

Green and Yampa Rivers: Spring Forecast and Runoff Summary

June 23rd, 2016

Ashley Nielson-Senior Hydrologist
Colorado Basin River Forecast Center
National Weather Service/NOAA



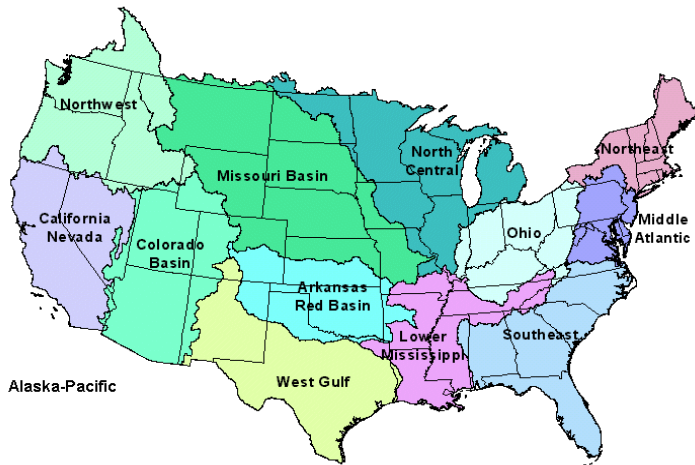
What is the Colorado Basin River Forecast Center?



Mission: To understand and predict changes in the Earth's environment...to meet our Nation's economic, social and environmental needs



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



The NWS has 13 river forecast centers defined by major river basins across the country that produce timely and accurate water forecasts to support the NWS/NOAA missions

CBRFC: Who are we?

- Forecast Areas:
 - Colorado River Basin
 - Eastern Great Basin
- Major Programs Include
 - Flood and daily river forecasts
 - Water Supply Forecasts
- 14 person staff includes meteorologists and hydrologists



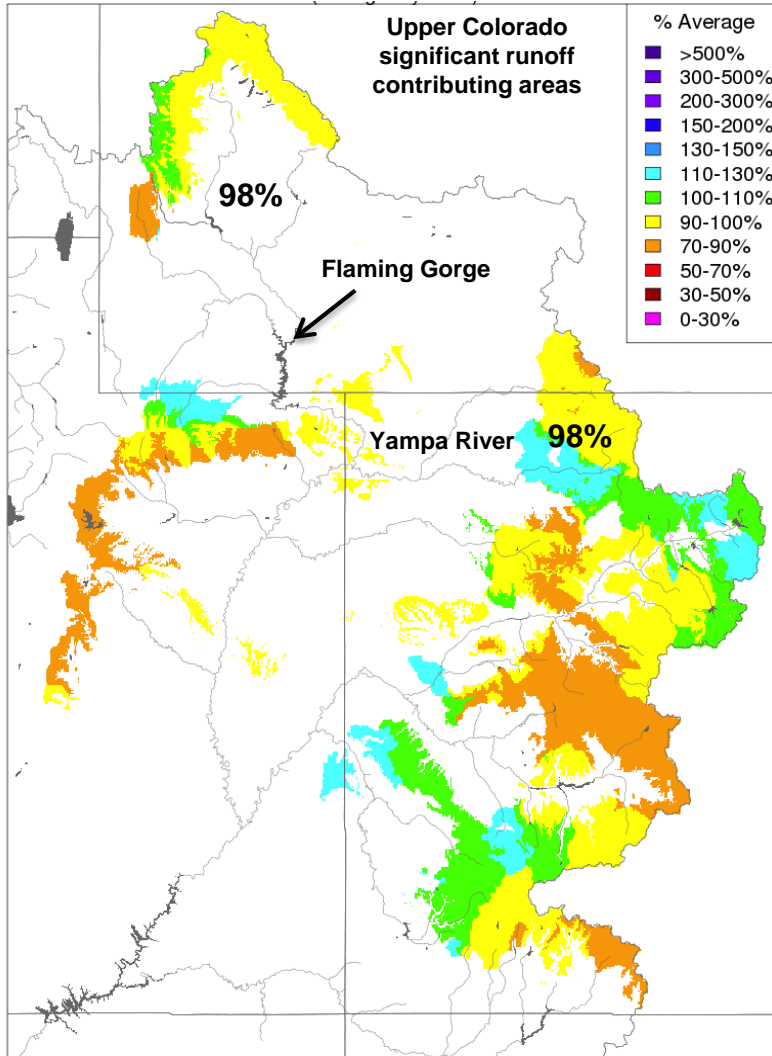
Today's Presentation – Questions to Answer

1. Late season water supply forecasts increased significantly
 - What happened ?
1. How did the Yampa - Deerlodge daily streamflow forecasts perform?
2. What are the sources of uncertainty in the forecasts?
1. How is the flood stage at Jensen determined?
 - Aldis Strautins – Service Hydrologist Grand Junction

