

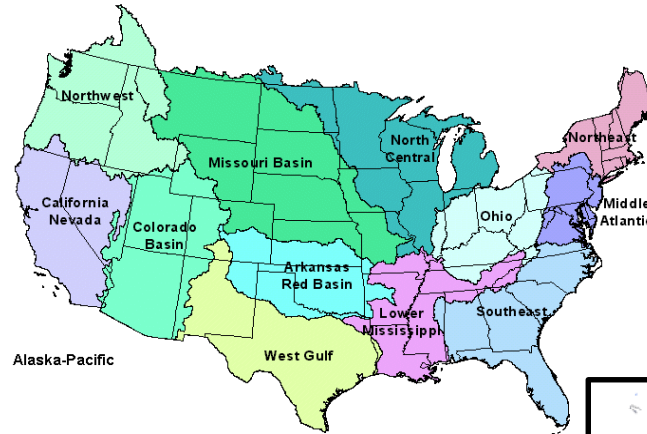
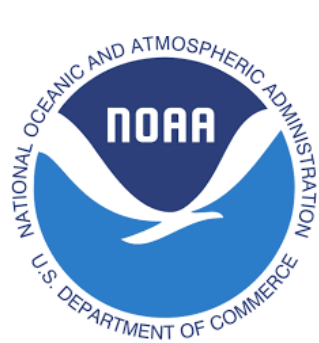
Green and Yampa Rivers: Spring Forecast and Runoff Summary

August 30th, 2016

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Colorado Basin River Forecast Center
National Weather Service/NOAA



What is the Colorado Basin River Forecast Center?



13 river forecast centers that produce timely and accurate water forecasts to support the NWS/NOAA mission

NWS Mission: To provide, weather, **hydrologic**, and climate forecasts and warnings....for the protection of life and property and the enhancement of the national economy

CBRFC:

- Forecast Areas:
 - Colorado River Basin
 - Eastern Great Basin
- Major Programs Include:
 - Flood and Daily River Forecasts
 - Water Supply Forecasts



Today's Presentation – Questions to Answer

1. Late season water supply forecasts increased significantly
 - What happened ?
 - How did the water supply forecasts perform?

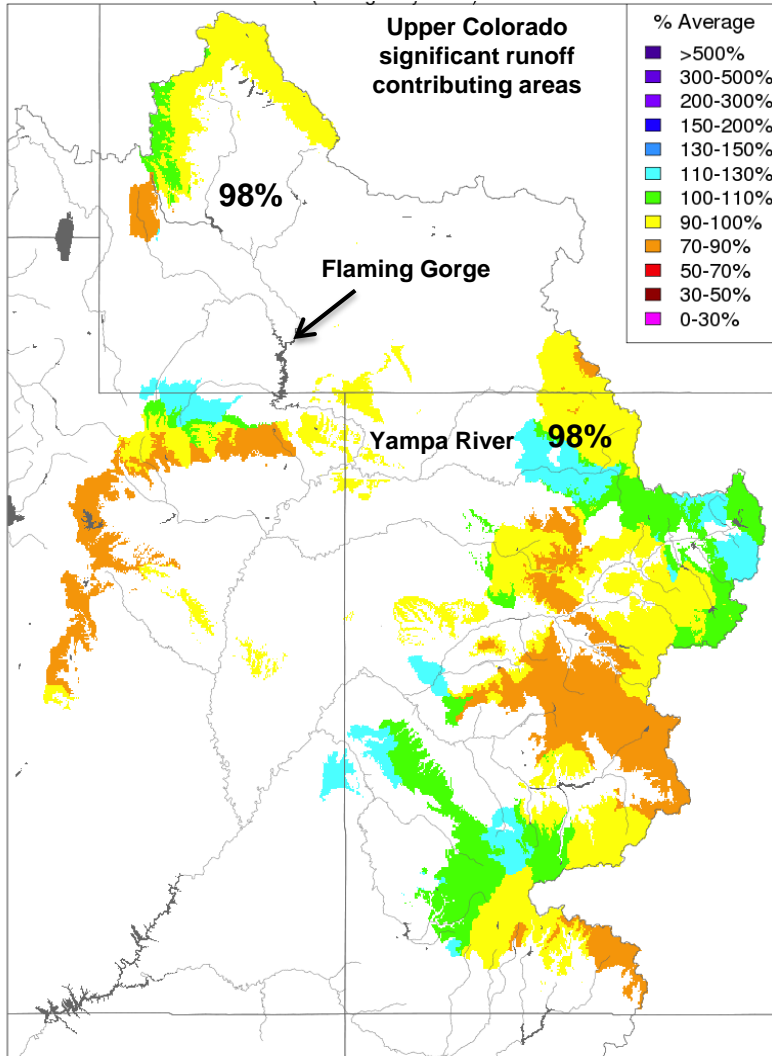
1. How did the Yampa River at Deerlodge daily streamflow forecasts perform?

1. What were the sources of uncertainty in the forecasts?

Looking Back – Snapshot on April 1st 2016

Water Year Precipitation

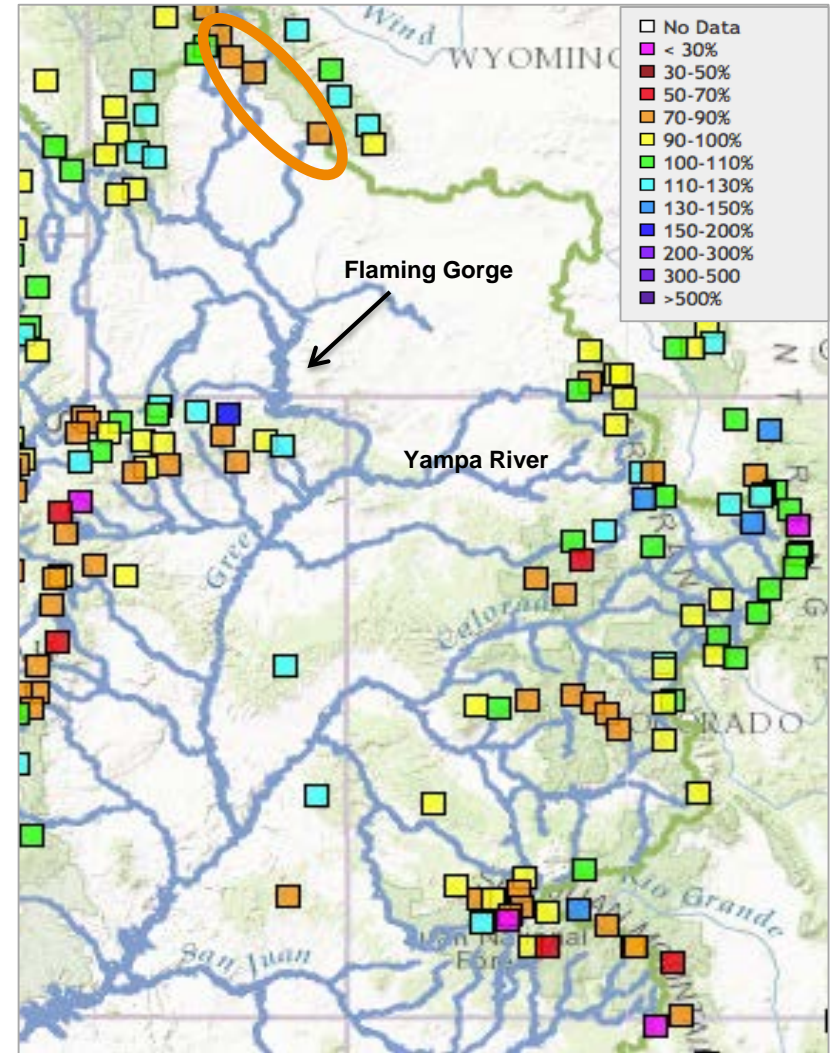
October 2015 – March 2016



Prepared by NOAA, Colorado Basin River Forecast Center
Salt Lake City, Utah, www.cbrfc.noaa.gov

