Colorado River Basin Water Supply Briefing

March 5, 2021

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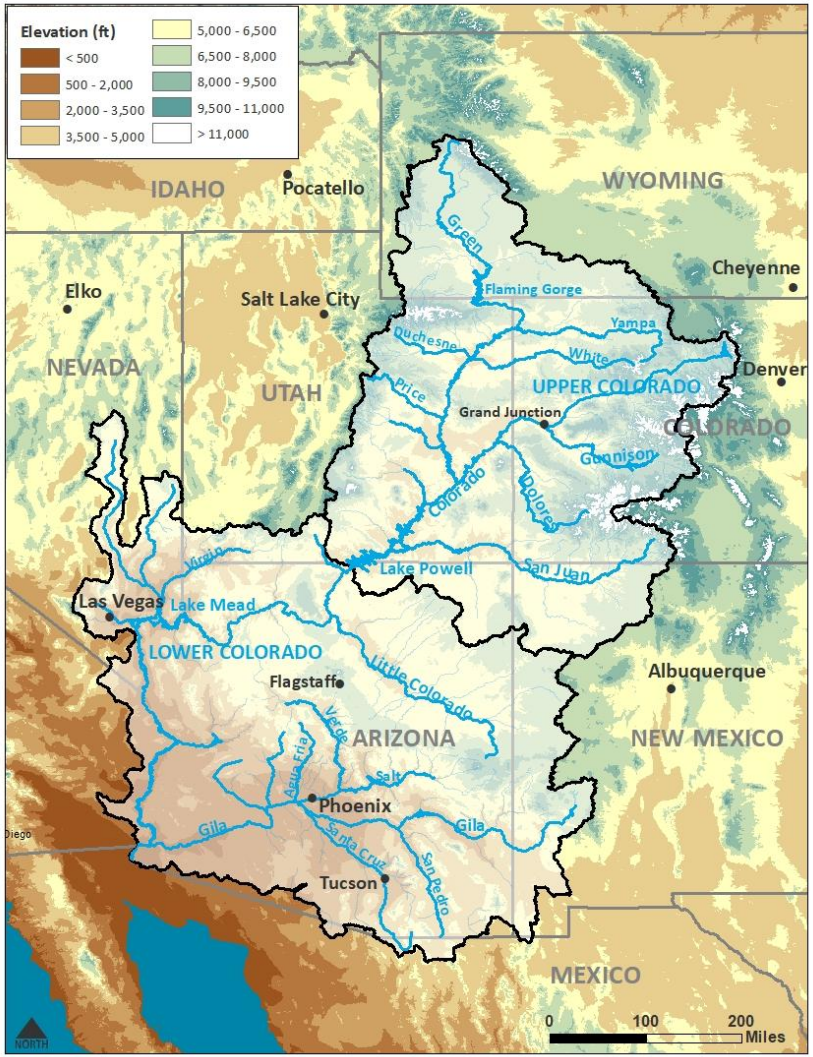
Colorado Basin River Forecast Center

Please mute your phone until the question period



Today's Presentation

Precipitation Review

Soil Moisture Conditions

Current Snowpack

2021 Water Supply Forecasts

March Forecast Error

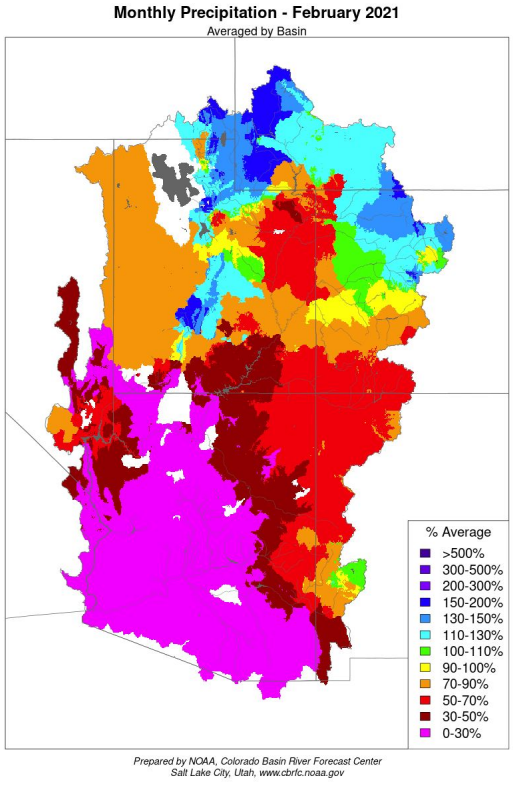
Upcoming Weather

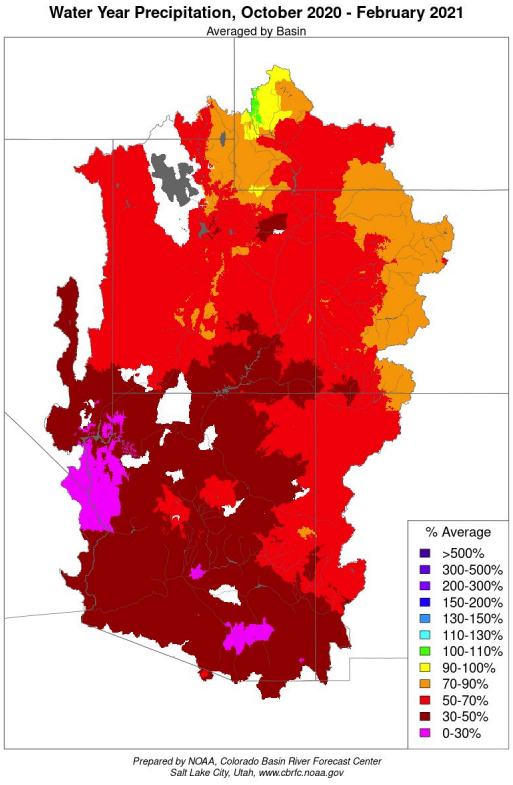
CBRFC Hydro Science Update

Contacts & Questions

Webinar recording & slides will be made available on CBRFC webpage

Precipitation Summary





Northern basins benefited the most from northwesterly flow and multiple storm systems