Looking Back – Snapshot on April 1st 2016

Water Year Precipitation

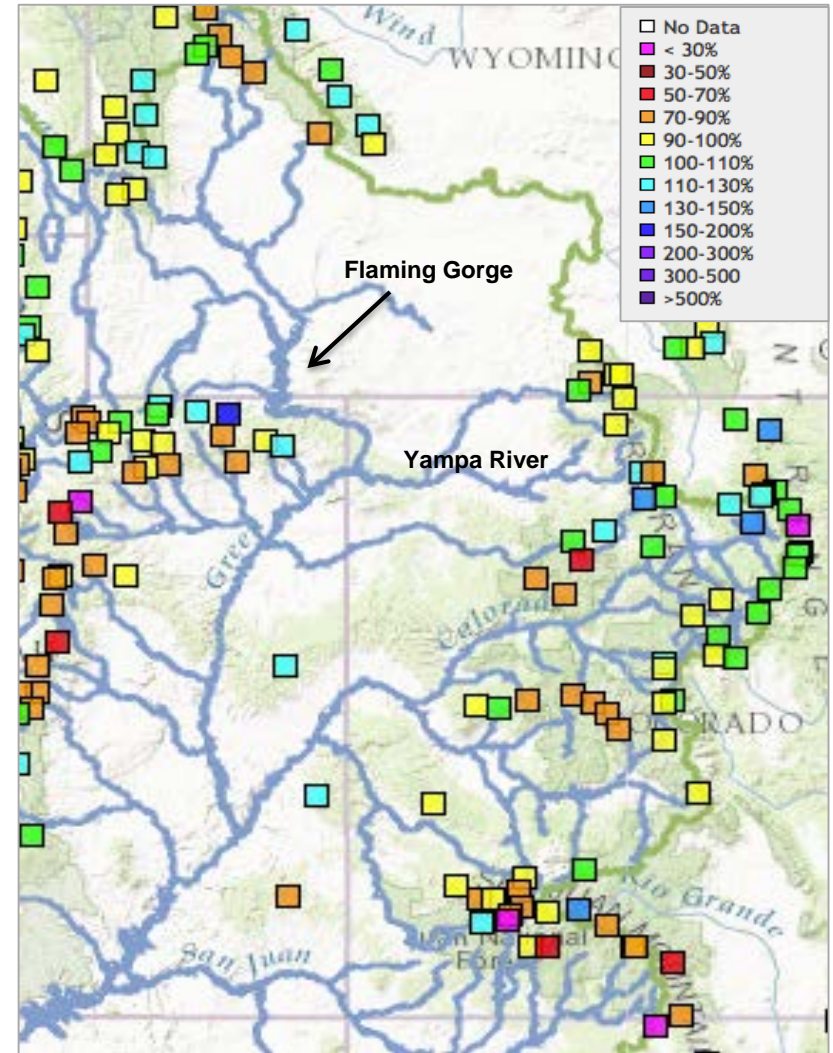
October 2015 – March 2016



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

Snow Conditions

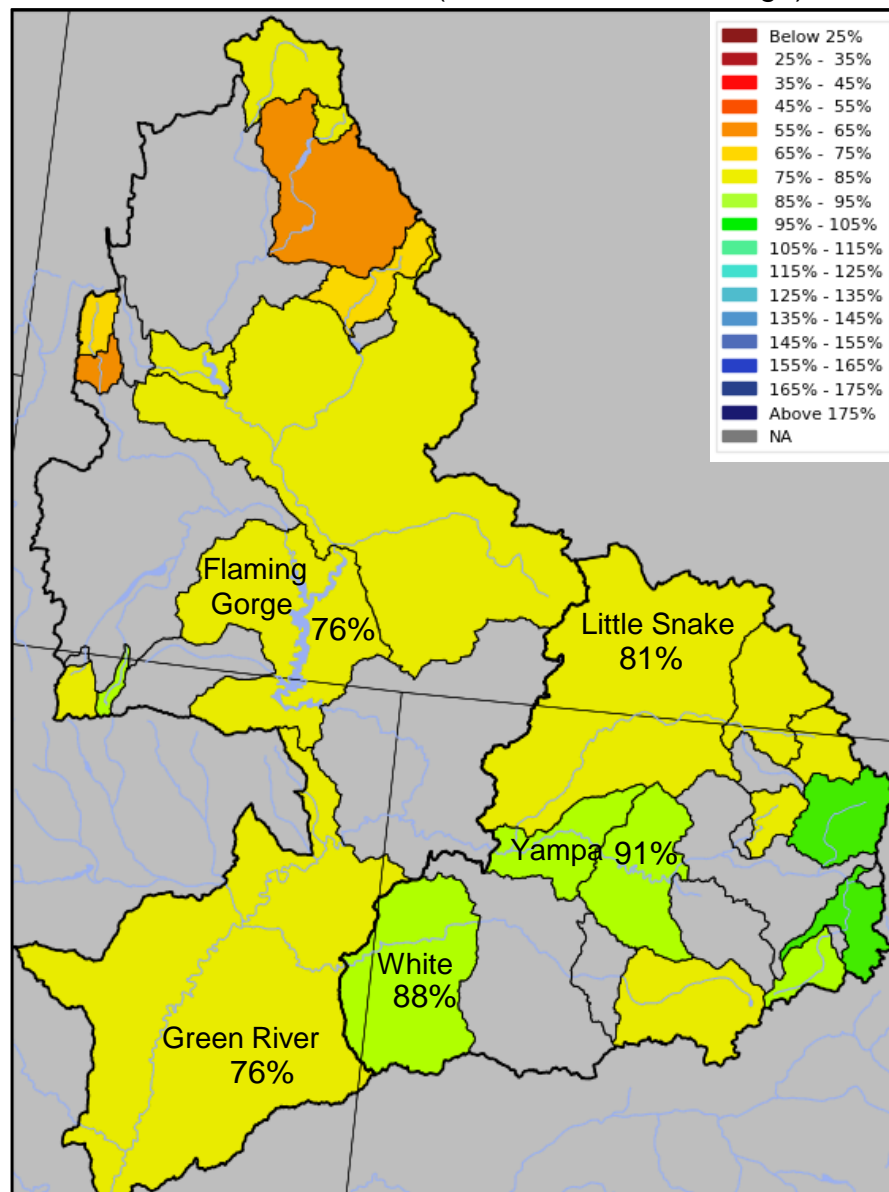
SNOTELS: % Median SWE



Looking Back – Snapshot on April 1st 2016

Water Supply Forecasts: April – July Volumes

Most Probable Scenario (% of 1981-2010 average)



- CBRFC model makes assumptions about long range future weather
- Official forecasts provide a range of possible outcomes based on “dry”, “average”, and “wet” weather scenarios
- “Average” scenario is most commonly used forecast

April 1st Flaming Gorge Forecasts:

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

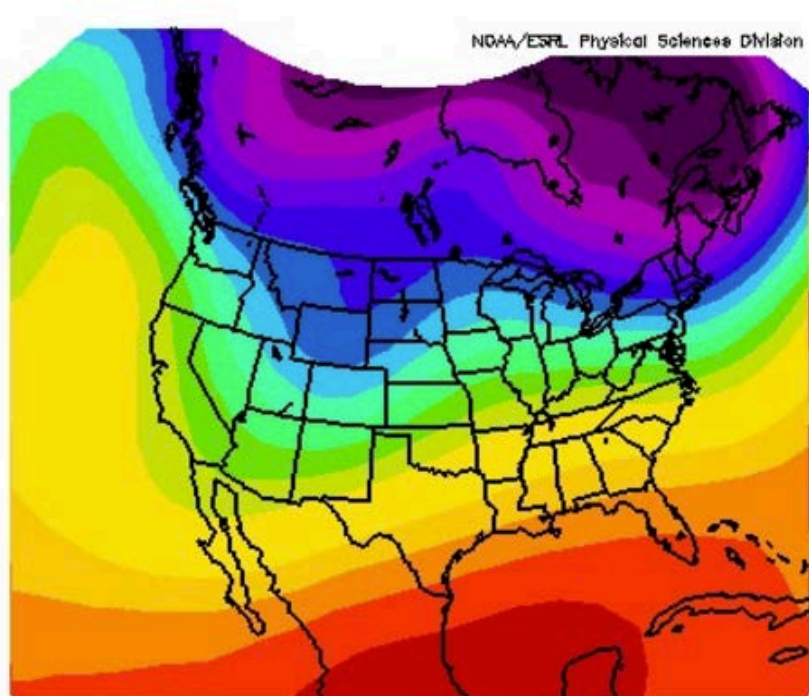
April 1st Yampa River Forecasts:

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

What happened after April 1st?

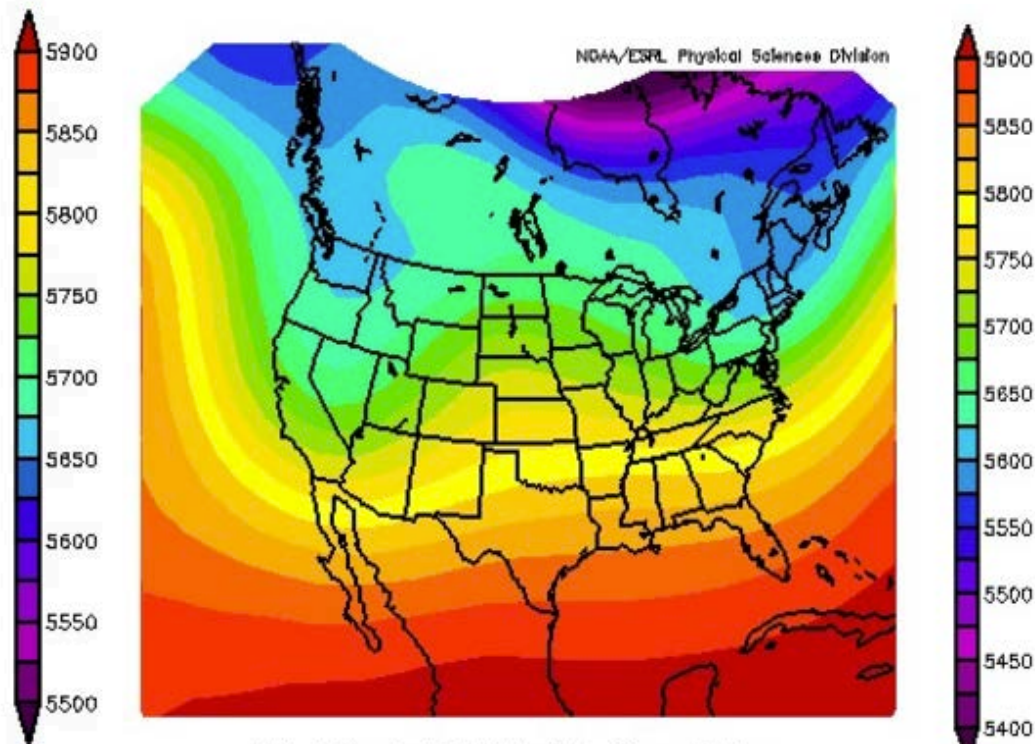
- Weather pattern shifted in late April and carried through May
- Series of slow moving low pressure systems

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



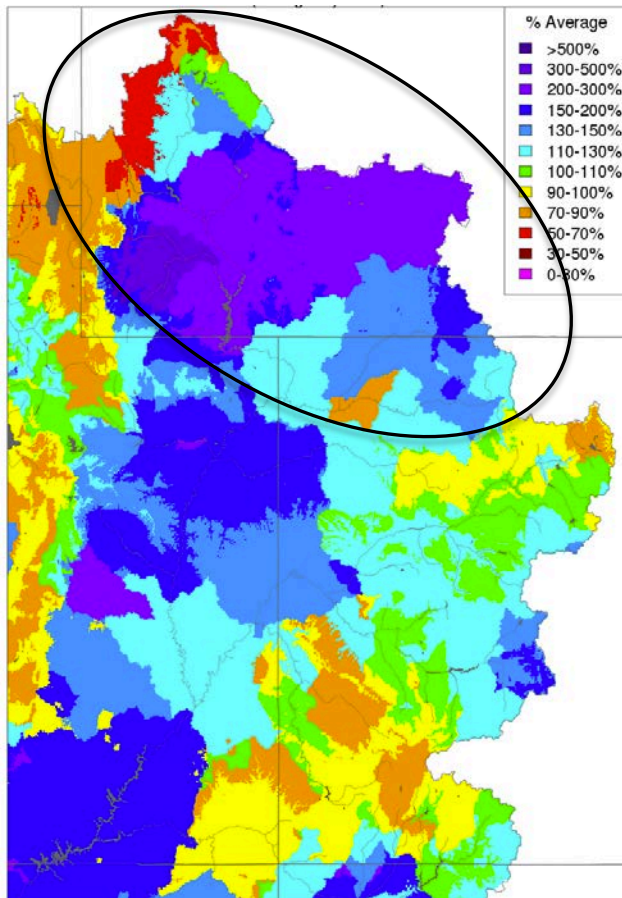
500mb Geopotential Heights (m) Composite Mean
5/15/16 12z to 5/25/16 12z
NCEP/NCAR Reanalysis

May 15 – May 25

What happened after April 1st?