Snow Conditions

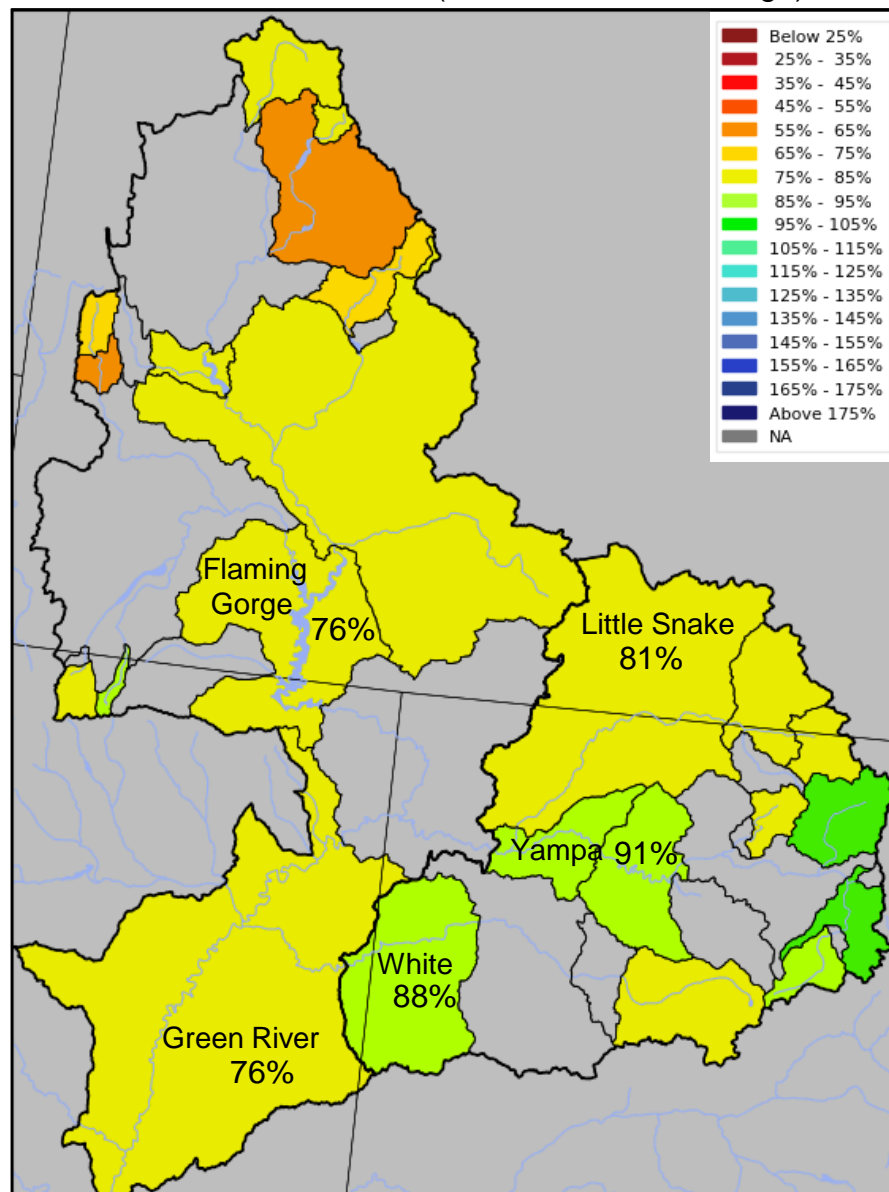
SNOTELS: % Median SWE



Looking Back – Snapshot on April 1st 2016

Water Supply Forecasts: April – July Volumes

Most Probable Scenario (% of 1981-2010 average)



- CBRFC model starts from current conditions and makes assumptions about long range future weather
- Official forecasts provide a range of possible outcomes (probabilistic)
 - can be interpreted as “dry”, “average”, and “wet” scenarios
- “Average” (50% exceedance) scenario is most commonly used forecast

April 1st Flaming Gorge Forecasts:

Dry (90%)	→	520 KAF	(53% average)
Average (50%)	→	740 KAF	(76% average)
Wet (10%)	→	1150 KAF	(118% average)

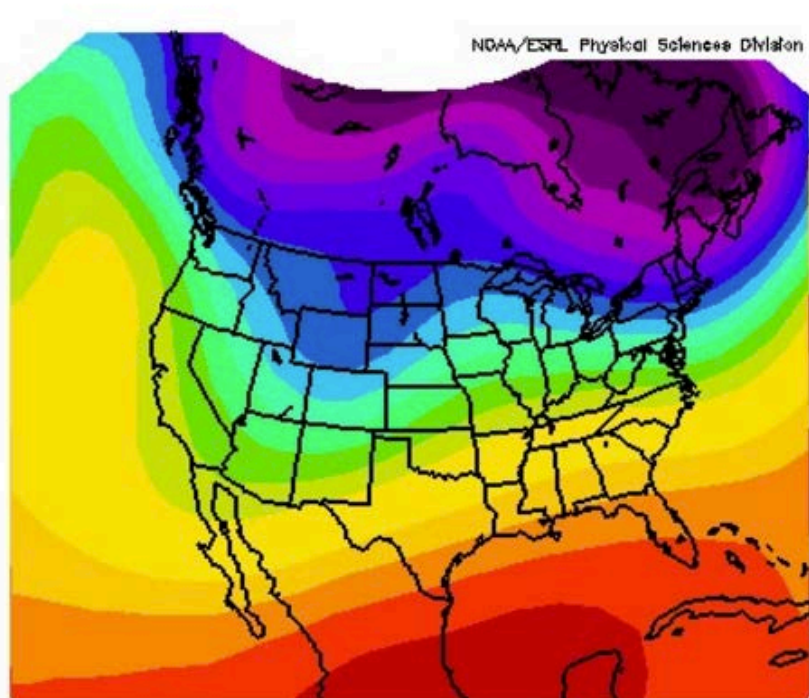
April 1st Yampa River Forecasts:

Dry (90%)	→	825 KAF	(66% average)
Average (50%)	→	1130 KAF	(91% average)
Wet (10%)	→	1450 KAF	(117% average)

What happened after April 1st?

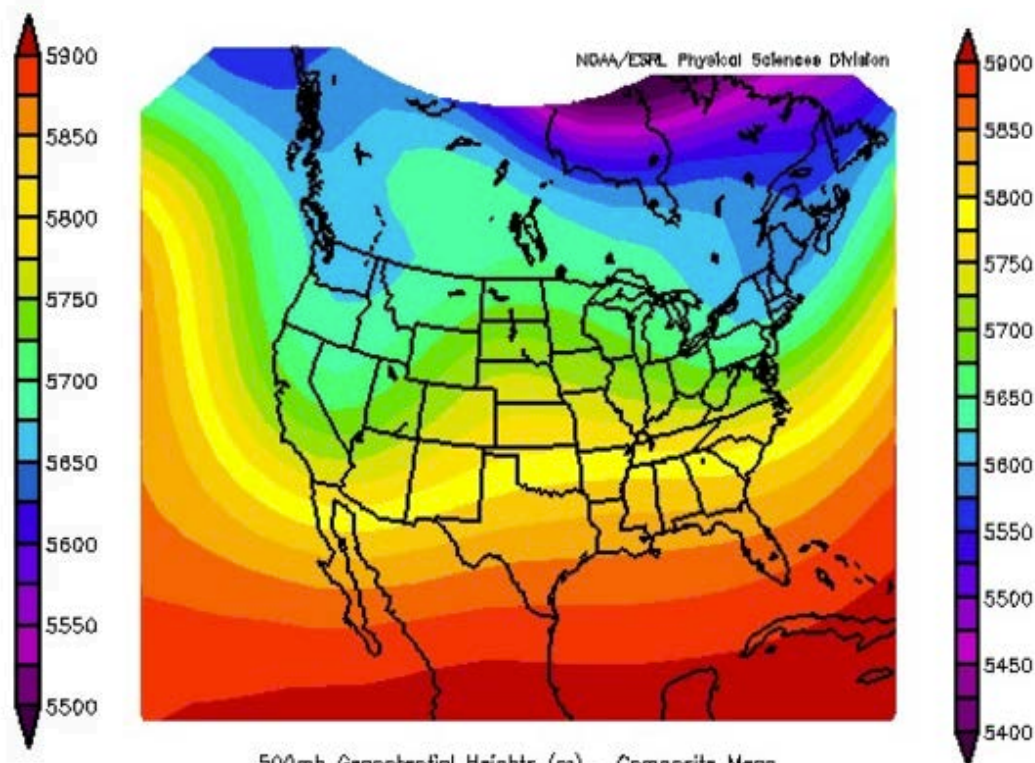
- Weather pattern shifted in late April and carried through May
- Series of slow moving low pressure systems

Upper Atmospheric Air Pattern at ~18,000 ft



500mb Geopotential Heights (m) Composite Mean
5/7/16 12z to 5/12/16 12z
NCEP/NCAR Reanalysis

May 7 – May 12



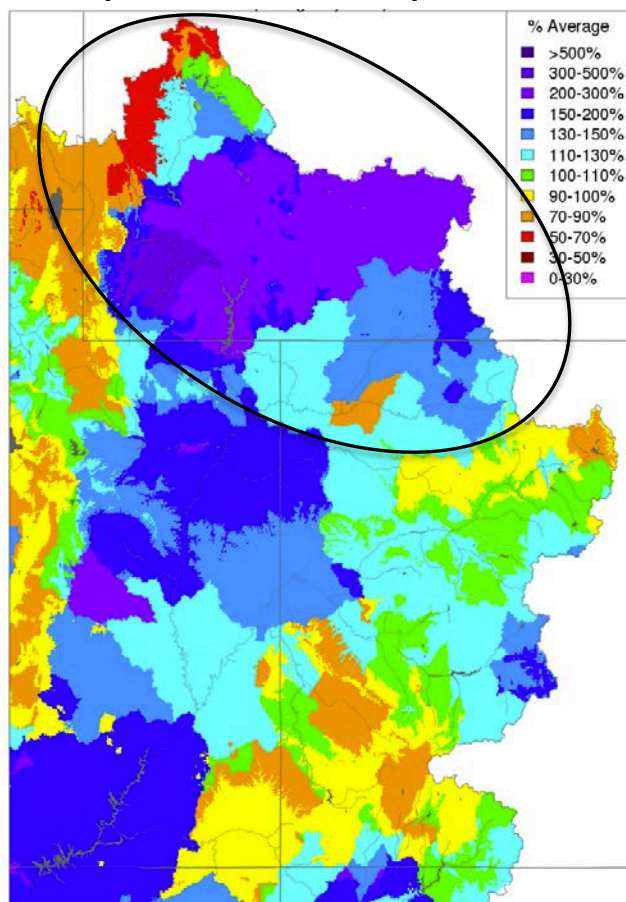
500mb Geopotential Heights (m) Composite Mean
5/15/16 12z to 5/25/16 12z
NCEP/NCAR Reanalysis

May 15 – May 25

What happened after April 1st?