Water Year 2021
Oct-Feb Precip Summary

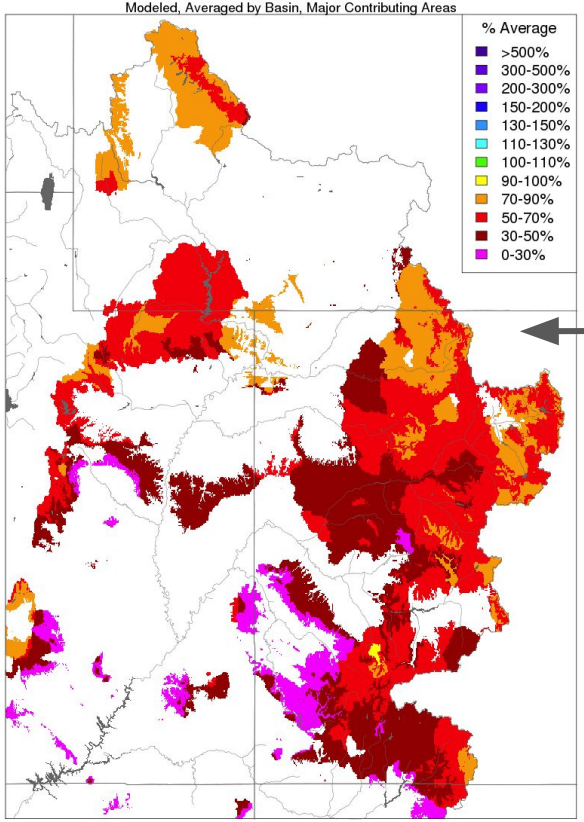
Basin	Precip (% Avg)
Upper Green	85%
Duchesne	65%
Price/San Rafael	70%
Yampa/White	80%
Upper CO Mainstem	75%
Gunnison	75%
Dolores	65%
San Juan	75%
Lake Powell	75%
Virgin	55%
Verde	45%
Salt	50%
Little Colorado	50%
Upper Gila	55%

Soil Moisture Conditions

Upper Colorado River Basin

Soil Moisture - Fall - 2020 (November 15)

Modeled, Averaged by Basin, Major Contributing Areas



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

Water supply impacts are most pronounced when soil moisture conditions and snowpack conditions are both much above or much below average.

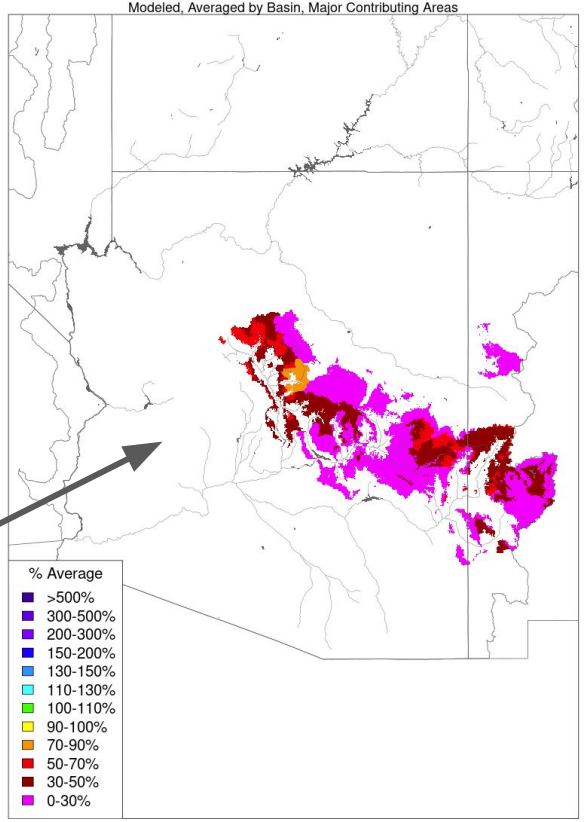
Model soil moisture is generally in the bottom 5 across the Upper Colorado over the 1981-2020 40-year period. The San Juan and Dolores are generally in the bottom 3 with some areas being record dry.

After a dry February over much of Arizona, soil moisture conditions still remain below to much below average.

