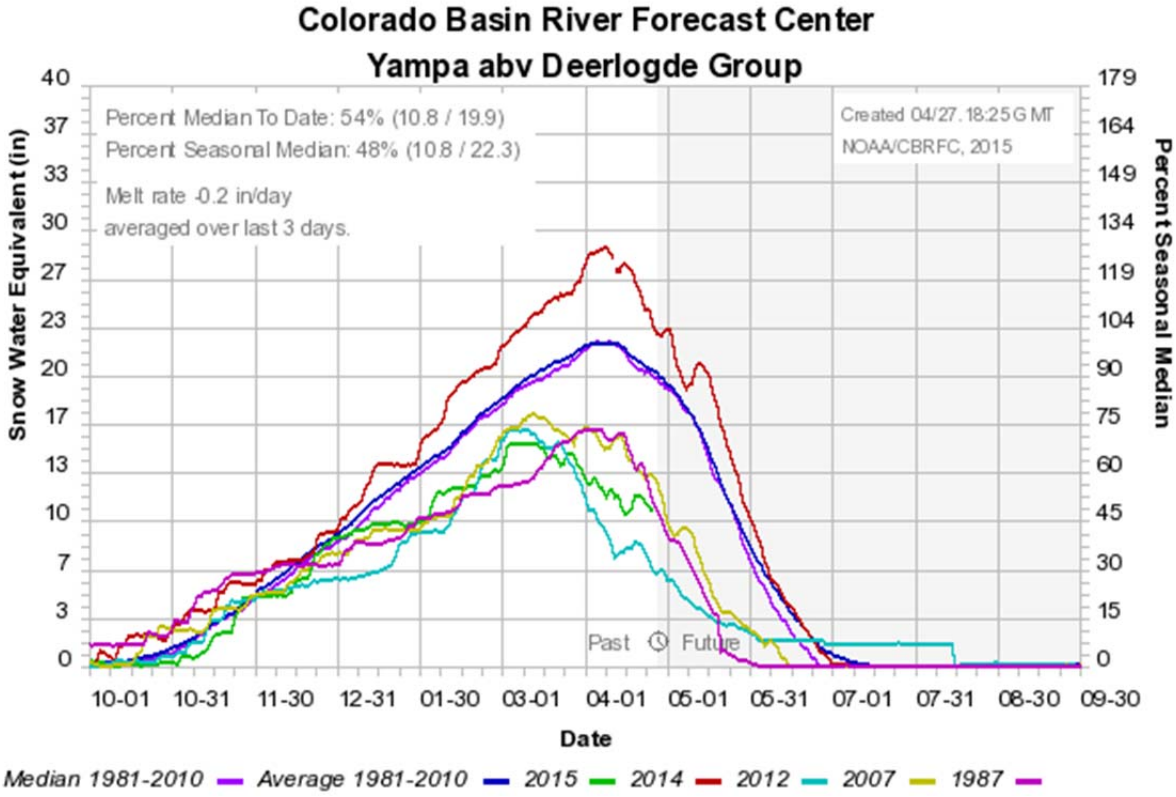

FIGURE 4. Yampa River above Deerlodge SNOTEL Group. 1981-2010 percent of average SWE compared against 2015 YTD, and analog years 1987, 2007 and 2012 percent of median SWE