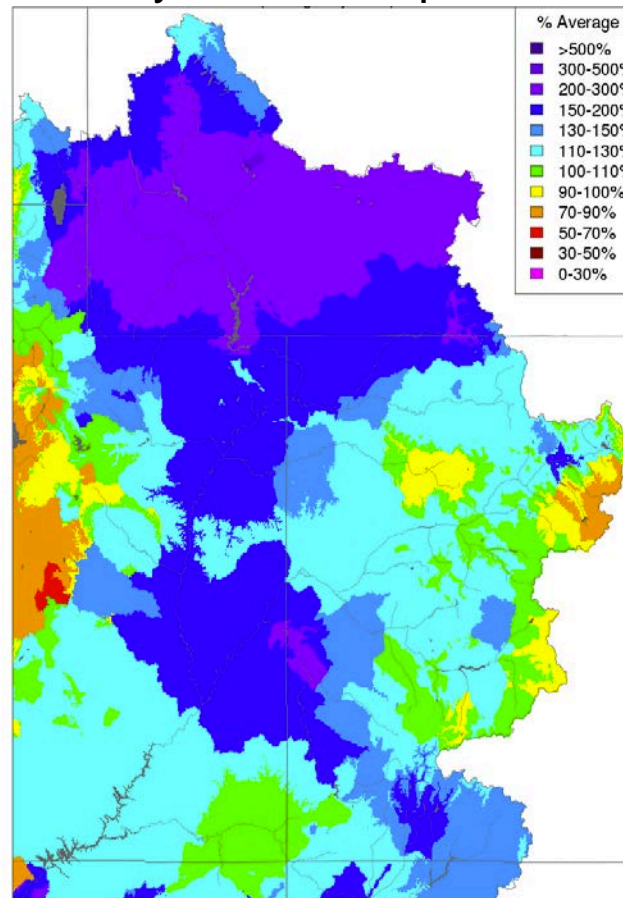
- Storms brought significant rain and snow to Green and Yampa River basins
- Much above average precipitation for April and May
- Much below average temperatures for May

April 2016 Precipitation



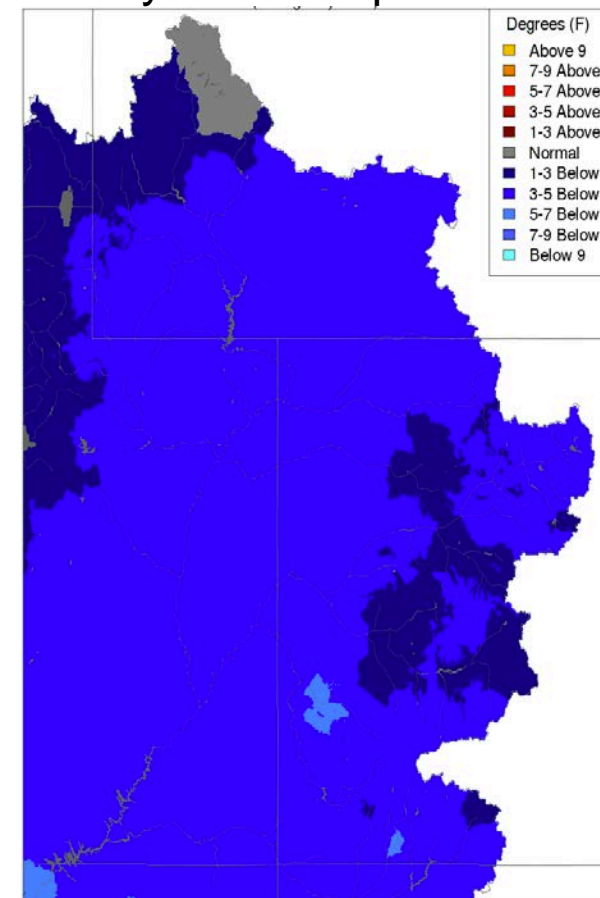
Prepared by NOAA, Colorado Basin River Forecast Center
Salt Lake City, Utah, www.cbrfc.noaa.gov

May 2016 Precipitation



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

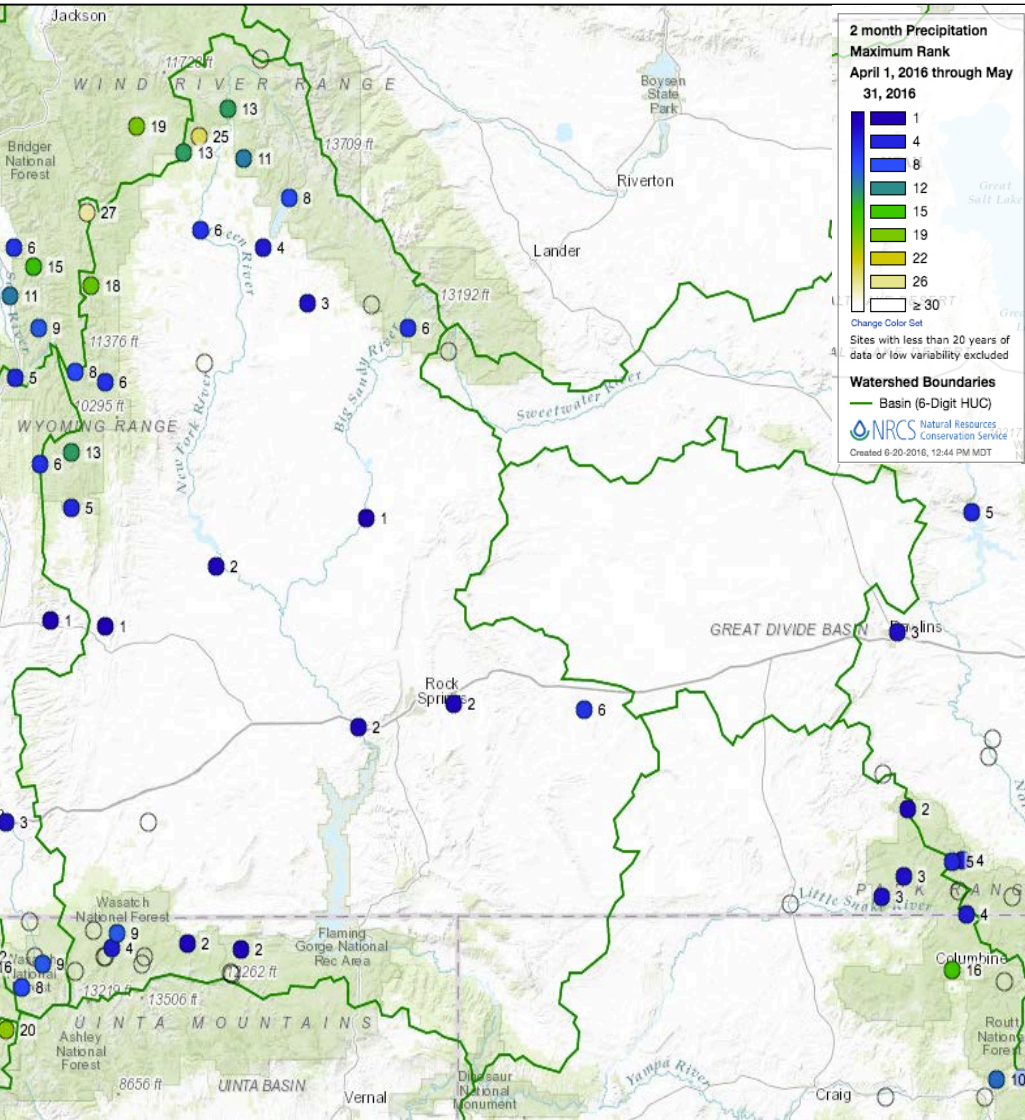
May Max Temperature



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



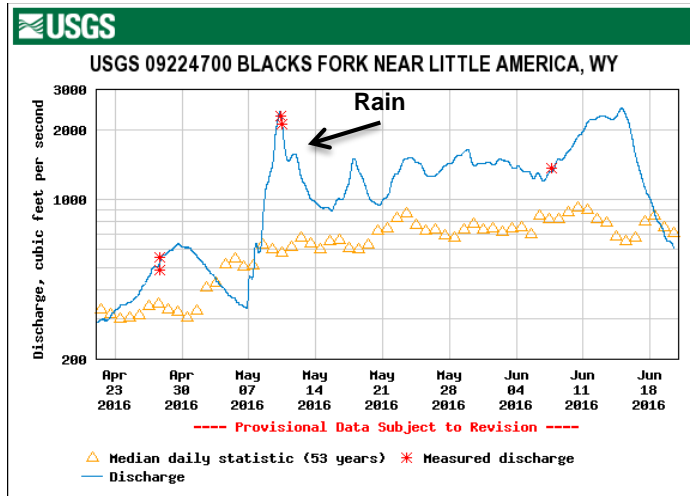
- April-May precipitation at many locations was in the top 3 of the historical record

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%

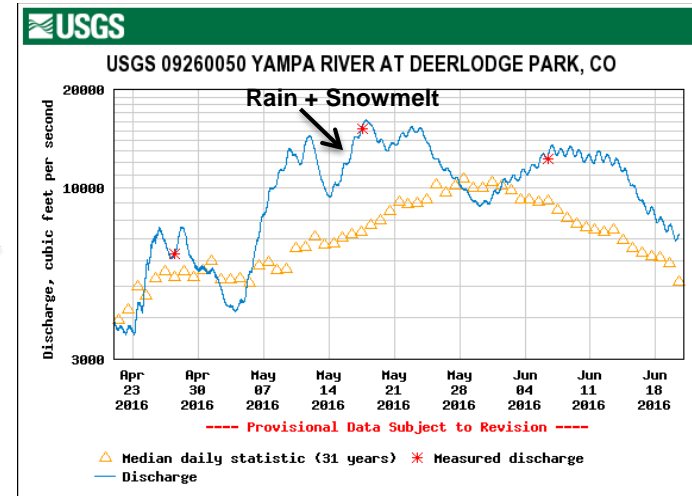
What were the impacts?