Lower Colorado River Basin

Soil Moisture - March 03 2021

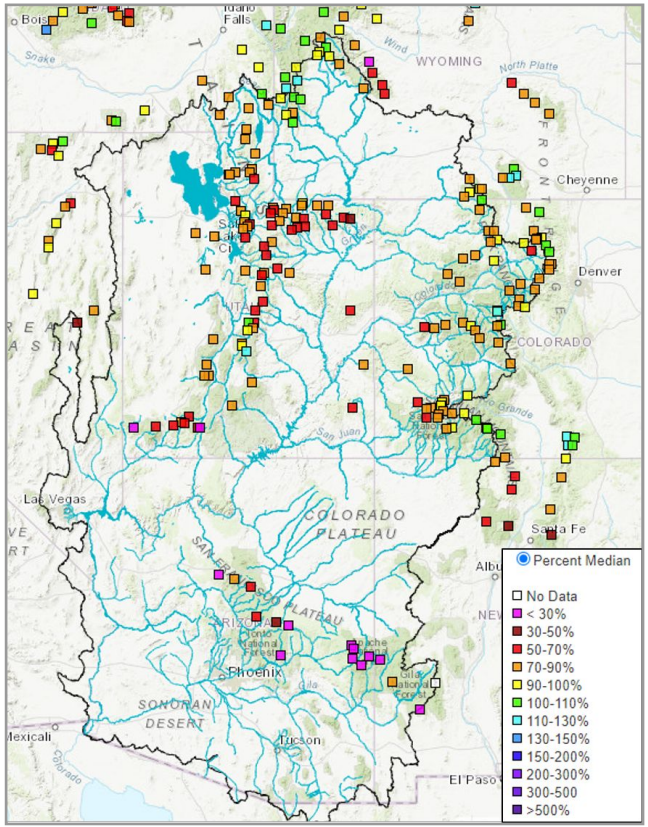
Modeled, Averaged by Basin, Major Contributing Areas



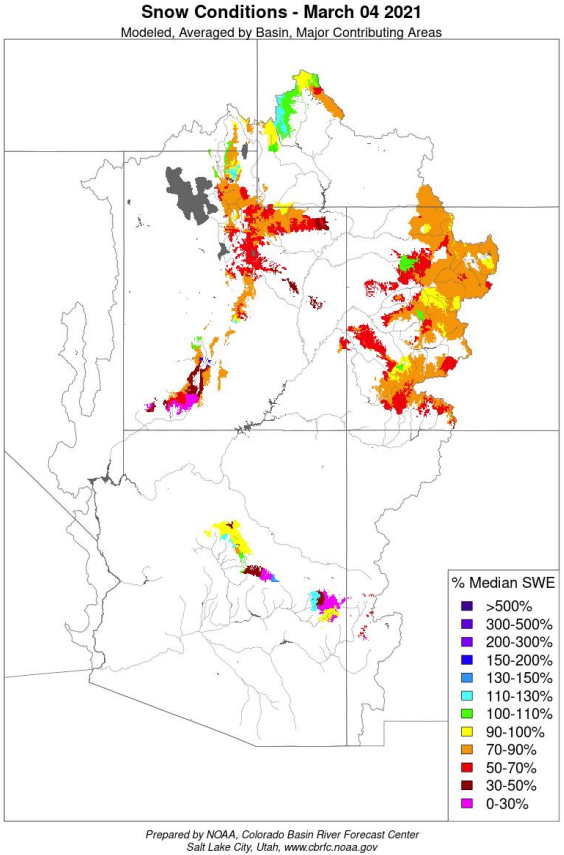
Prepared by NOAA, Colorado Basin River Forecast Center
Salt Lake City, Utah, www.cbrfc.noaa.gov

Early March Snow Conditions

SNOTEL (Observed)



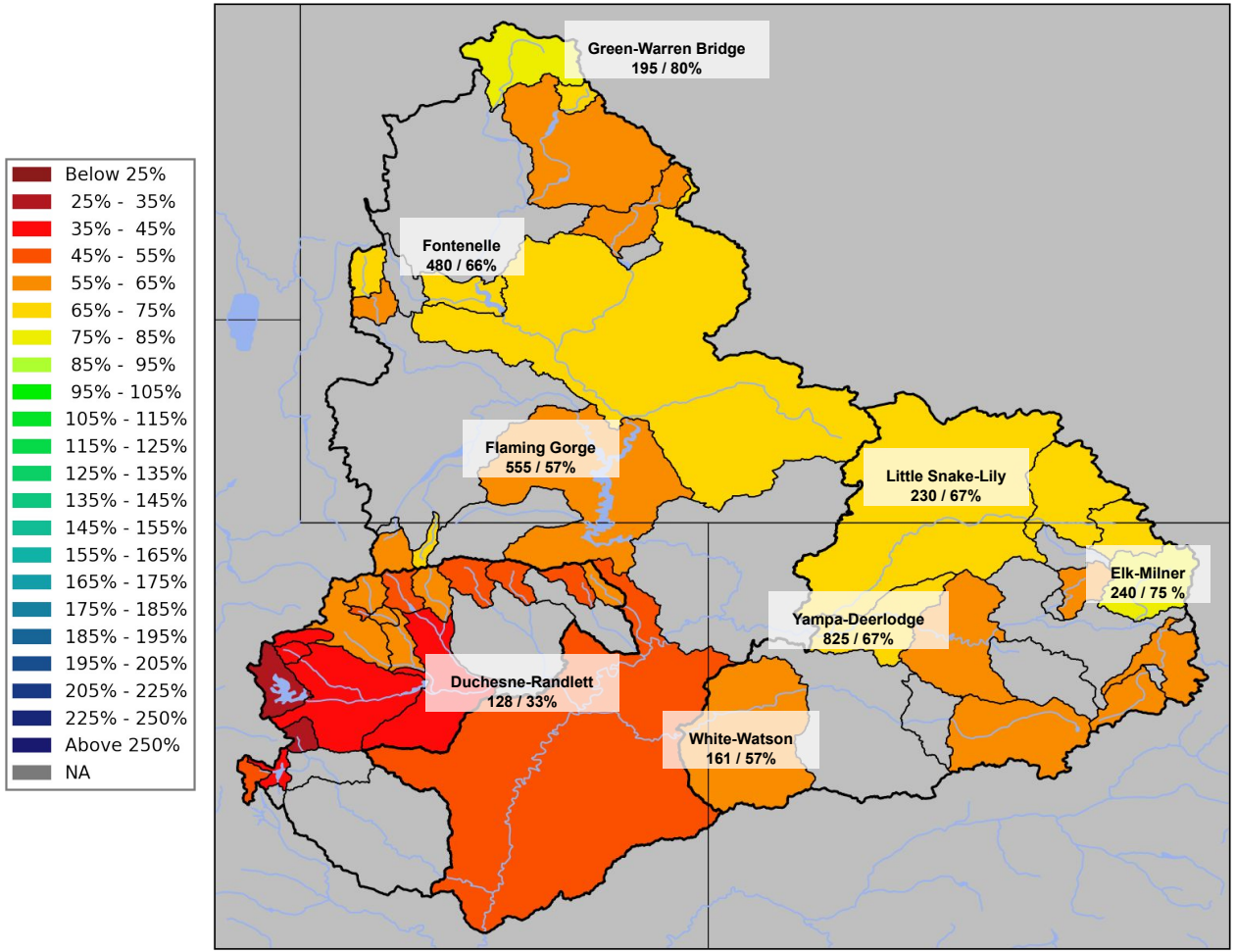
CBRFC (Model)