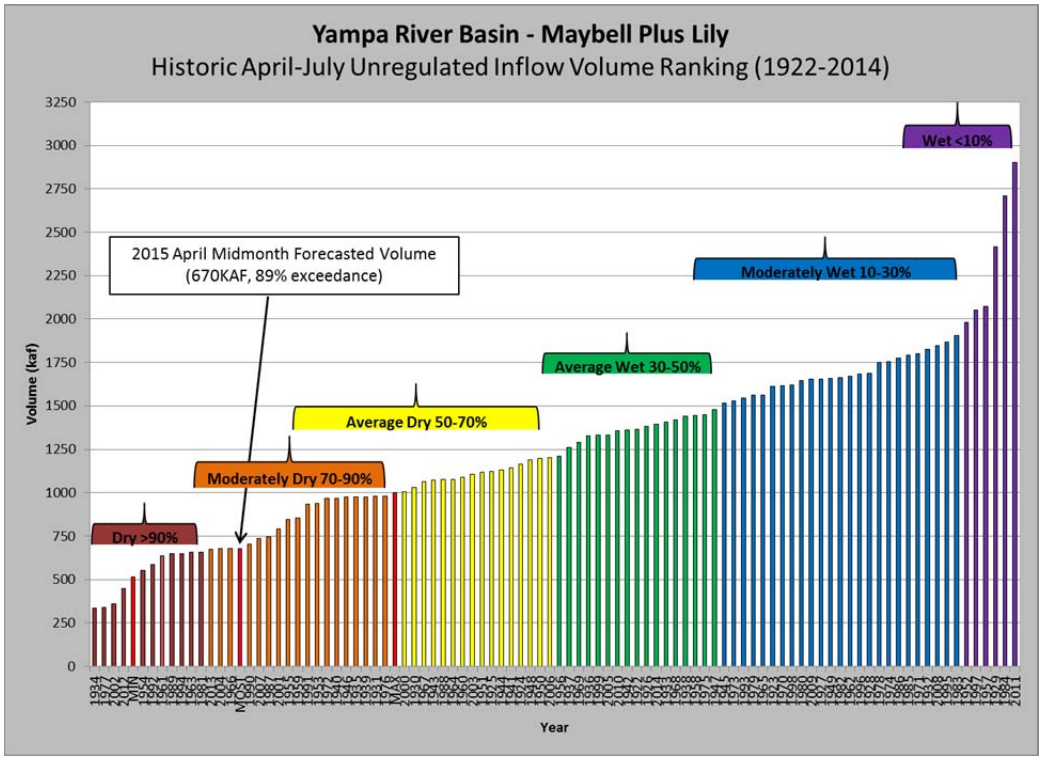

FIGURE 5. Yampa River Basin (Maybell plus Lily) April midmonth forecast and ranked April-July unregulated inflow volume for years 1922-2014

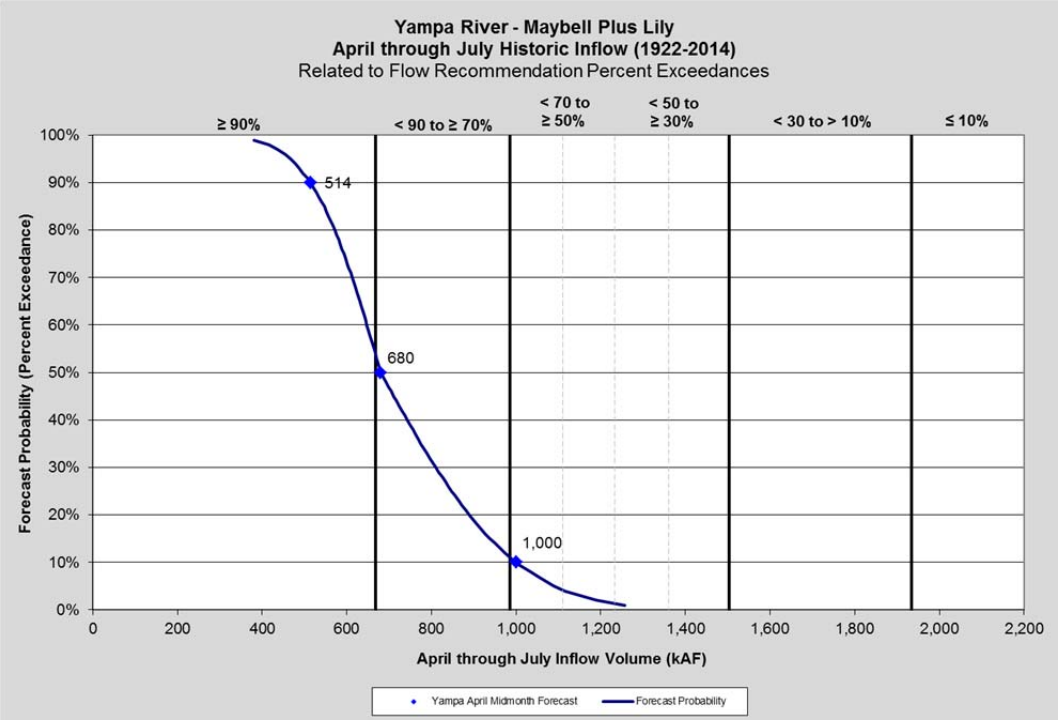

FIGURE 6. Flaming Gorge Reservoir April midmonth forecast probability (percent exceedance) and historic April-July unregulated inflow volume for years 1963-2014