- Significant rises in streamflow from precipitation events*

Upper Green →

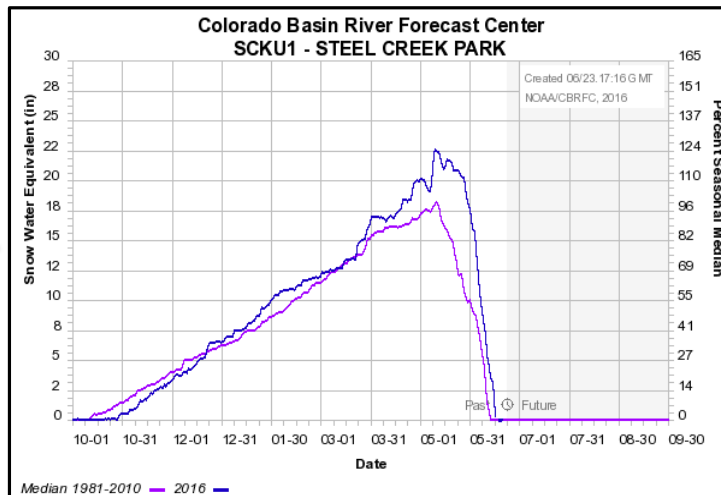


Yampa →

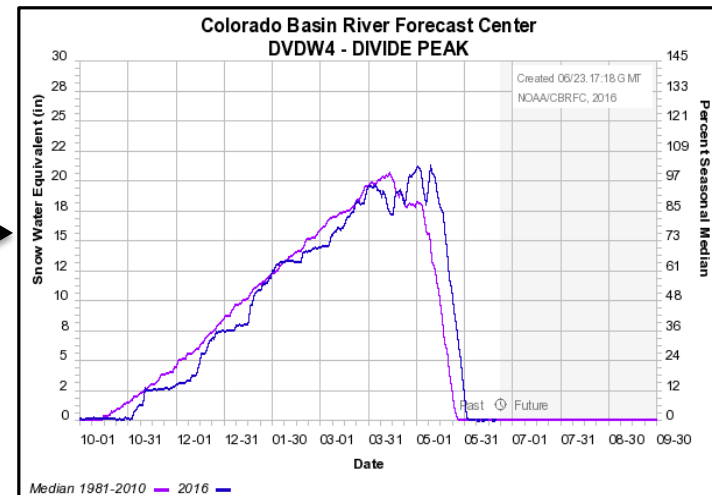


- Increase in snowpack and delay of melt and runoff*

Upper Green →

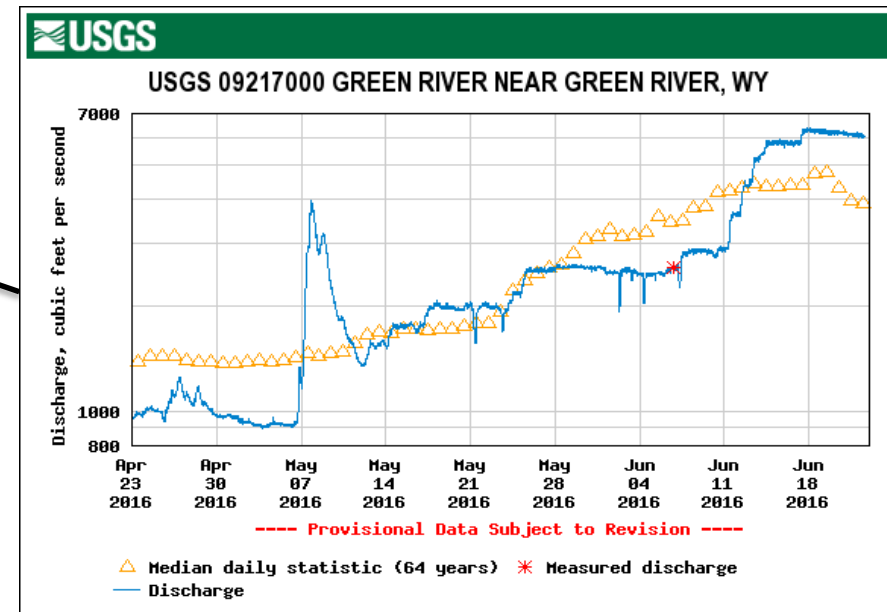
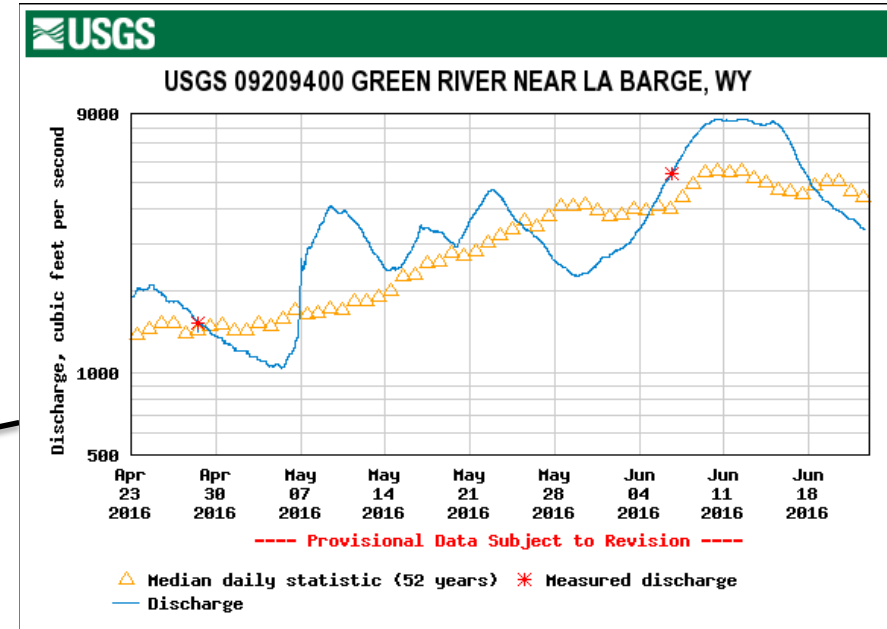
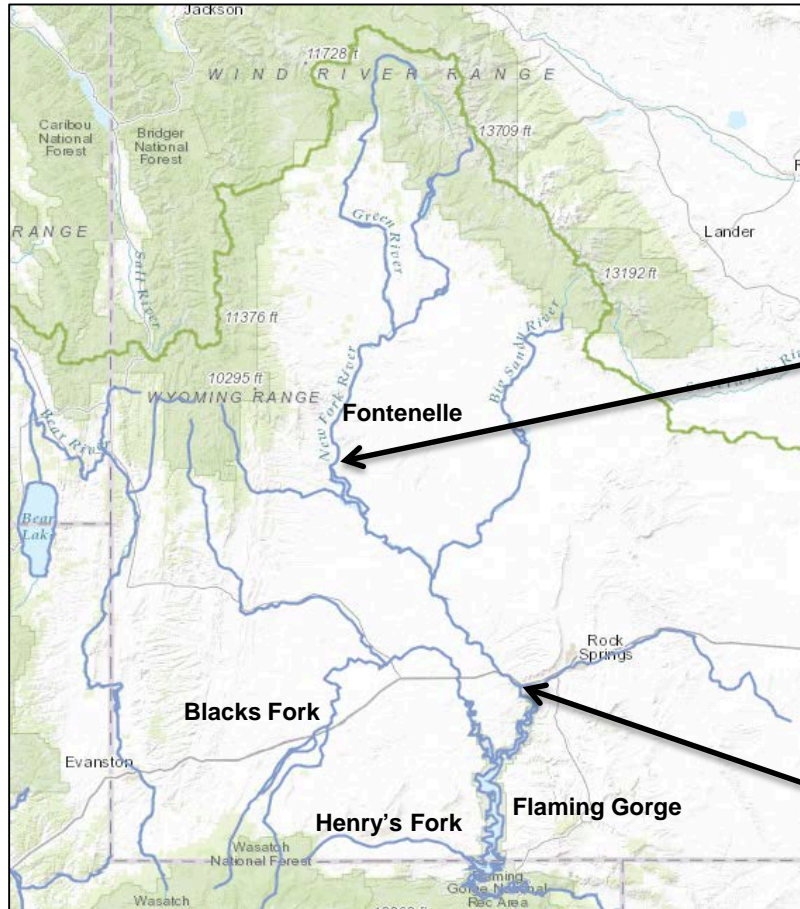


Yampa →



What were the impacts?