Mar 4 SWE Summary (SNOTEL)

Basin	SWE (% Median)
Upper Green	95%
Duchesne	70%
Price/San Rafael	70%
Yampa/White	85%
Upper CO Mainstem	85%
Gunnison	80%
Dolores	80%
San Juan	90%
Lake Powell	80%
Virgin	65%
Verde	55%
Salt	15%
Little Colorado	30%
Upper Gila	50%

Mar 1st Water Supply Forecasts: Green, Yampa, White, Duchesne



March 1st 2021 Forecasts

Volume (kaf) / % of 1981-2010 avg

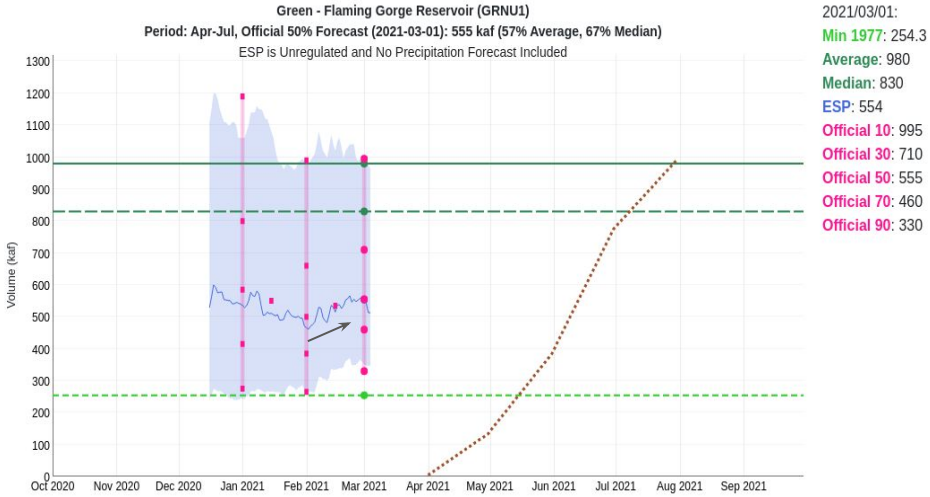
Forecast Ranges & (1-month Trend)

Upper Green: 55 - 80% avg
(0 - 10% increase)

Yampa/White: 55 - 75% avg
(0 - 15% increase)

Duchesne: 30 - 60% avg
(0 - 5% decrease)

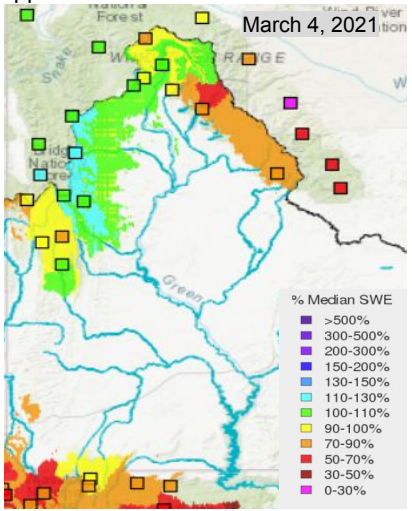
Upper Green Water Supply Forecasts & Snow Conditions



2021/03/01:
Min 1977: 254.3
Average: 980
Median: 830
ESP: 554
Official 10: 995
Official 30: 710
Official 50: 555
Official 70: 460
Official 90: 330

Above average precipitation during the month of February resulted in an increase in the forecast from February to March.