Probabilities of Flow Events for Spring 2015

The Flaming Gorge unregulated inflow and Yampa River forecasts are moderately dry and trending drier. Conditions this year are similar to 2002, 2007 and 2012. An analysis was completed to assist in the determination of appropriate flow objectives for spring and summer 2015. 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). The current analysis indicates that it is likely Yampa River flows above 10,000 cfs will not be achieved this year.

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

Year	April-July Unreg Inflow Volume (KAF)
MIN	514
1963	658
1981	659
2013	676
2004	678
1966	679
MOST	680
1990	703
2007	736
1987	746
2001	790
1955	845
MAX	1,000

Table 2
Spring 2015 – Days above Specific Flow Thresholds in the Yampa River
(Maybell plus Lily)
Based on the April Midmonth Forecast
Percent Exceedance (%)

April Midmonth Forecast	% Exceed	Days above 3500 cfs	Days above 4500 cfs	Days above 5500 cfs	Days above 6500 cfs	Days above 7500 cfs	Days above 8500 cfs	Days above 10000 cfs
YAMPA	25%	48	35	25	17	7	1	0
	50%	43	33	21	13	4	1	0
	75%	40	23	14	6	3	0	0
	90%	38	22	11	5	2	0	0

Colorado Basin River Forecast Center Yampa River Analysis

The Colorado Basin River Forecast Center (RFC) calculates percent exceedance based on thirty years of historic temperature and precipitation data (1981-2010) using a modified Monte Carlo method to provide projections of flow. The RFC provides projections based upon (1) strict observance to the historic dataset and (2) incorporation of the five-day quantitative precipitation forecast (QPF). QPF is the forecasted precipitation over the five-day climate forecast period. The model also incorporates the ten-day forecasted temperatures.

The RFC provides a synopsis of the current seasonal outlook for the Yampa River at Deerlodge. This synopsis is provided below:

> *This outlook is based on flows from ESP with model states and snow conditions as of April 17. Seasonal precipitation was below average in the Yampa River Basin at 80 percent of normal as of April 1.*
>
> *April month to date precipitation in the basin is below normal. However, a storm system is currently impacting the basin. Temperatures for the first two weeks of April have been a mix of near, below and slightly below normal. As a result of the precipitation and temperature so far for April, the current snow water equivalent as of April 17 is 50% of median and has decreased as a percent of median since the first of the month.*
>
> *A complicated early spring storm is currently over the basin. A closed low pressure system is centered over southwest Colorado which is resulting in wrap around precipitation over the basin. The low will slowly track northeast out of Colorado by Saturday afternoon. The unsettled pattern continues through Sunday and Monday with a chance of more precipitation early in the week. Model guidance for the end of next week is showing yet another storm system entering the region however details of this system are not clear at this point.*
>
> *Short term (10 day) stream flow forecasts suggest decreasing flows over the next 10 days as a result of the cooler temperatures associated with the current progressive weather pattern.*

The RFC provides updated Yampa River April through July seasonal exceedance probabilities for both the river flows and daily maximum peak flow. Table 3 presents the RFC projections based on current information. Figures 7 and 8 illustrate the probabilities of the Yampa River at Deerlodge river flows exceeding certain thresholds and exceedance probabilities over the April through July spring period.

Table 3
Maximum Peak Daily Flow on the Yampa River at Deerlodge
Based on the April 17, 2015, RFC Analysis
Percent Exceedance (%)

CBRFC April 17, 2015 Projections	% Exceed	Maximum Daily Peak (cfs)	Number of Days to Peak from 04/01/15	Number of Days Above 8,300 cfs	Number of Days above 10,000 cfs
YAMPA	10%	10,658	58	11	2
	25%	9,247	45	3	0
	50%	7,339	37	0	0
	75%	6,195	32	0	0
	90%	5,871	27	0	0