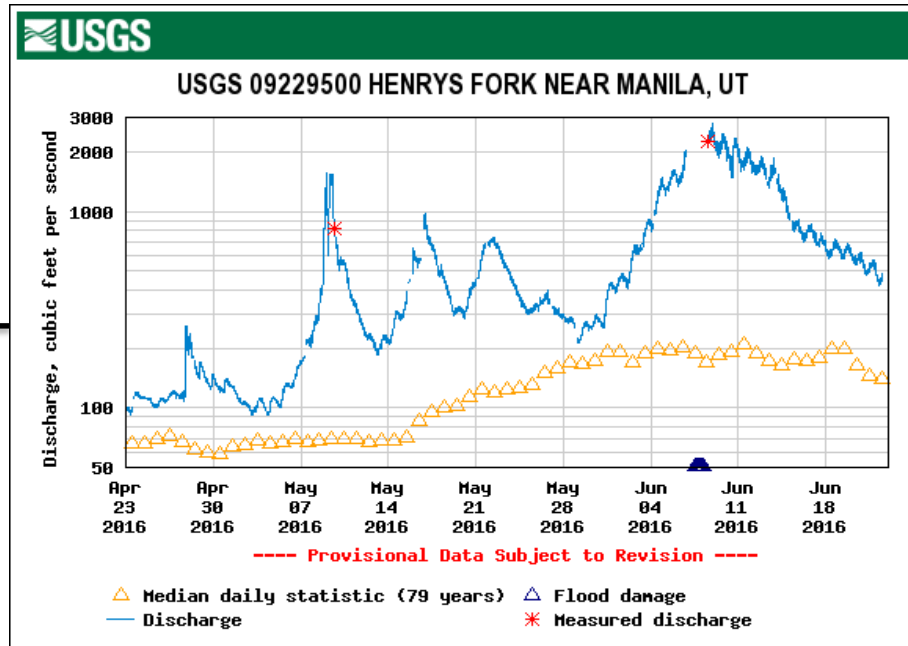
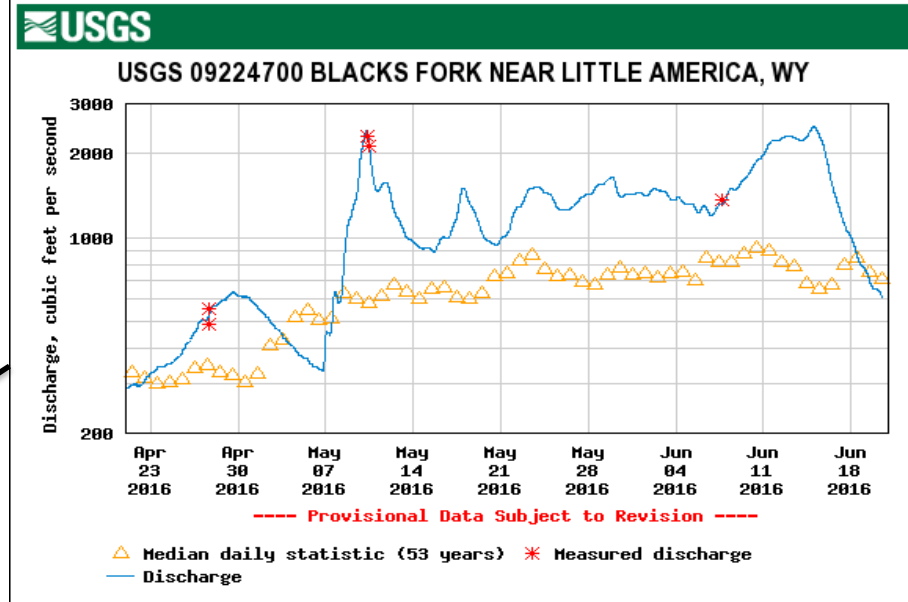
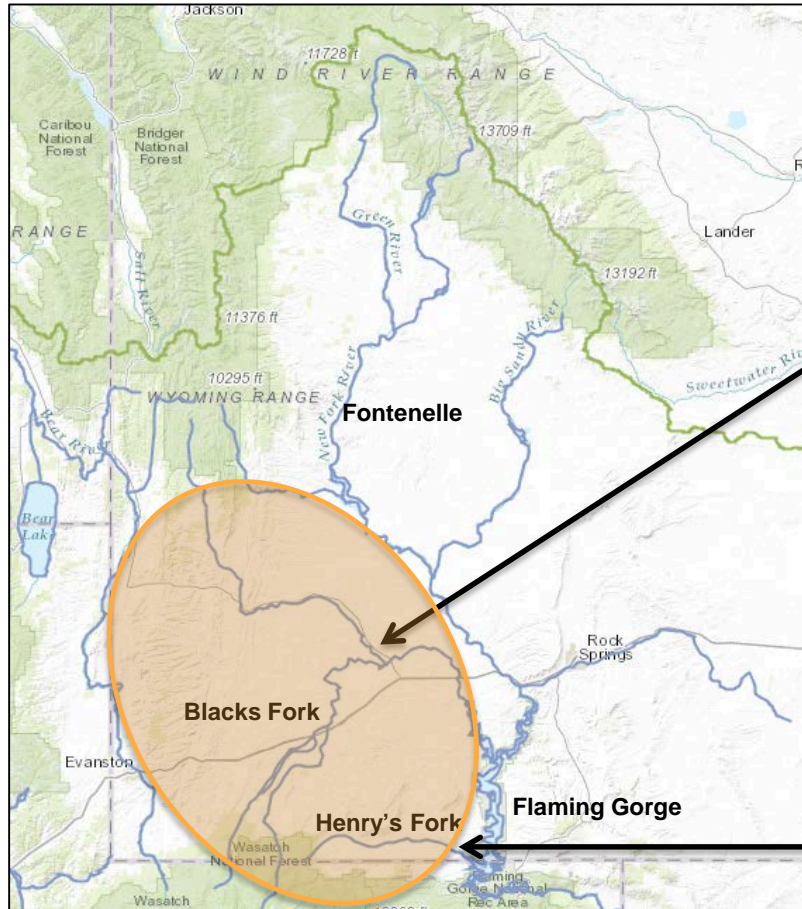
- Extended period of high flows*



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

What were the impacts?

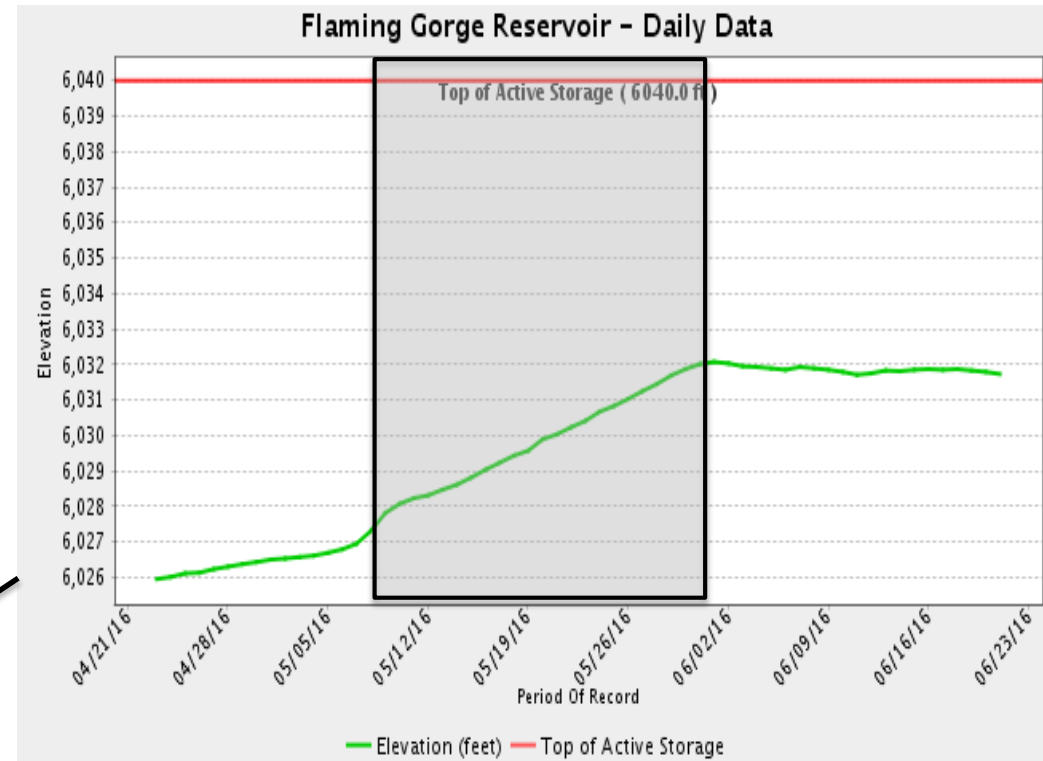
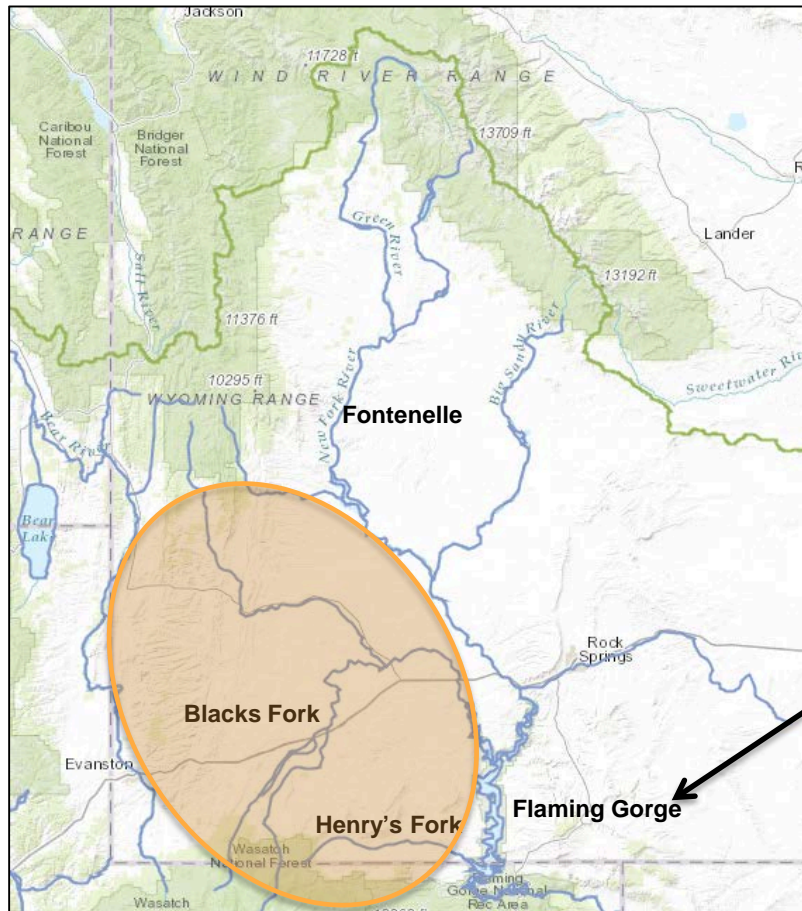
- Extended period of high flows



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

What were the impacts?