Upper Green SNOTEL and Model Snow

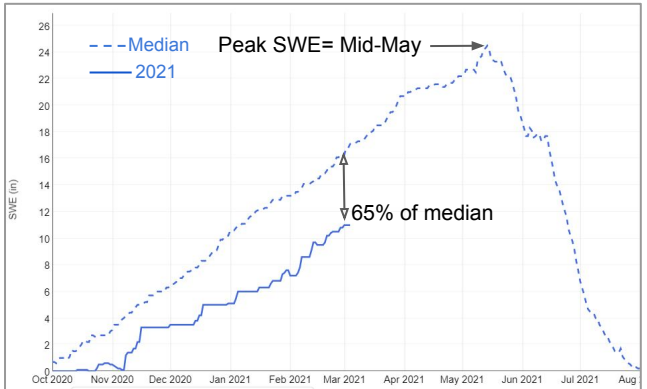


Upper Green snow conditions vary widely across the basin:

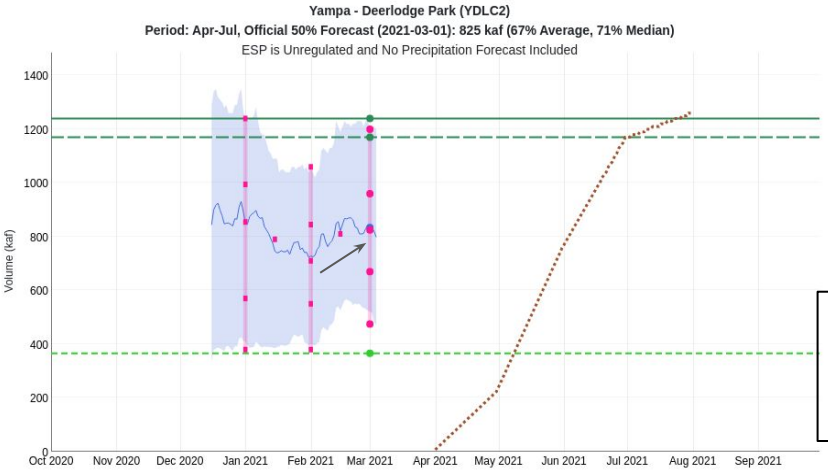
- Basin total: 97% median
- Wind River Range: 87% median
- Wyoming Range: 110%
- North Slope Uintas: 85%

On average, half of the Flaming Gorge unregulated inflow comes from the Wind River Range.

Model snow above 10,000 ft: Wind River Range

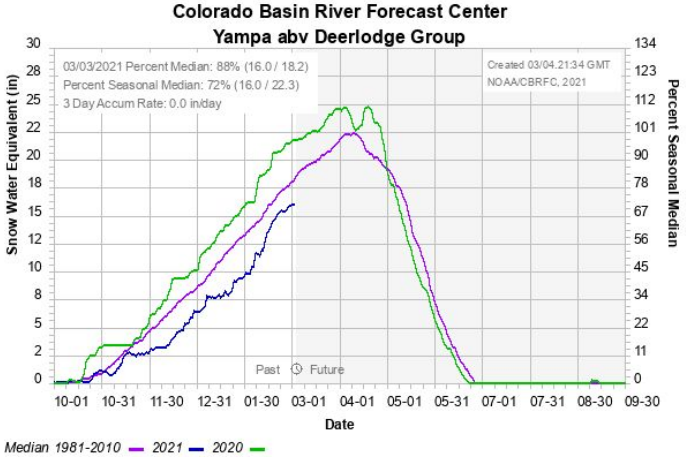


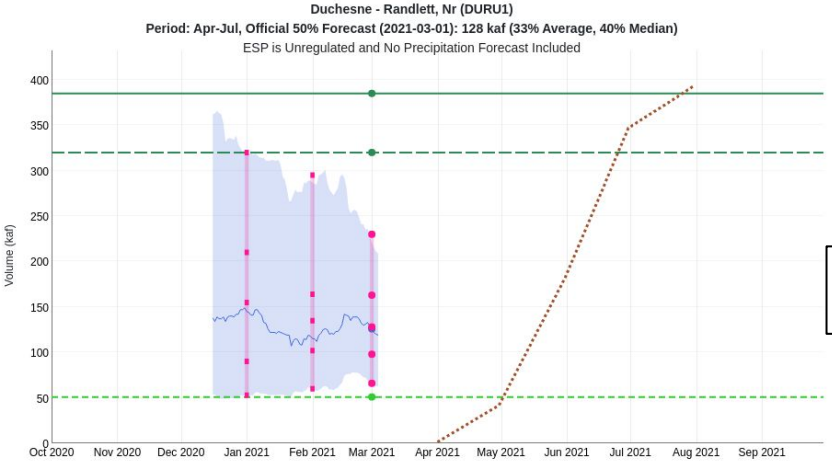
Yampa & Duchesne Water Supply Forecasts & Snow Conditions



2021/03/01:
Min 2002: 366.16
Average: 1240
Median: 1170
ESP: 834
Official 10: 1200
Official 30: 960
Official 50: 825
Official 70: 670
Official 90: 475

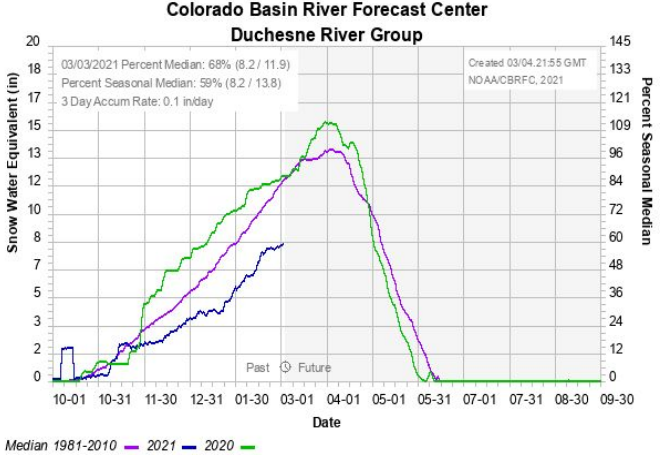
Significant improvement to water supply conditions in the Yampa River during February.
SWE/Volume: +15-20% from Feb-Mar





2021/03/01:
Min 1977: 50.97
Average: 385
Median: 320
ESP: 126
Official 10: 230
Official 30: 163
Official 50: 128
Official 70: 98
Official 90: 66