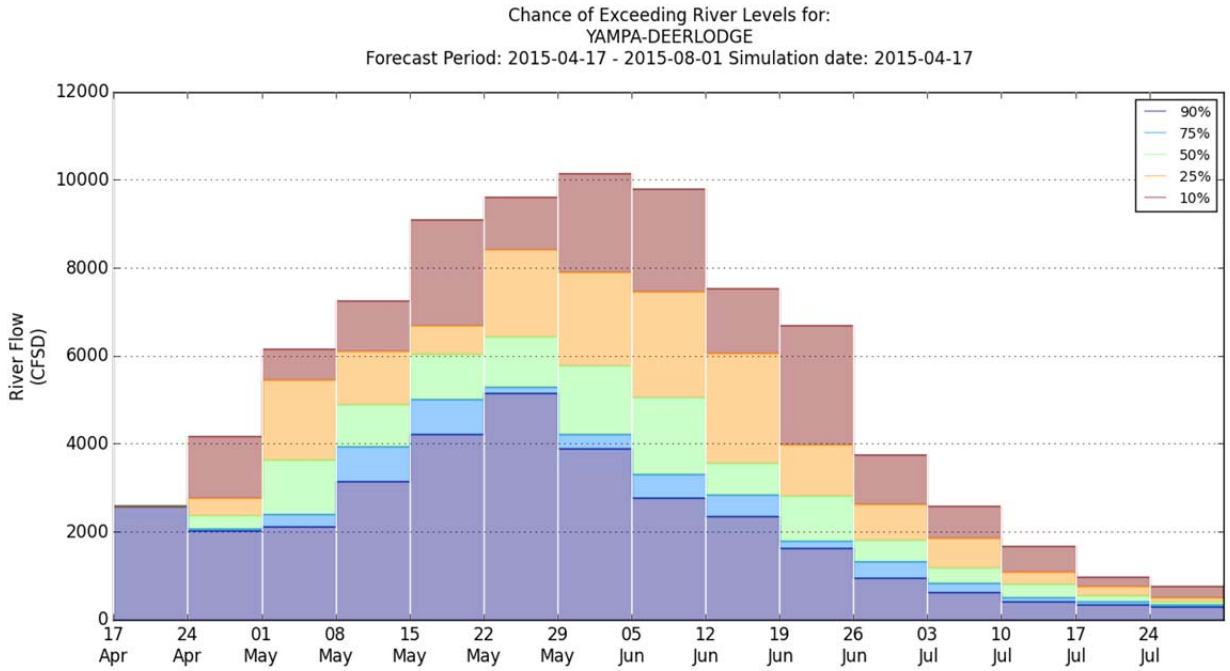

FIGURE 7. RFC April 17, 2015 projection of Yampa River at Deerlodge flows exceeding thresholds for various percent exceedance for the 2015 April through July spring period.