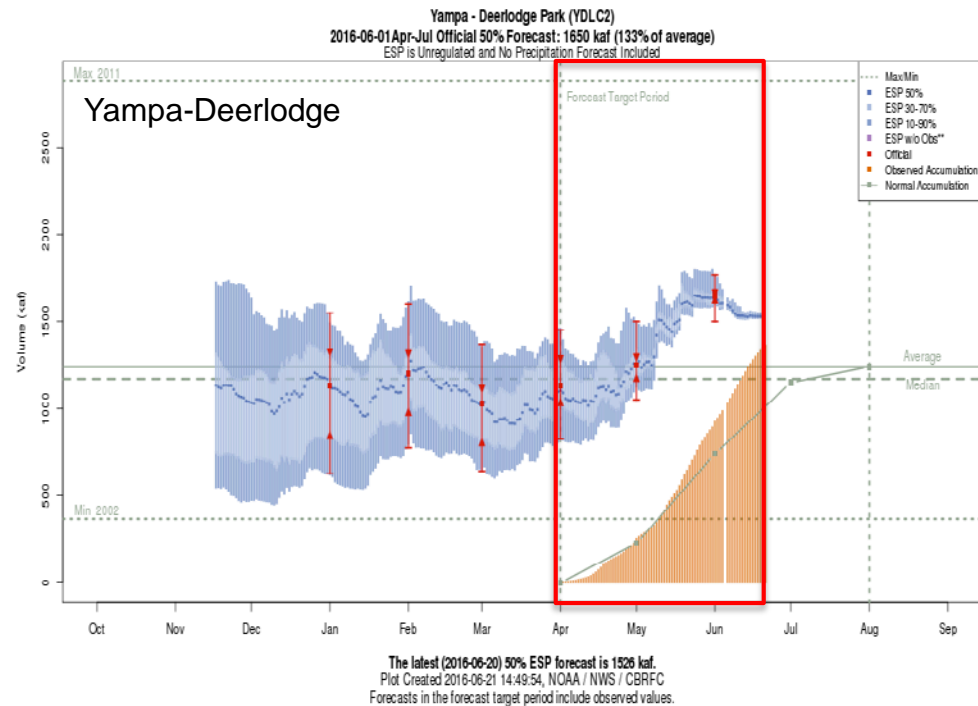
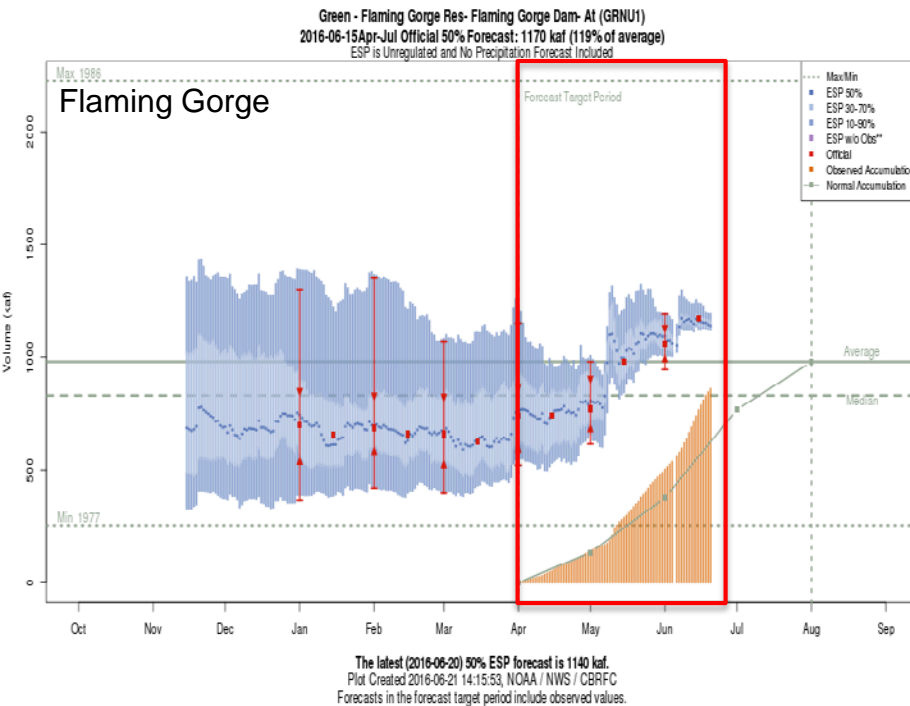
- Extended period of high flows increased Flaming Gorge elevations*



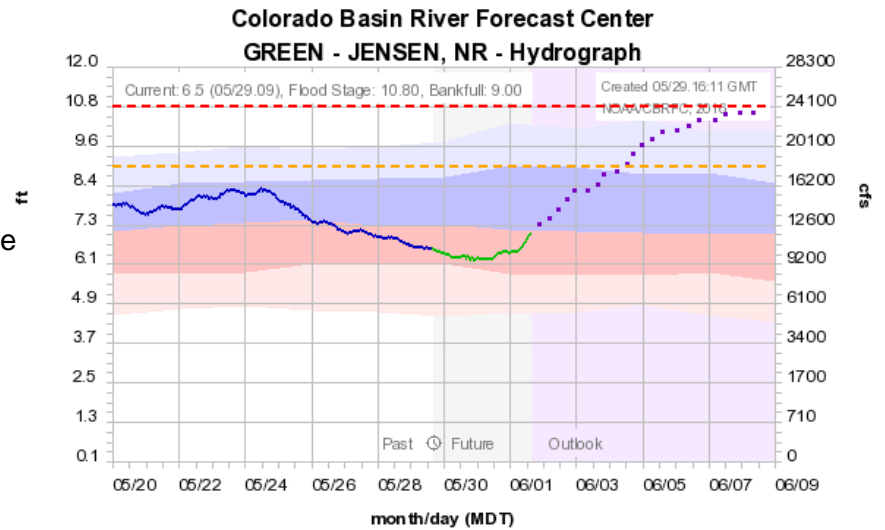
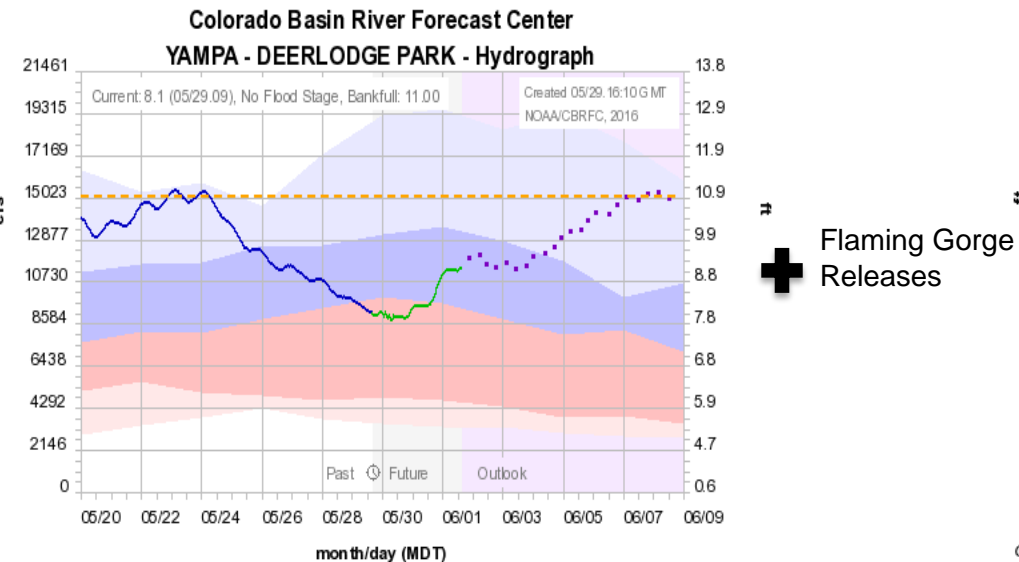
- A significant amount of inflow during May and early June was from the area below Fontenelle reservoir including Blacks Fork, Henry's Fork, and other tributaries
- Typically this area does not contribute significant flows

What were the impacts?