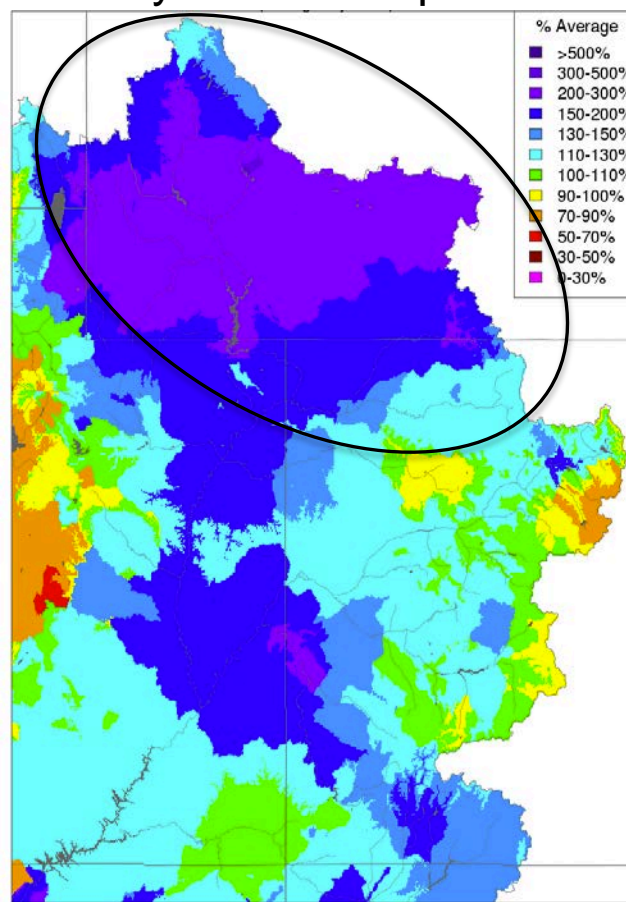
- Storms brought significant rain and snow to Green and Yampa River basins
- Much above average precipitation for April and May
 - especially at lower elevations
- Much below average temperatures for May

April 2016 Precipitation



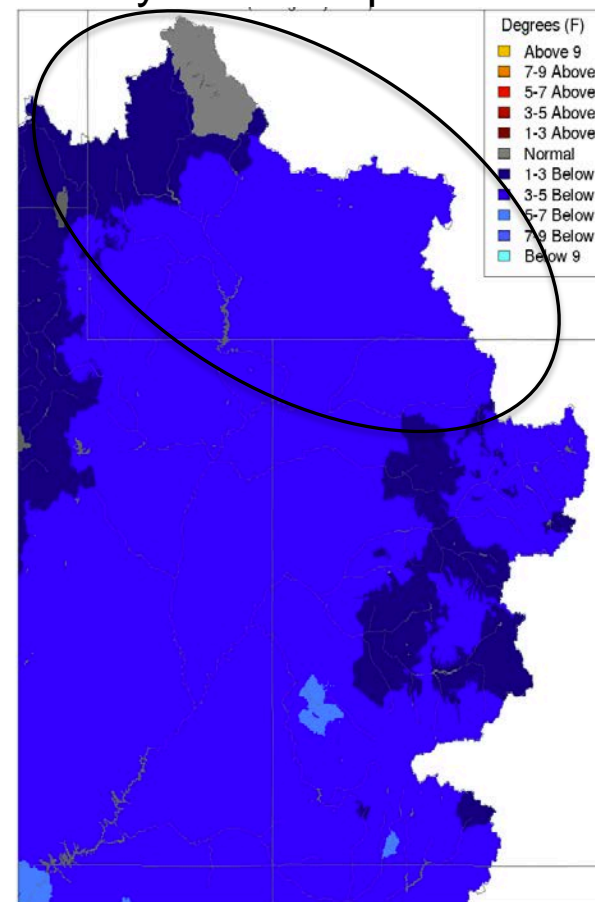
Prepared by NOAA, Colorado Basin River Forecast Center
Salt Lake City, Utah, www.cbrfc.noaa.gov

May 2016 Precipitation



Prepared by NOAA, Colorado Basin River Forecast Center
Salt Lake City, Utah, www.cbrfc.noaa.gov

May Max Temperature

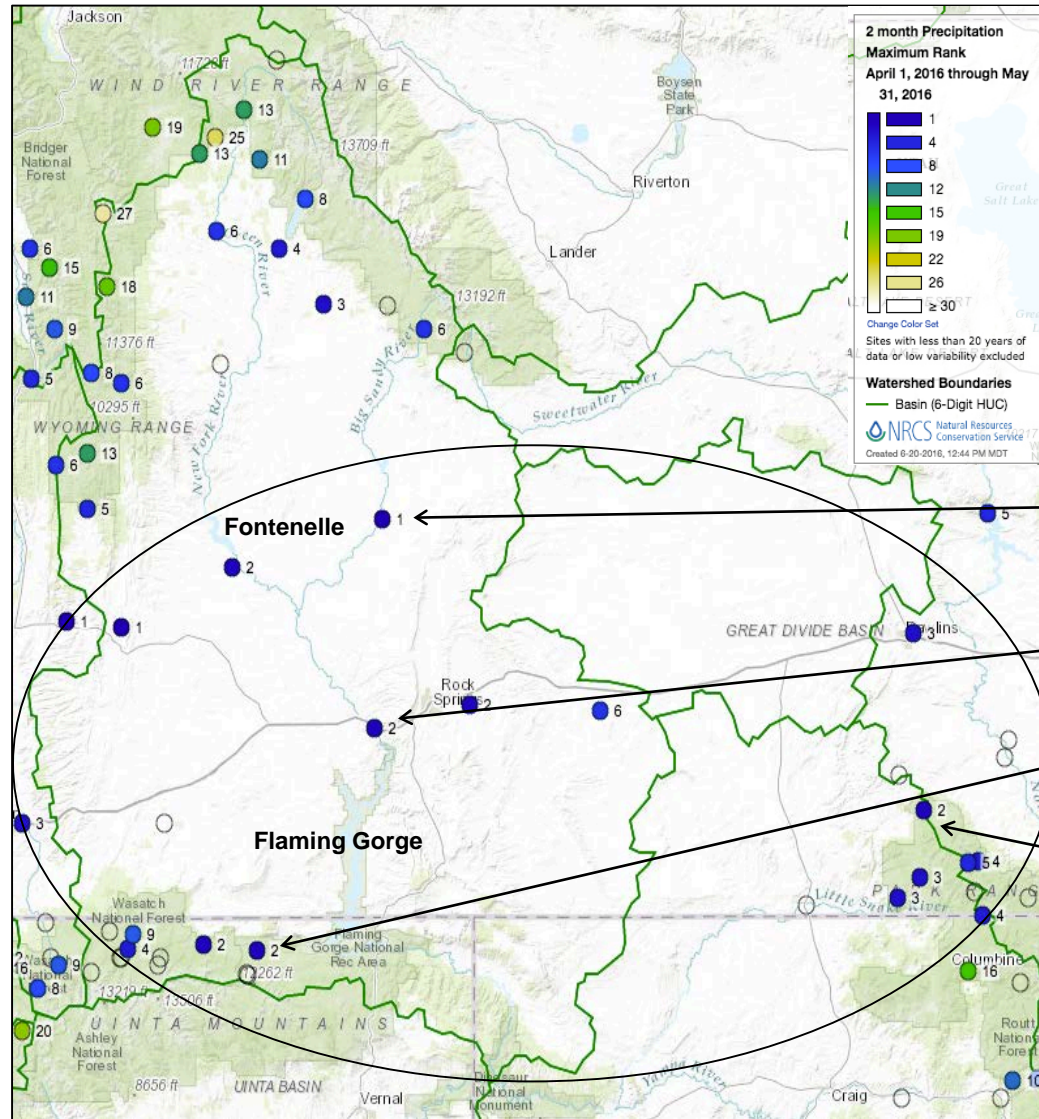


Prepared by NOAA, Colorado Basin River Forecast Center
Salt Lake City, Utah, www.cbrfc.noaa.gov

How wet was it?

Upper Green and Yampa April-May Precipitation Historical Ranking

- April-May precipitation at many locations was in the top 3 of the historical record

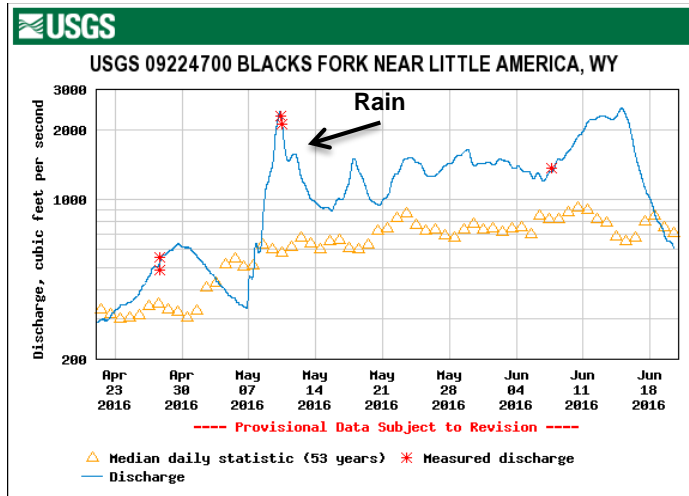


Location	April-May Average (in)	April-May Observed (in)	% of Average
Farson (47)	1.9	6.95	372%
Green River (50)	2.2	5.98	270%
Hickerson Park (31)	5.05	9.2	182%
Divide Peak (36)	7.3	13.1	180%

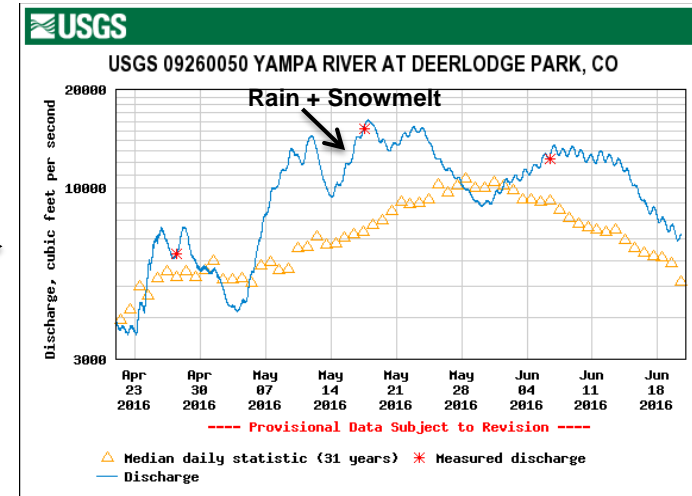
What were the impacts of the wet spring?