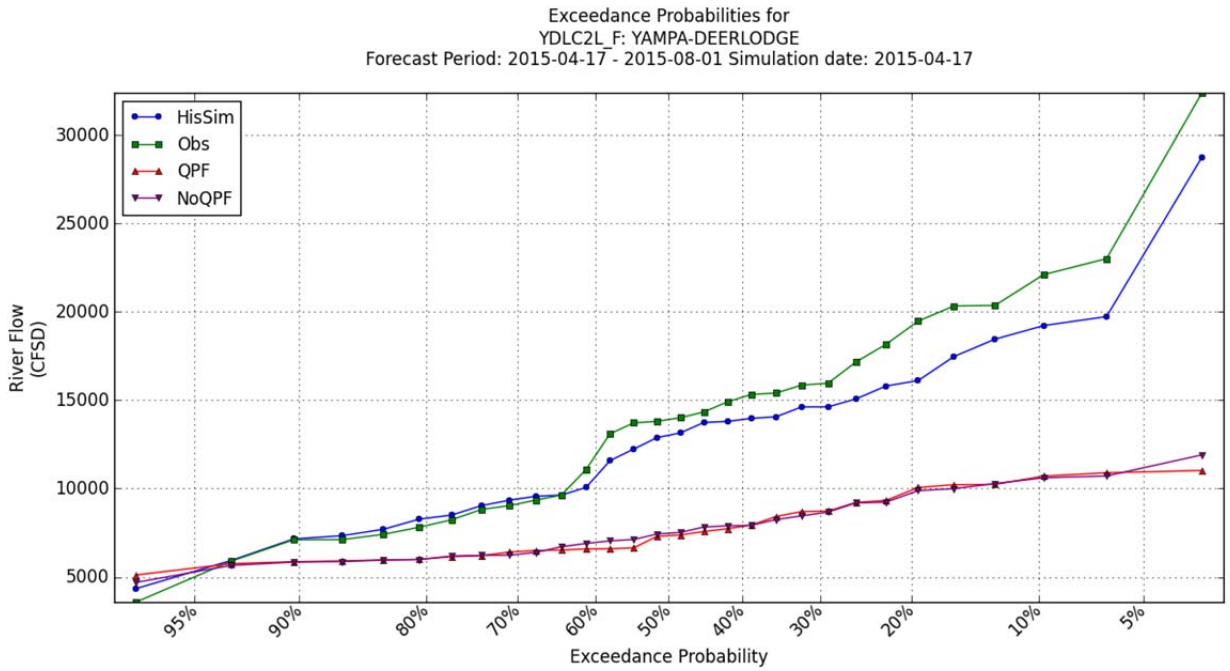

FIGURE 8. RFC April 17, 2015 projection of Yampa River at Deerlodge flow exceeding thresholds for based on the historic observed, simulation of historic climate with current initial conditions and simulation of historic climate including the ten-day QPF with initial conditions.

Larval Trigger Study Plan Projected Operations

Previous to the implementation of the ROD, the U.S. Fish and Wildlife Service issued a Biological Opinion in 1992 that timed releases from Flaming Gorge to occur during the spring peak of the Yampa River. Under the ROD, Flaming Gorge releases are timed during the Yampa River spring peak and immediate post peak.

The Larval Trigger Study Plan experimental protocol alters Flaming Gorge releases to occur after razorback sucker larvae have been observed in the Green River below Flaming Gorge Dam. This modification in timing of spring peak releases alters projected operations from Flaming Gorge as compared against historic releases.

Figures 9-11 below illustrate potential Flaming Gorge releases utilizing similar hydrologic years to the current one.

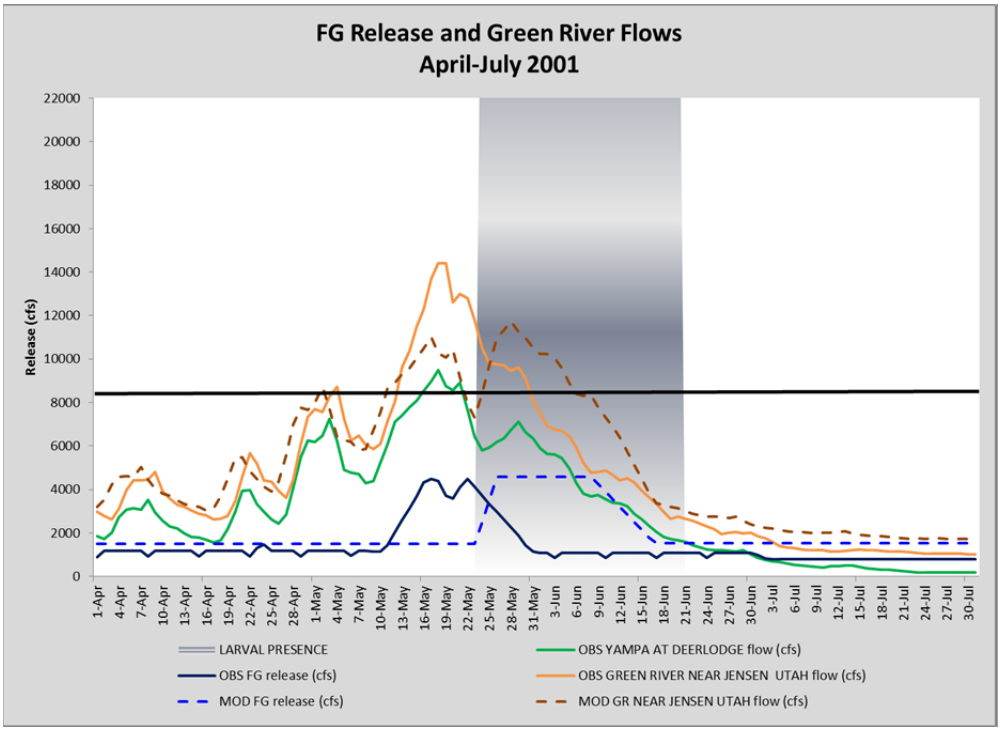

FIGURE 9. Flaming Gorge release, Yampa and Jensen flows for WY2001 and projected operations under LTSP using 2001 flows. Shaded grey area indicates larval presence.