- April-July water supply forecasts increased on May 1st and June 1st*

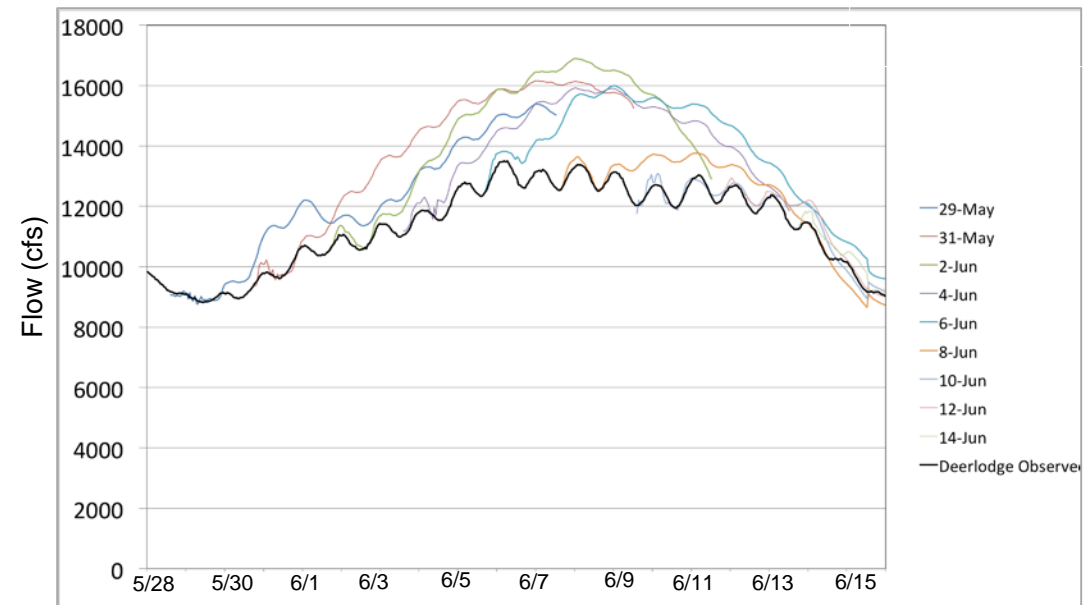


10-Day Streamflow Forecasts: Yampa River –Deerlodge and Green River-Jensen



Observed — Forecast (05/29.14:00) — Outlook (increasing uncertainty) — Bankfull 9.00 — Flood 10.8 —
Historical Exceedance Probability (USGS): 90-75% 75-50% 50-25% 25-10%

Yampa Deerlodge Forecasts 5/29-6/14



- Daily forecasts were higher than observed values
- Why?

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 melted and rain resulted in efficient runoff and a long period of elevated flows*
- *Important to evaluate forecast range (dry, average, wet scenarios)*

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?



NWS Critical Levels Green River- Jensen



National Weather Service River Critical Levels

Critical levels are defined by local NWS Service Hydrologists so flood watches and warnings can be issued.

- **Bankfull Stage:** *established gage height at a given location above which a rise in water surface will **cause the river to overflow the lowest natural stream bank***
- **Flood Stage:** *established gage height for a given location at which a **rise in water surface level begins to impacts lives, property, or commerce.***
 - **Minor Flooding:** *minimal or no property damage but possible public threat (roads, etc)*
 - **Moderate Flooding:** *some inundation of structures and roads near stream. Some evacuations of people and/or transfer of property to higher elevations*
 - **Major Flooding:** *extensive inundation of structures and roads. Significant evacuations/transfers.*