- Significant rises in streamflow from rain events*

Upper Green →

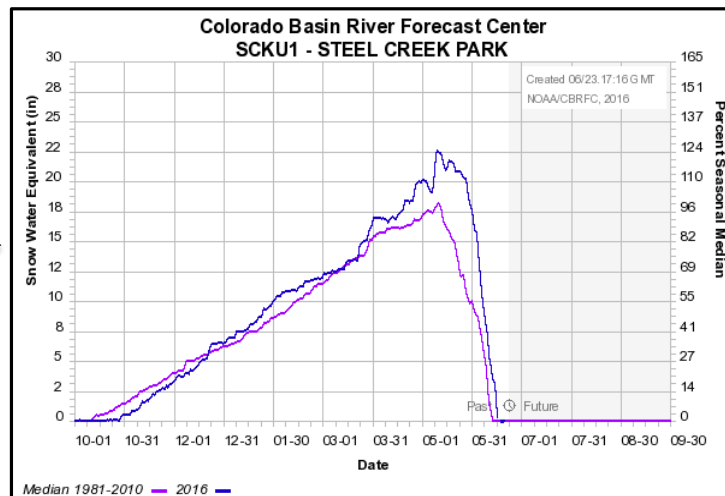


Yampa →

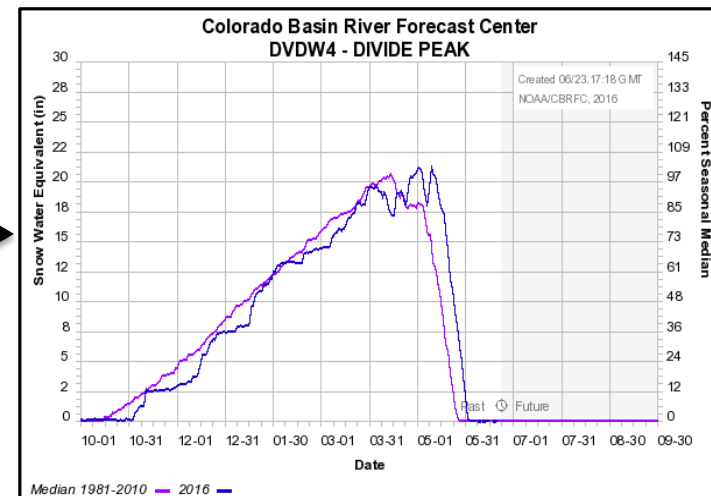


- Increase in snowpack and delay of melt and runoff*

Upper Green →

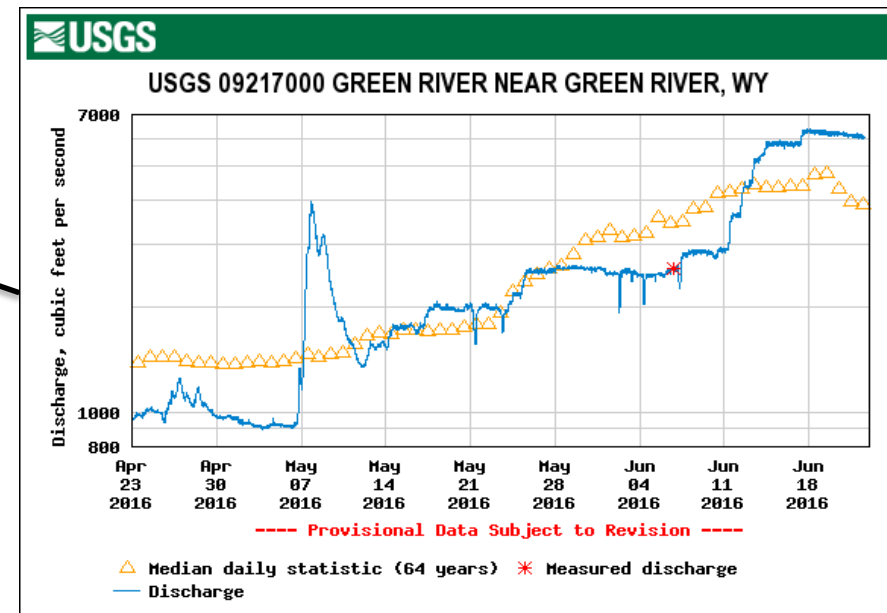
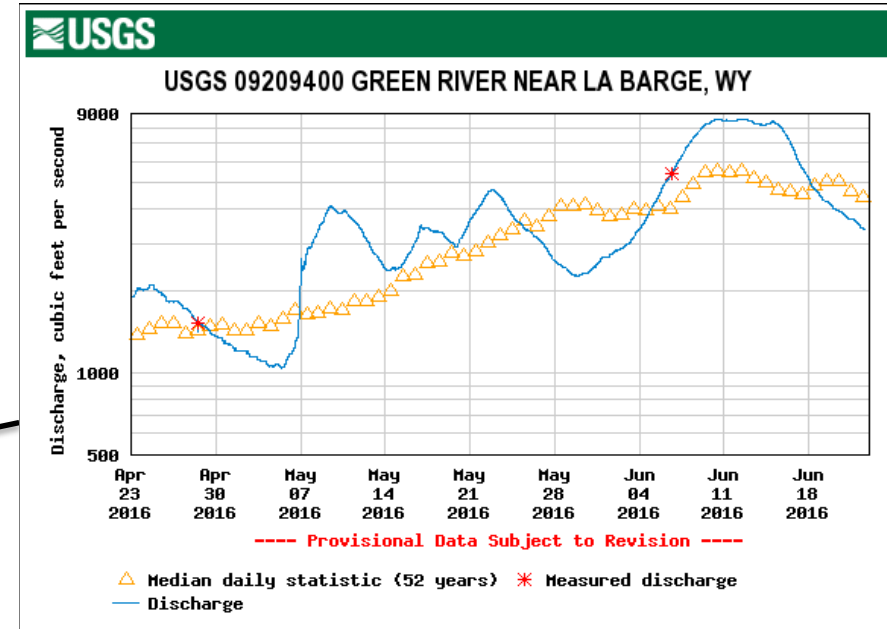
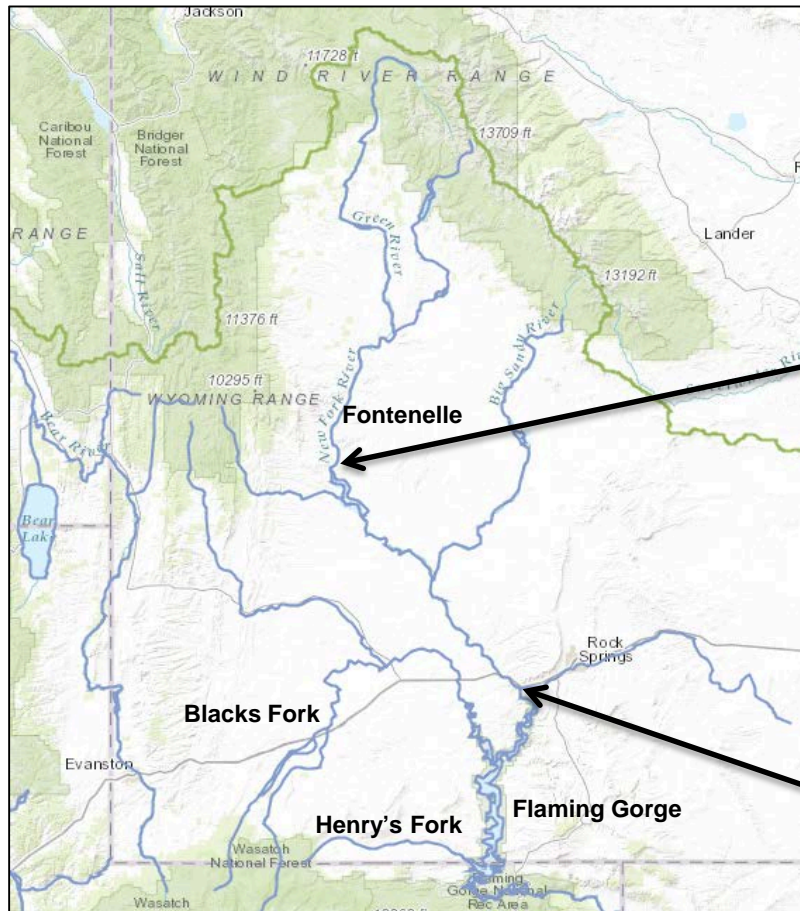


Yampa →



What were the impacts of the wet spring?