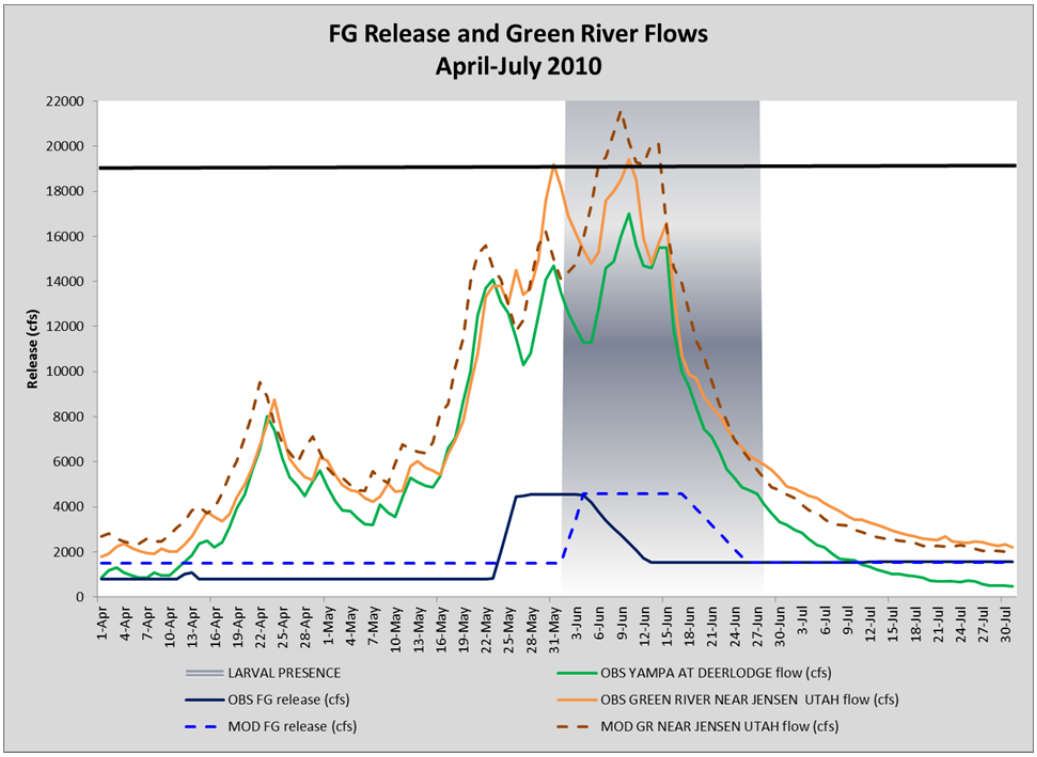

FIGURE 10. Flaming Gorge release, Yampa and Jensen flows for WY2010 and projected operations under LTSP using 2001 flows. Shaded grey area indicates larval presence.