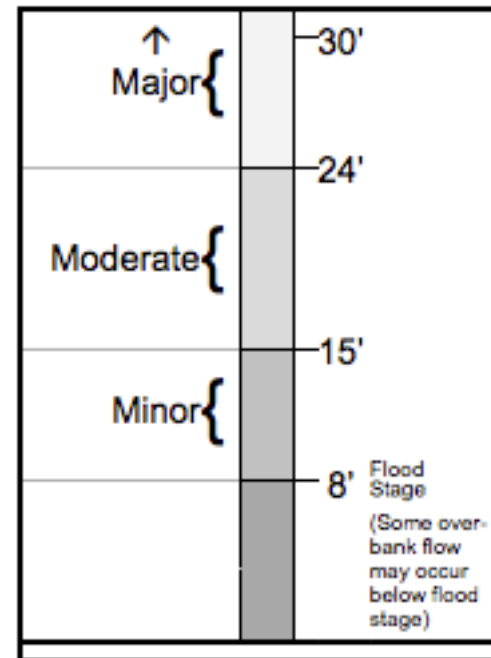


Figure 1. *Stage - flood category relationship.*

National Weather Service River Critical Levels

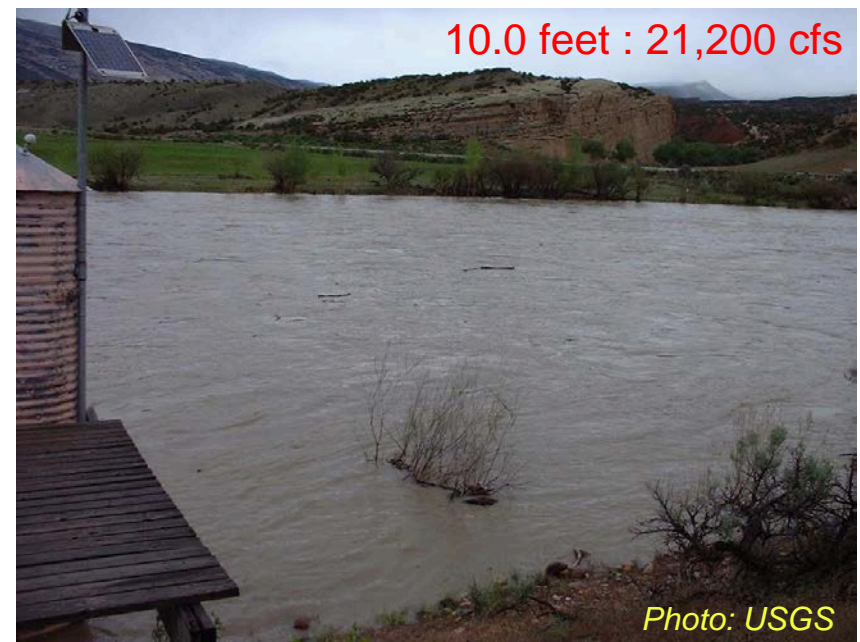
Green River near Jensen

Bankfull Stage = 9.0 feet ^{Current USGS Rating Table} → ~18,100 cfs

Flood Stage = 10.8 feet → ~24,000 cfs

Moderate = 12.0 feet → ~28,400 cfs

Major = 14.0 feet → ~36,000 cfs



National Weather Service River Critical Levels

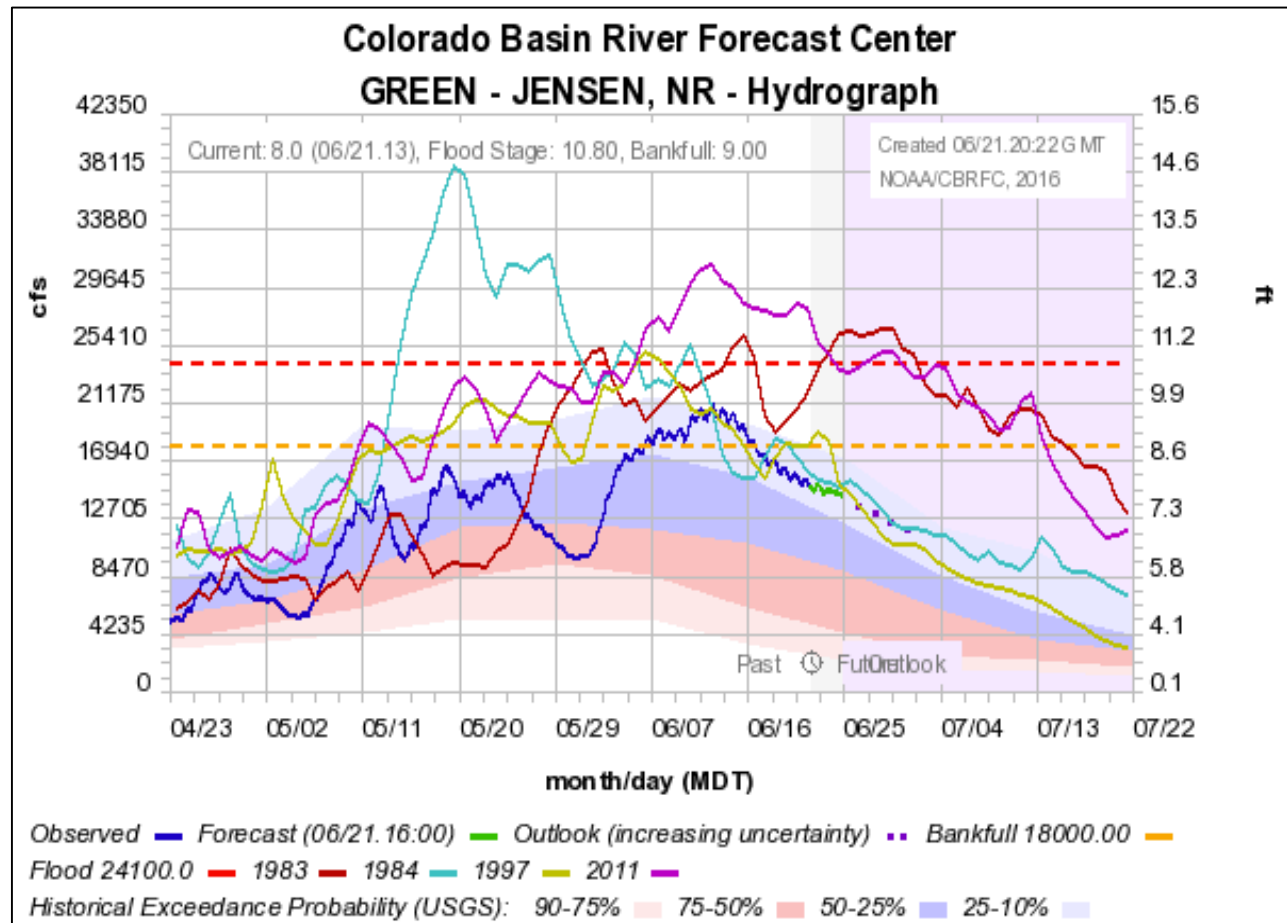
Green River near Jensen

Current USGS Rating Table

Bankfull Stage = 9.0 feet → ~18,100 cfs

Flood Stage = 10.8 feet → ~24,000 cfs

Years since 1980 > Flood Stage
1983
1984
1997
2011



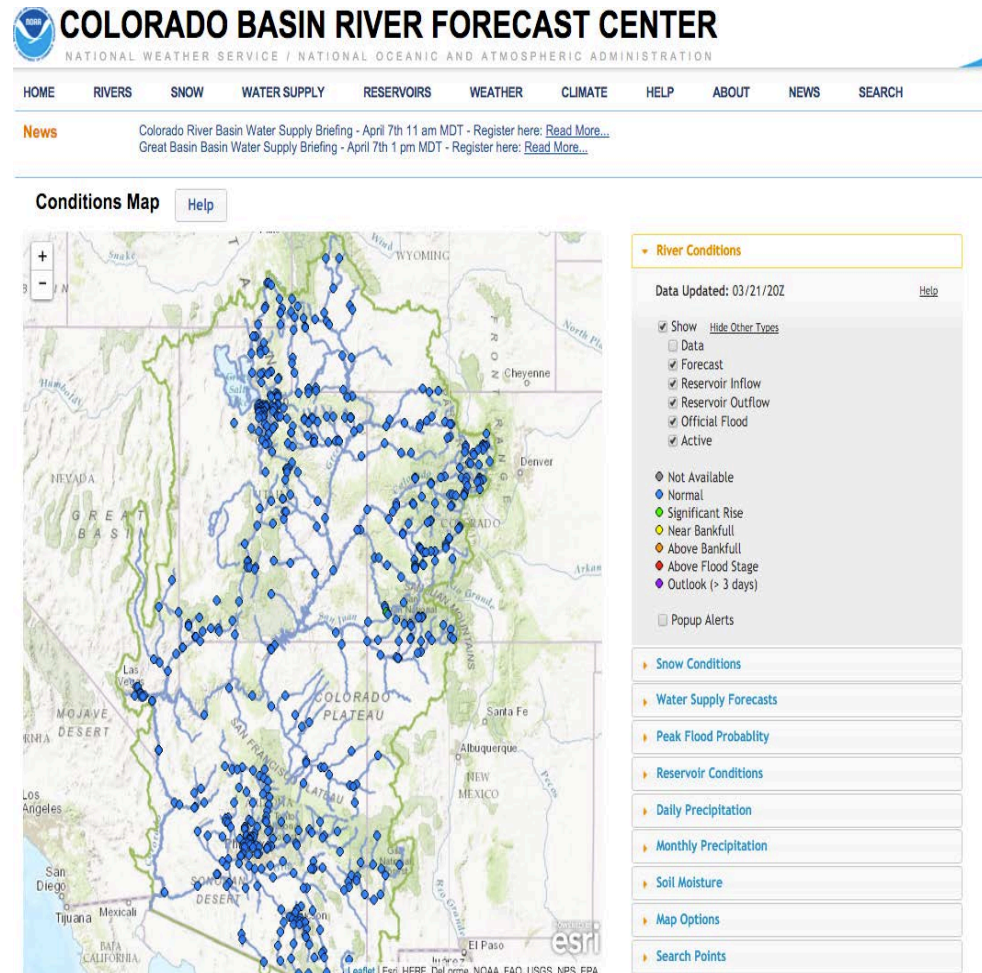
Contact Us!

- Ashley Nielson-Green River Forecaster

- ashley.nielson@noaa.gov
- 801-524-5130 x333

- Aldis Strautins-Service Hydrologist

- aldis.strautins@noaa.gov
- 970-256-9463



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Extra Slides



Why is the Flaming Gorge forecast only ~75 % of average when the snowpack is near normal?

1. Dry fall soil moisture conditions

- Can impact spring runoff efficiency
- Negative impact on the forecasts

2. High elevation snow conditions are not as good

- Rain rather than snow in Fall, normally snow
- SNOTELS don't represent this area
- Largest contributing area for water supply

3. Distribution of snow in contributing areas

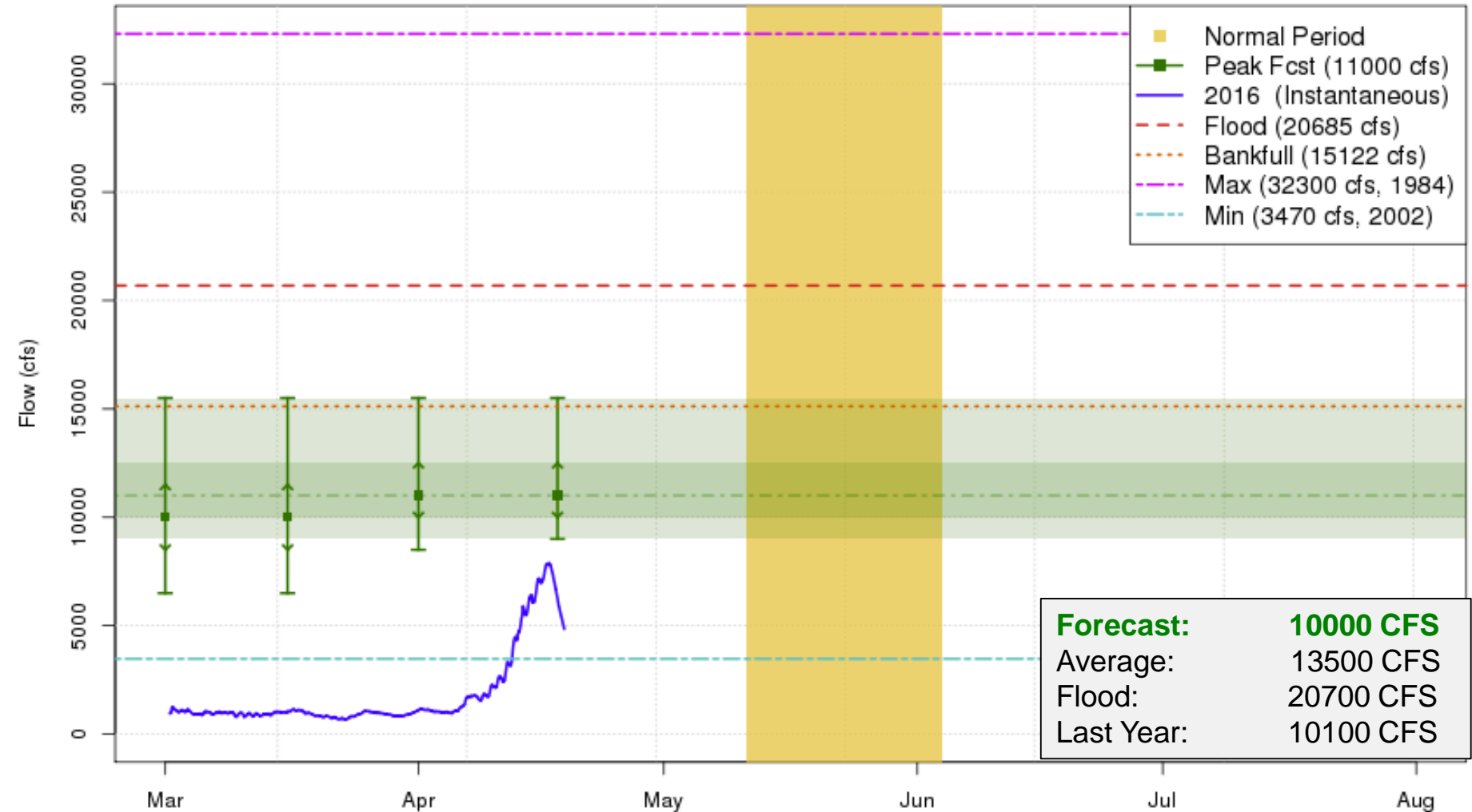
- Flaming Gorge Inflow = Green River + Local (Hams Fork, Uintas, Big Sandy)
- Green River = ~80% Local = ~20%
 - Green River Breakdown

Wind Rivers → Below normal snow → ~75-80% of inflow

Wyoming Range → Normal snow → ~20-25% of inflow

Peak Flow Forecast: Yampa River-Deerlodge

2016 Mean Daily Peak Flow Forecast
Yampa - Deerlodge Park (YDLC2)



These graphics are updated approximately every two weeks between 3/1 and 5/1

Plot Created 2016-04-18 15:24:45
CBRFC / NWS / NOAA