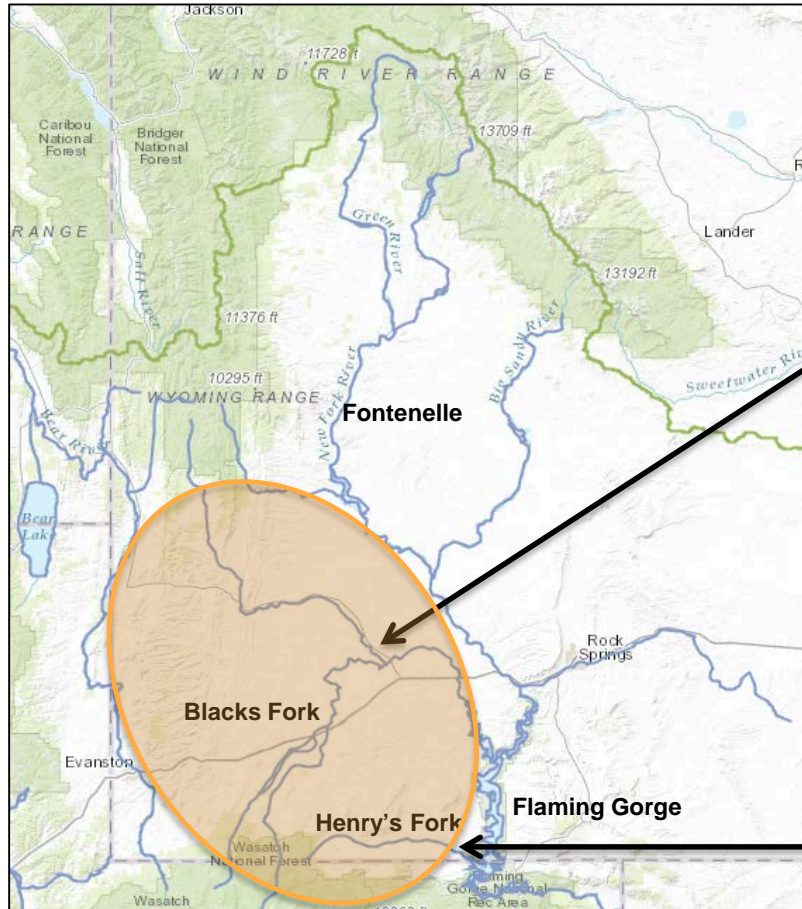
- Extended period of high flows*



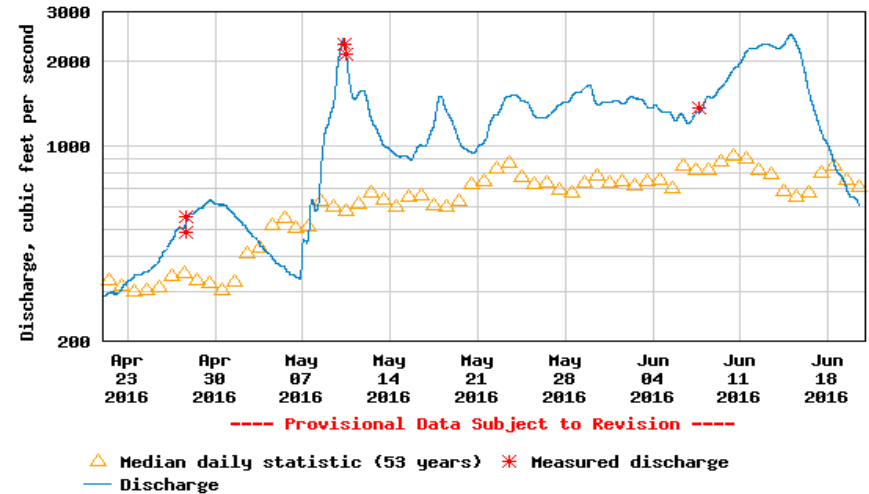
- Efficient runoff and higher peak flows when melt started in early June*
- Reduced demands and irrigation*

What were the impacts of the wet spring?

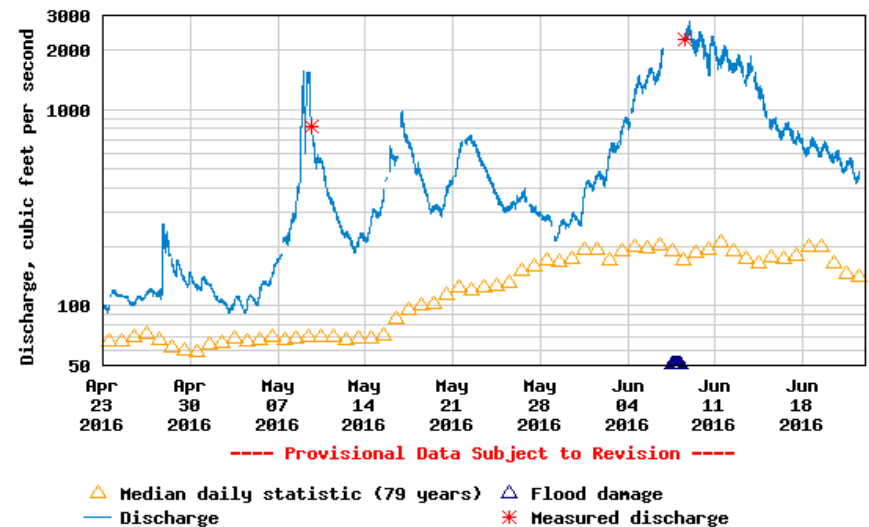
- Extended period of high flows



USGS 09224700 BLACKS FORK NEAR LITTLE AMERICA, WY



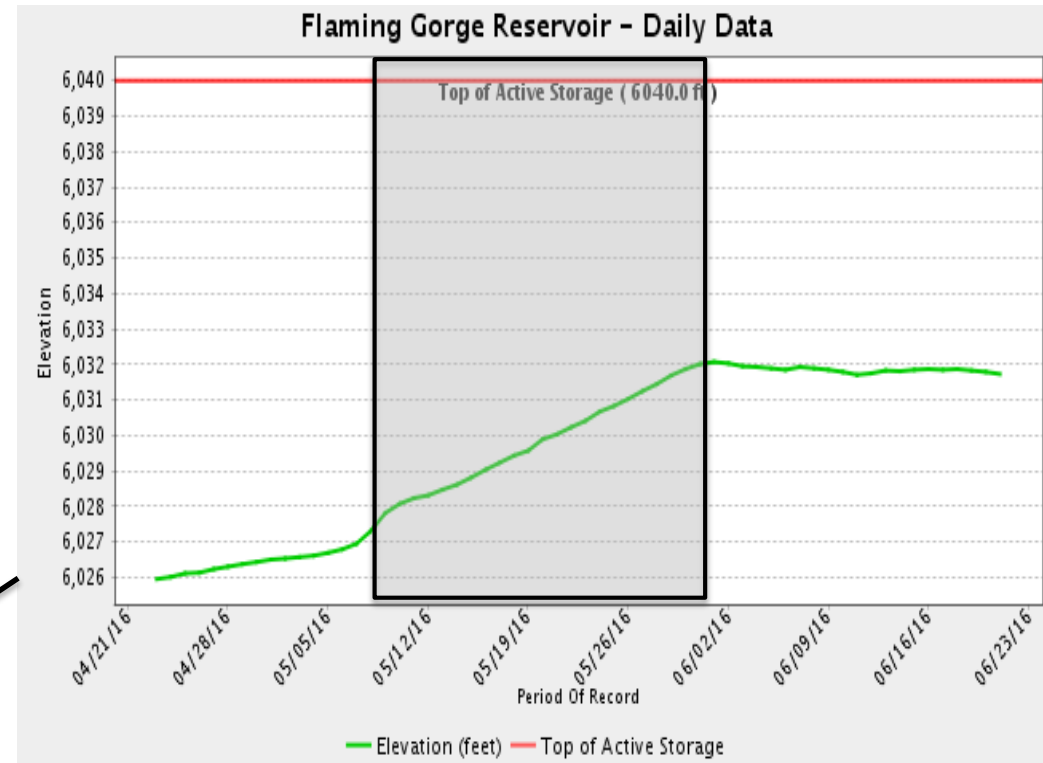
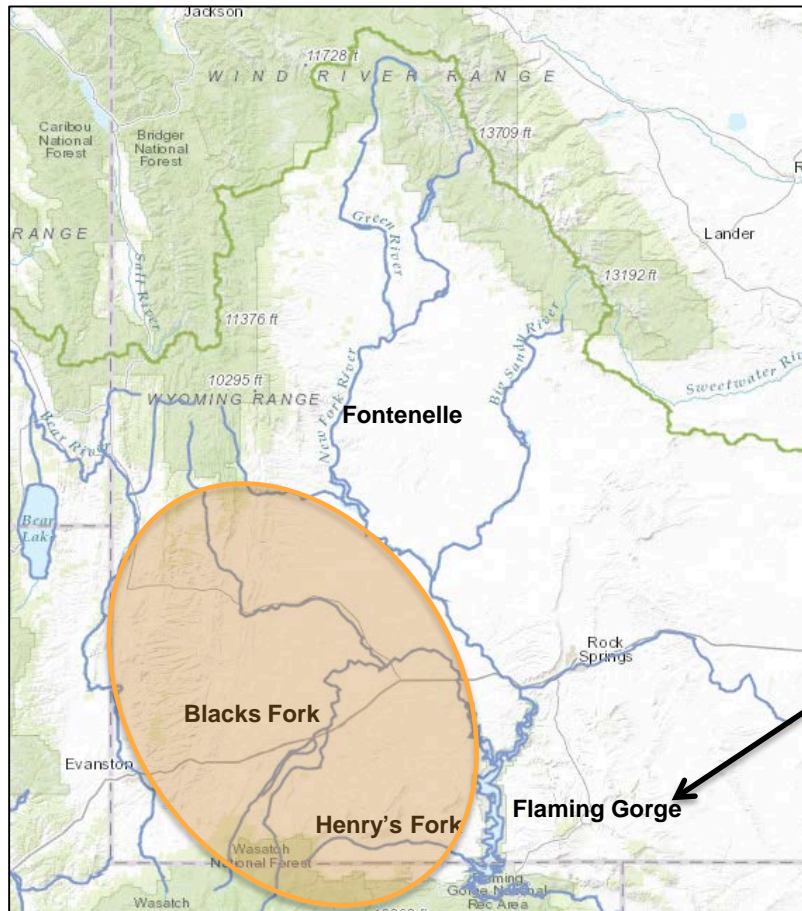
USGS 09229500 HENRYS FORK NEAR MANILA, UT