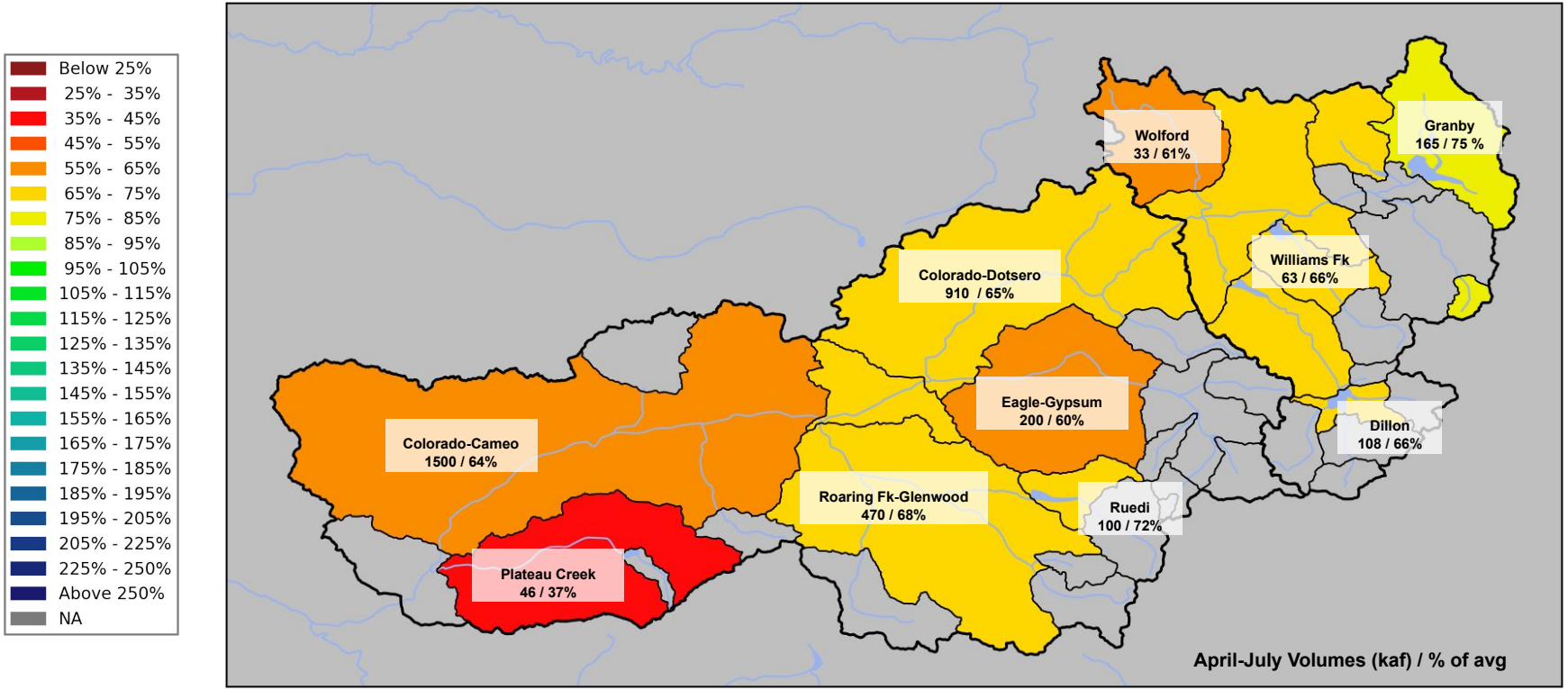
Very poor conditions continue in the Duchesne River basin.



Mar 1st Water Supply Forecasts: Upper Colorado River Mainstem

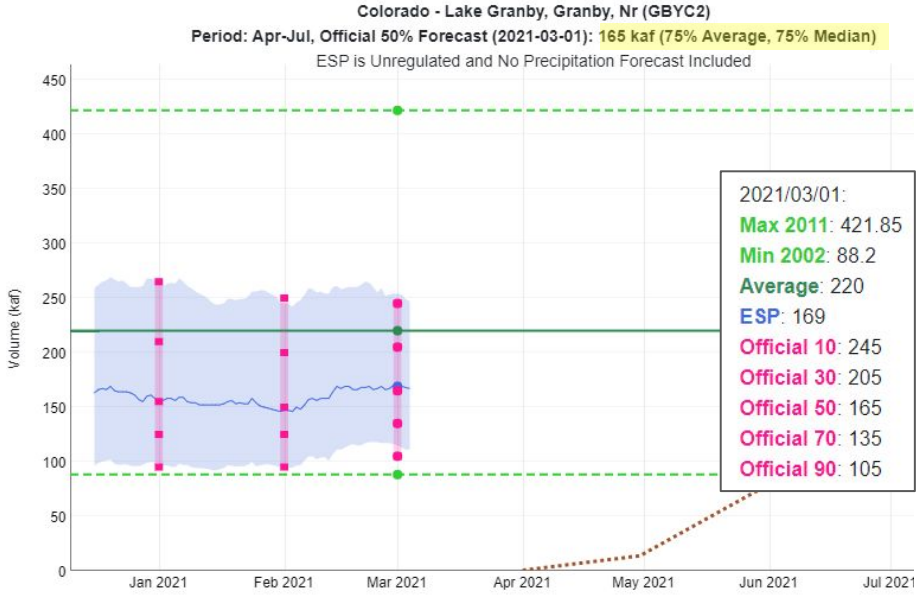
Forecast Ranges & (1-month Trend):