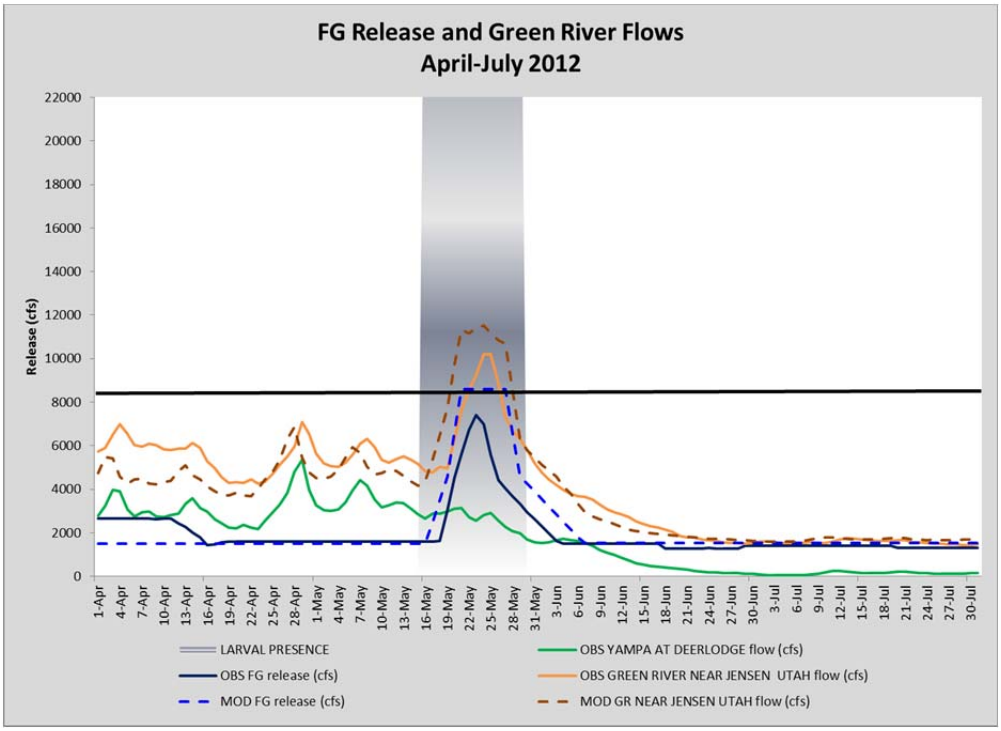

FIGURE 11. Flaming Gorge release, Yampa and Jensen flows for WY2012 and projected operations under LTSP using 2012 flows. Shaded grey area indicates larval presence.

Record of Decision Spring Flow Objectives

This hydrologic update provides information regarding current conditions and how it relates to the Operating Plan detailed in the 2005 Flaming Gorge Final Environmental Impact Statement (FEIS) 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. 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 2015 are as follows:

Moderately Dry Classification

If the April through July unregulated inflow into Flaming Gorge Reservoir remains in the range from 405,000 AF to 774,000 AF the hydrological classification would be moderately dry.

The peak flow as measured at Jensen, Utah this year would correspond with the moderately dry hydrologic condition. The LTSP outlines moderately dry flows between 8,300 cfs and 14,000 cfs at Jensen for a period between 7 to 14 days, and minimum seven-day duration. These flows provide connection at Stewart Lake, Above Brennan and Old Charley Wash.

The ROD spring flow objectives for moderately dry years are:

Table 4 – 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

Average (Below Median) Classification

It is likely that hydrologic conditions into Flaming Gorge Reservoir will change before implementation of the proposed 2015 flow objectives. In the event conditions become wetter and the Flaming Gorge Reservoir unregulated inflow forecast for April through July falls between 774,000 AF to 1,047,000 AF, and the Yampa River hydrologic classification increases to average (below median), the hydrological classification would be average (below median).

The peak flow as measured at Jensen, Utah, would correspond with the average (below median) hydrologic condition with targeted flows between 14,000 and 18,600 cfs for a period between 1 to 14 days in Reach 2. These flows provide connection at the Stewart Lake, Above Brennan, Old Charley Wash, Thunder Ranch, Bonanza Bridge, Johnson Bottom, Stirrup and Leota 7 floodplains.

ROD spring flow objectives for average (below median) years are:

Table 5 – Average (Below Median) 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 in 50% of average years	One week (i.e. 7 days) in 50% of average years

Flow Recommendations and FEIS

Average (Above Median) Classification

If conditions become wetter than the current forecast at Flaming Gorge Reservoir and the April through July forecast increases between 1,047,000 AF and 1,334,000 AF, the hydrological classification would be average (above median).

The peak flow as measured at Jensen, Utah, would correspond with the average (above median) hydrologic condition with targeted flows between 18,600 and 20,300 cfs for a period between 1 to ≥14 days in Reach 2. These flows provide connection at the Stewart Lake, Above Brennan, Old Charley Wash, Thunder Ranch, Bonanza Bridge, Johnson Bottom, Stirrup and Leota 7 floodplains.

ROD spring flow objectives for average (above median) wet years are:

Table 6 – Average (Above Median) 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

Flow Recommendations and FEIS