- Meeks Cabin and Stateline reservoirs spilled
- Observed flows from this area were much more than expected

What were the impacts of the wet spring?

- Extended period of high flows increased Flaming Gorge elevation*

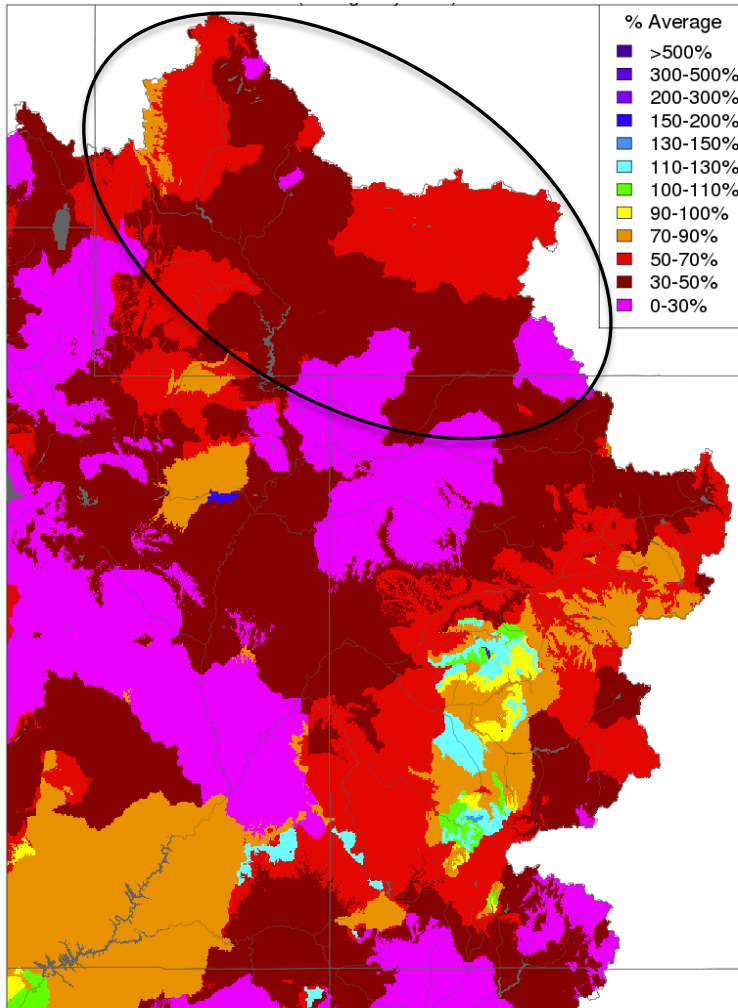


- A significant amount of inflow during May and early June was from the area below Fontenelle reservoir including Blacks Fork, Henry's Fork, and other tributaries
- Typically this area does not contribute significant flows to Flaming Gorge inflow
Average % Contribution = ~25% 2016 % Contribution = ~40%

After the wet spring.....

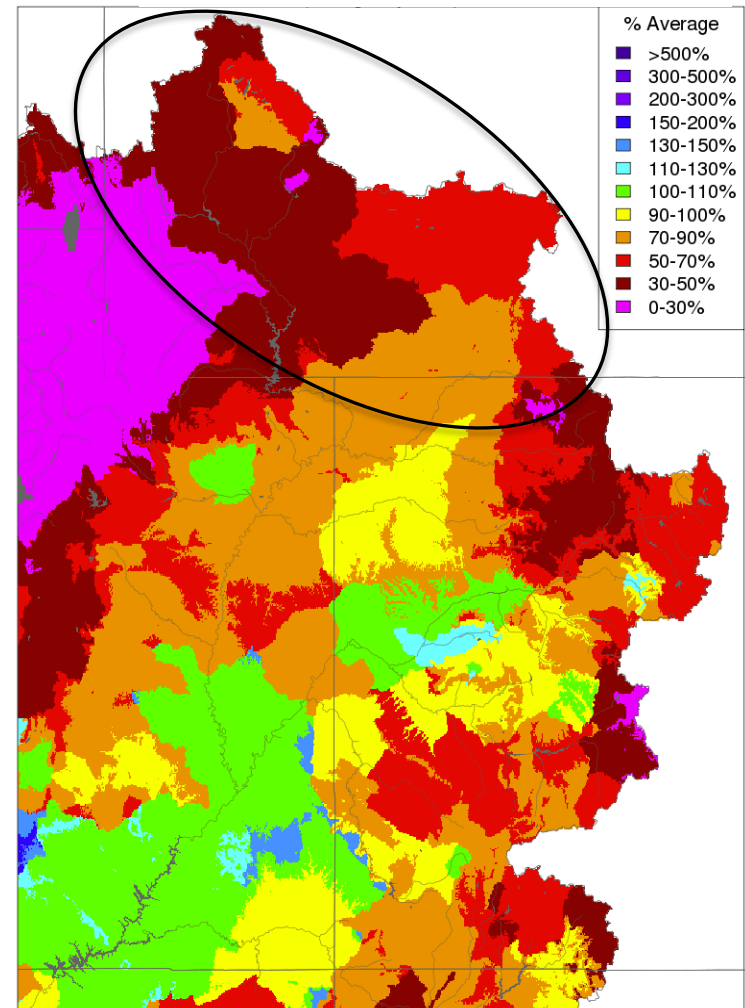
- Conditions turned to warm and dry
- June and July had much below average precipitation

June 2016 Precipitation



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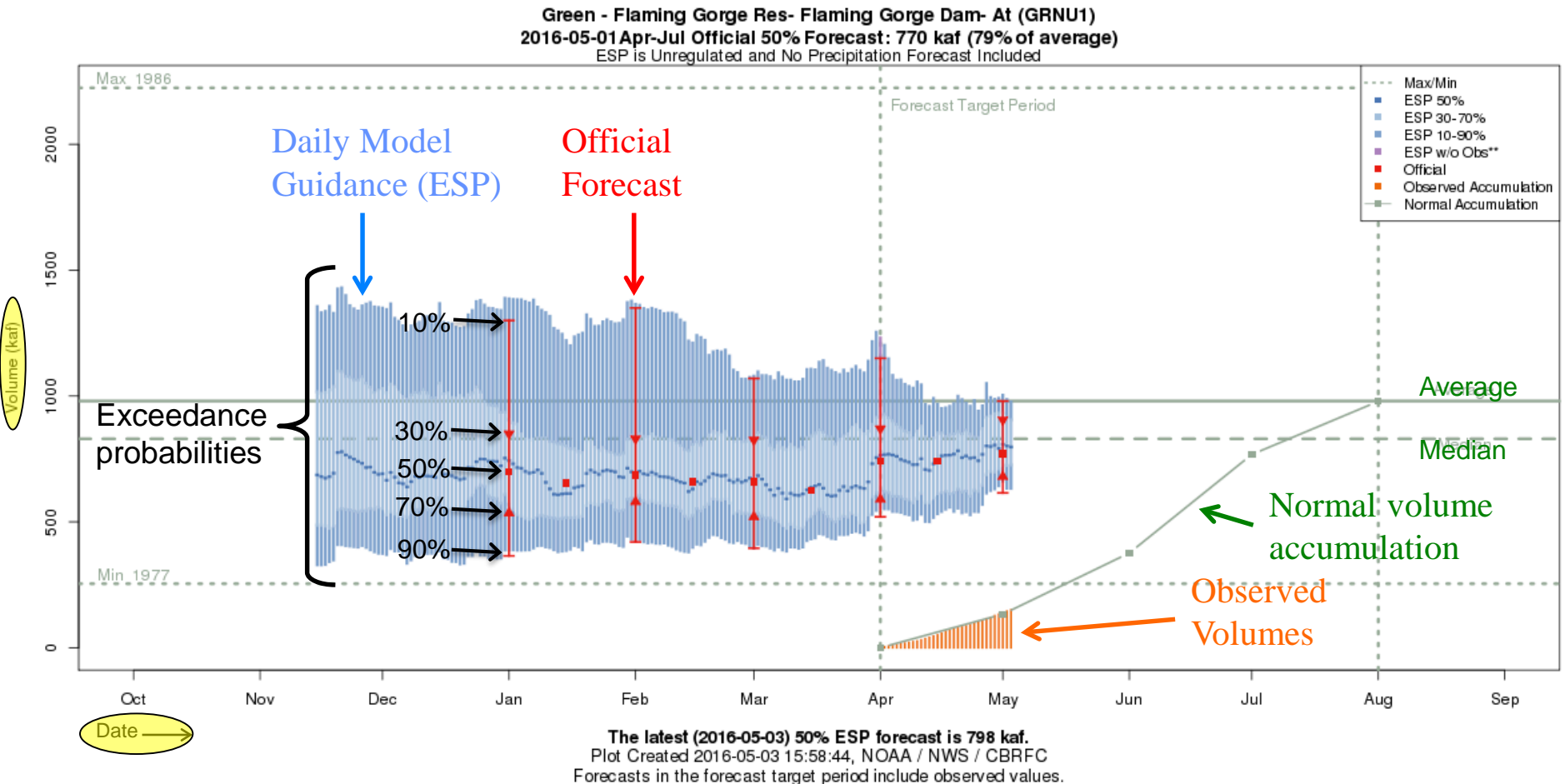
July 2016 Precipitation