Granby to Kremmling: 60 - 75% avg (0 - 5% increase)
Kremmling to Cameo: 40 - 70% avg (0 - 5% increase)

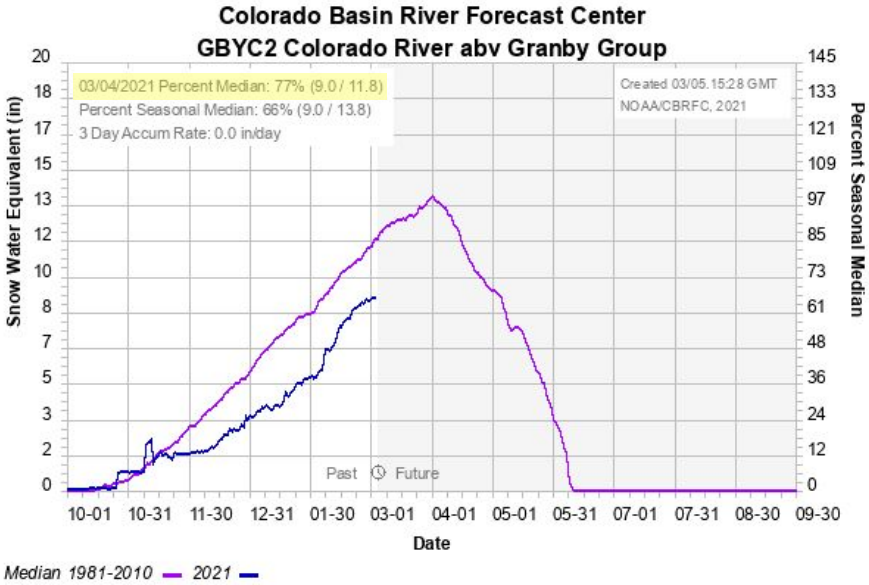


Upper Colorado Mainstem Water Supply Forecasts & Snow Conditions

Above normal February precipitation
~7% increase in Feb 1 to Mar 1 water supply guidance