Prepared by NOAA, Colorado Basin River Forecast Center
Salt Lake City, Utah, www.cbrfc.noaa.gov

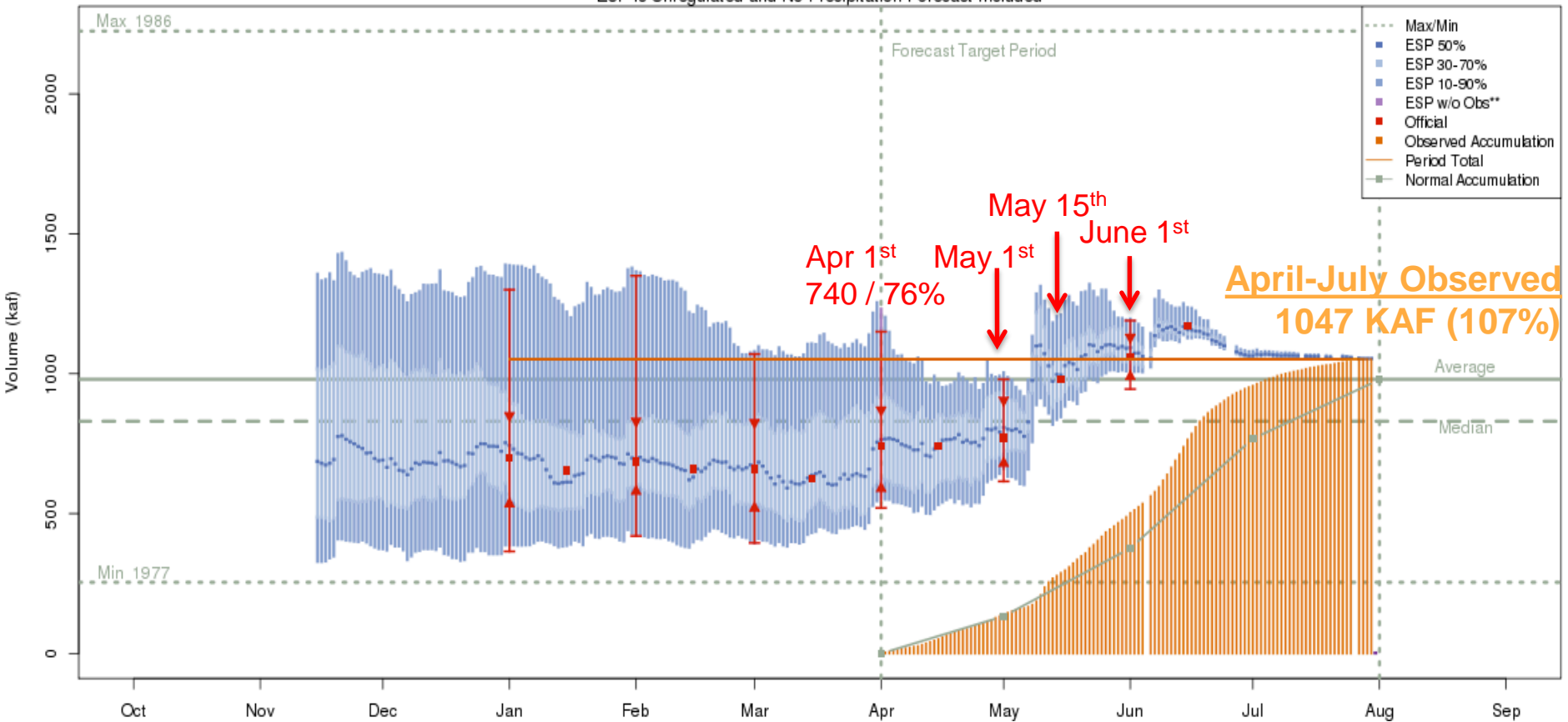
Forecast Evolution Plot

Daily Forecast of Apr-Jul Runoff Volume



Water Supply Forecasts: Flaming Gorge Reservoir

Green - Flaming Gorge Res- Flaming Gorge Dam- At (GRNU1)
 2016-06-15 Apr-Jul Official 50% Forecast: 1170 kaf (119% of average)
 ESP is Unregulated and No Precipitation Forecast Included



May 1st

Max (10%) : 980

Most (50%): 770 (79%)

Min (90%) : 615

May 15th

Most (50%): 980 (100%)

*Increase due to wet May
 (Observed flow + new snow)*

June 1st

Max (10%) : 1190

Most (50%): 1060 (108%)

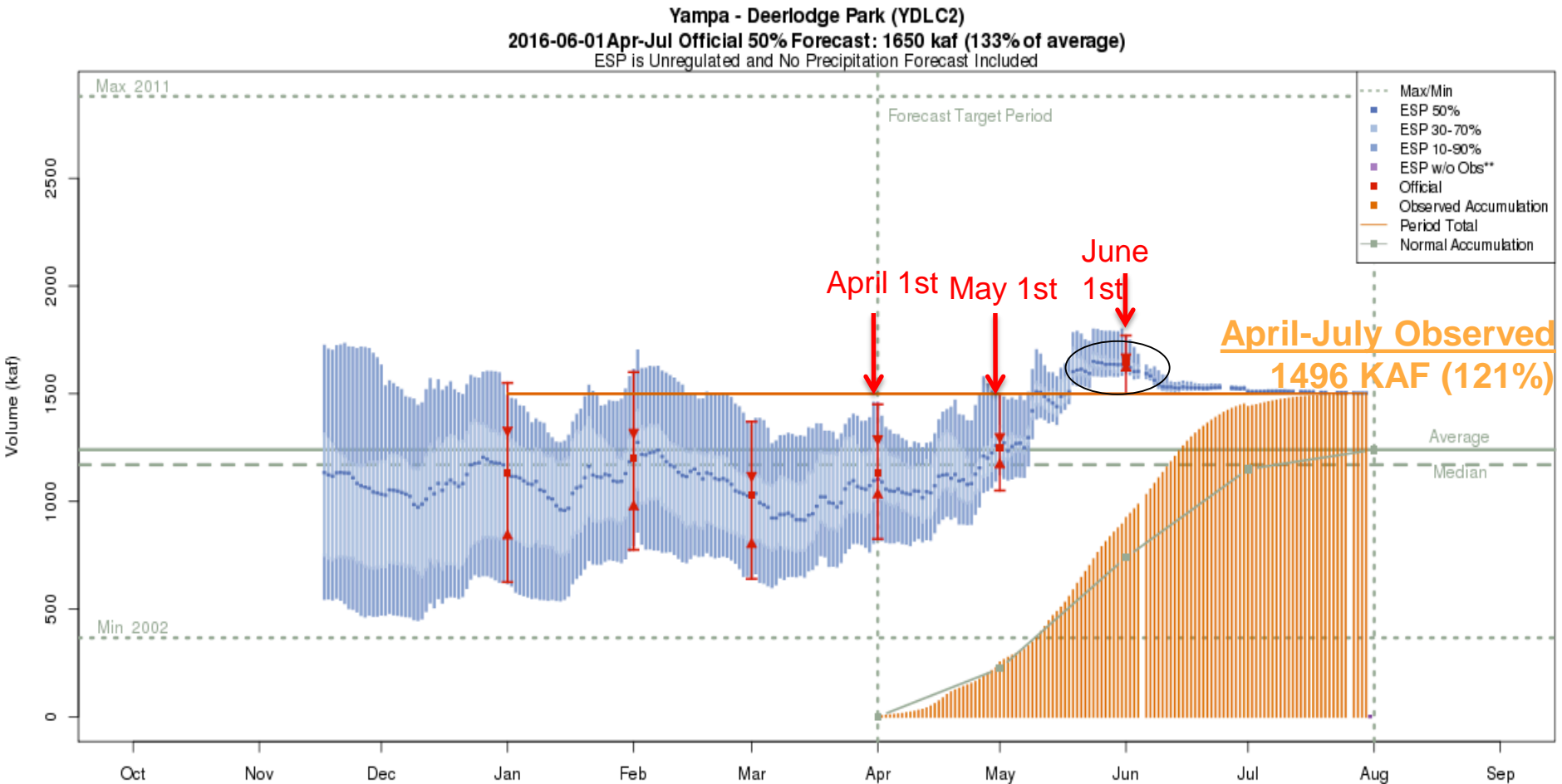
Min (90%) : 945

*Increase due to wet May
 (Observed flow + new snow)*

June 15th

Most (50%): 1170 (120%)

Water Supply Forecasts: Yampa-Deerlodge



April 1st

Max (10%) : 1450

Most (50%): 1130 (91%)

Min (90%) : 825

May 1st

Max (10%) : 1500

Most (50%): 1250
(100%)

Min (90%) : 1050

June 1st

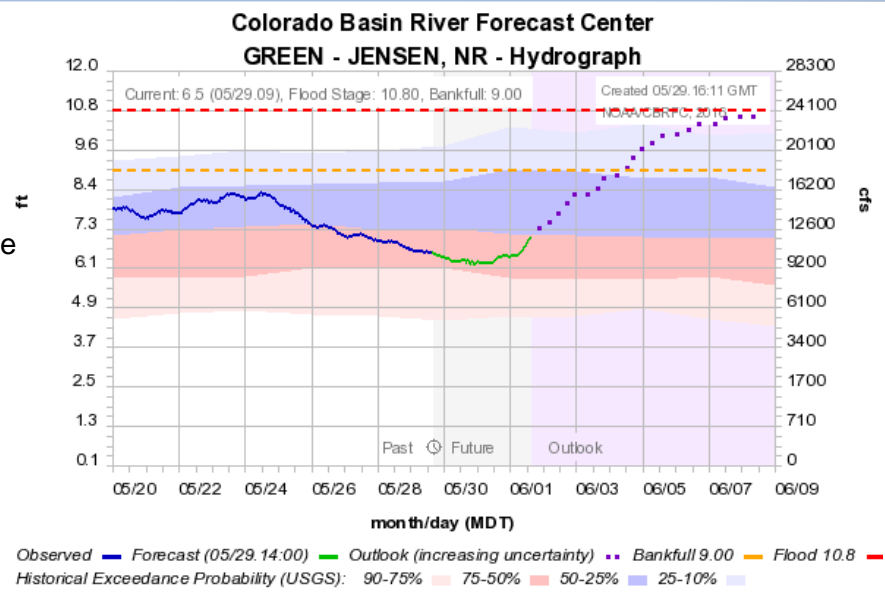
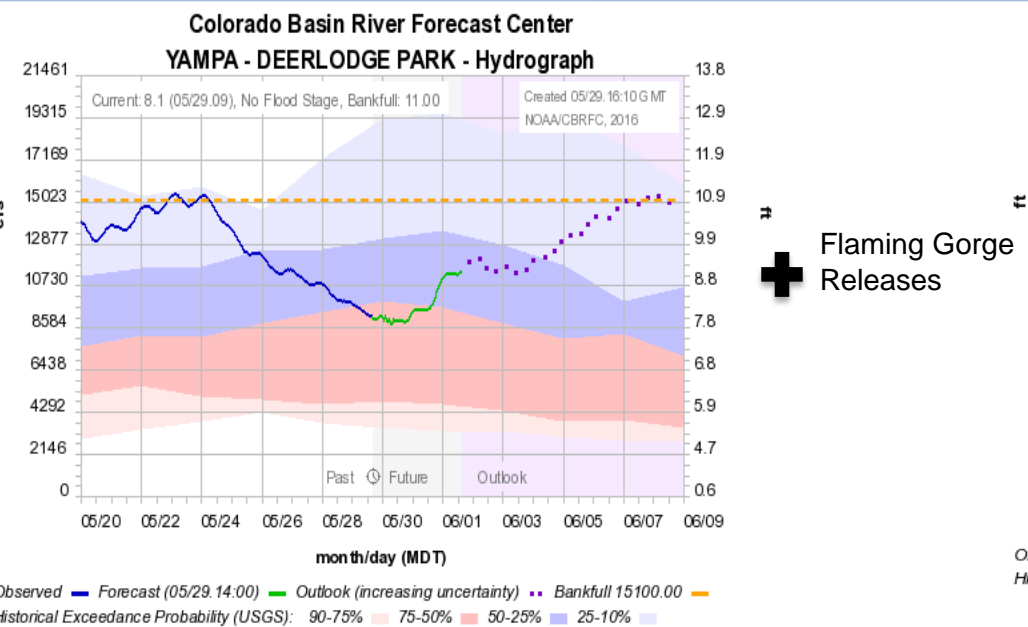
Max (10%) : 1770

Most (50%): 1650 (133%)

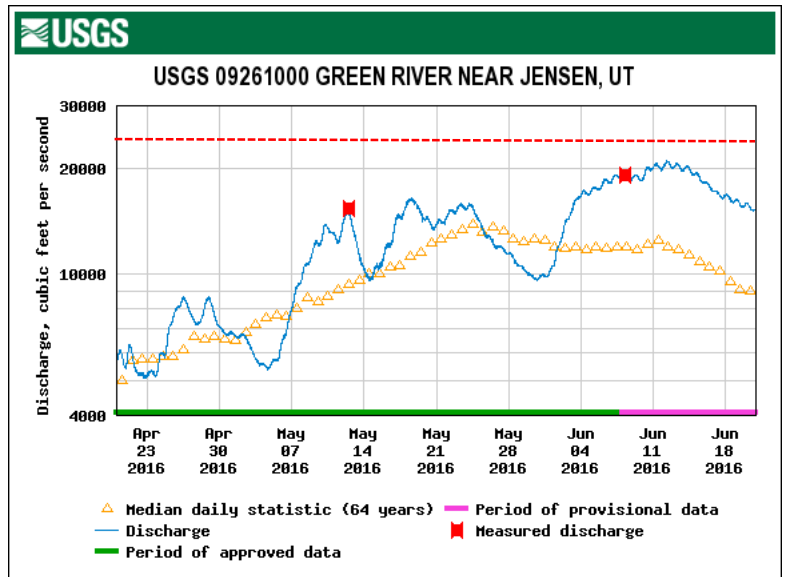
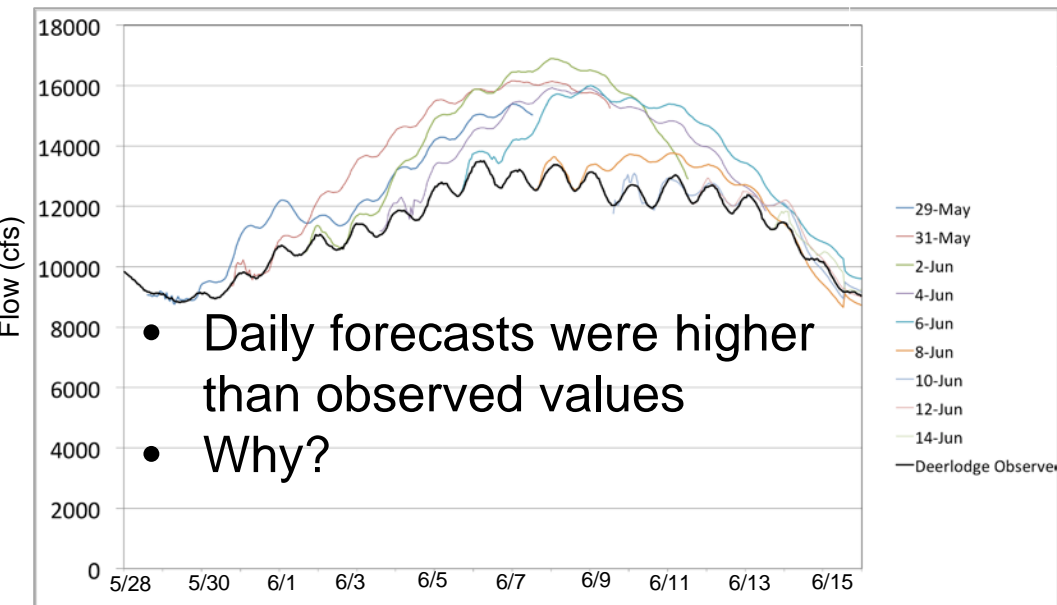
Min (90%) : 1500

*Increase due to wet May
(Observed flow + new snow)*

10-Day Streamflow Forecasts: Yampa River –Deerlodge and Green River-Jensen



Yampa Deerlodge Forecasts 5/29-6/14



What are the sources of uncertainty in the forecasts?

1. Future Weather

- Uncertainty in temperature and precipitation forecasts

2. Model Snow States

- Is the model's representation (amount and extent) of the snowpack correct?
- SNOTELS and satellite images used to verify model snow states
- Wet cold springs are especially difficult to verify snow states
 - Many SNOTELS already melted out; not useful
 - Limited satellite images due to cloud cover; not useful

3. Observed Streamflow

- USGS gage errors \pm ~5-8%

1. Demands/Diversions Assumptions

- Model makes assumptions about future diversions/demands
- Typically less than assumptions in wet springs

Today's Presentation – Questions to Answer

1. Late season water supply forecasts increased significantly
 - What happened ?
 - *Change in weather pattern in late April through May*
 - *Near record or record April-May precipitation*
 - *Delayed melt and rain resulted in efficient runoff and a long period of elevated flows*
 - How did the forecasts perform?
 - *Early season forecasts were low; June forecasts were high*
 - *Forecast range captured the observed with a few exceptions*
 - *Don't expect range to capture extremes (May precipitation)*
 - *Important to evaluate forecast range*
1. How did the Yampa - Deerlodge daily streamflow forecasts perform?
 - *Forecasts were too high*
 - *Model mostly likely had too much snow*
2. What are the sources of uncertainty in the forecasts?
 - *Future Weather*
 - *Model Snow States*
 - *Observed Data*
 - *Demand/diversions assumptions*

Questions?