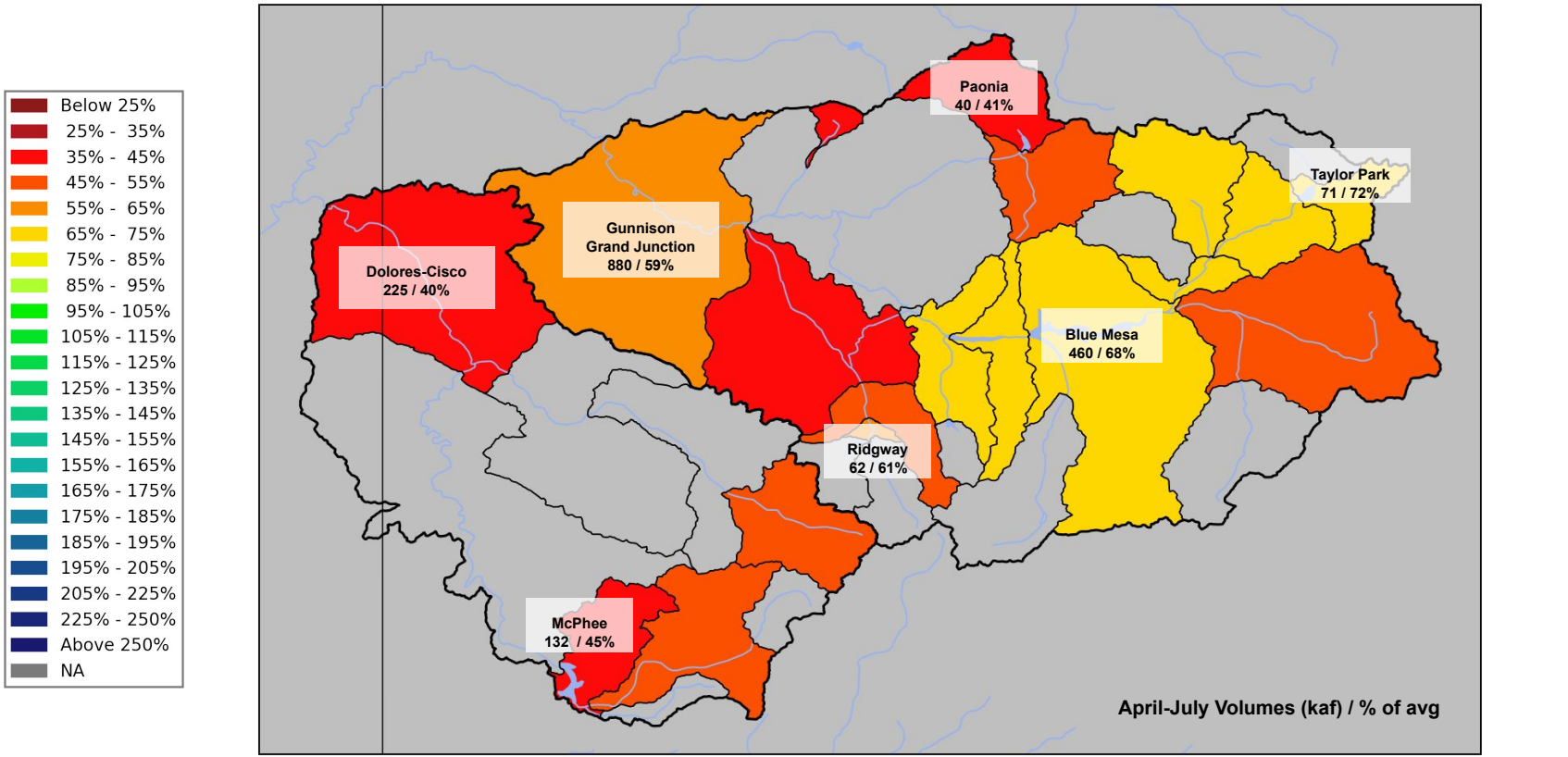
~80% through snow accumulation season



Mar 1st Water Supply Forecasts: Gunnison, Dolores

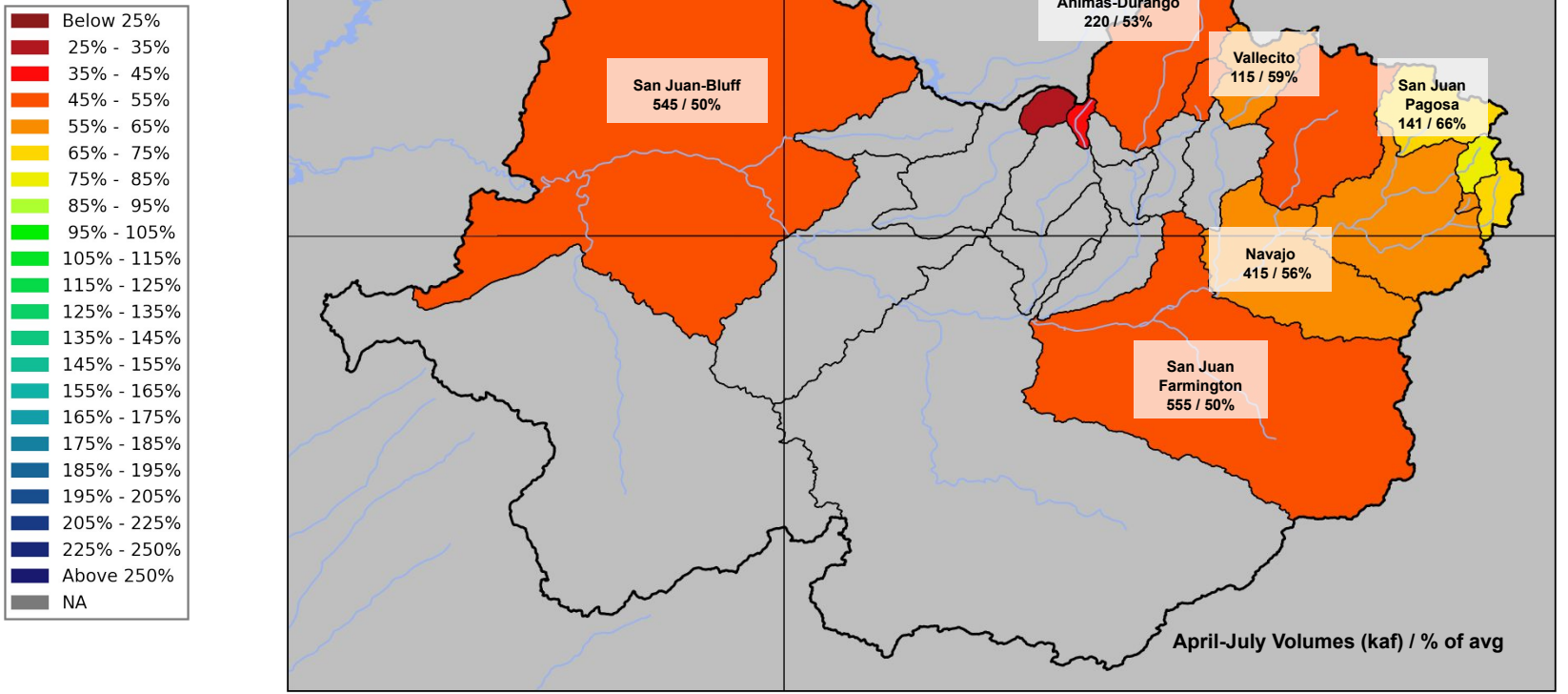
Forecast Ranges & (1-month Trend):

Gunnison:	40 - 70% avg	(0 - 5% decrease)
Dolores:	40 - 50% avg	(0 - 5% decrease)

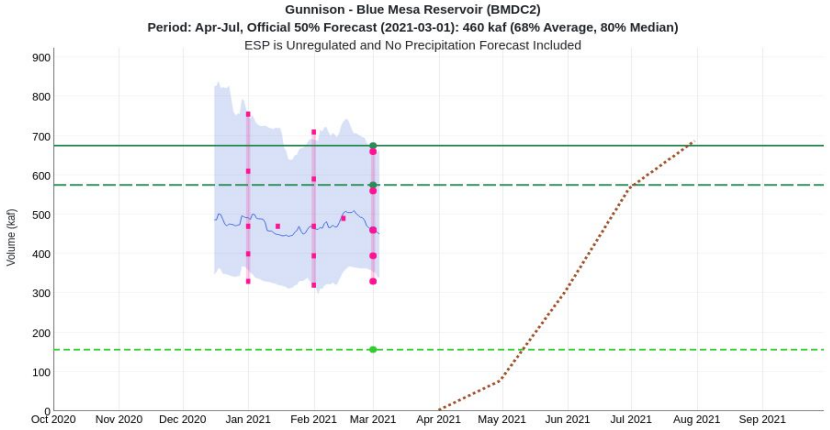


Mar 1st Water Supply Forecasts: San Juan

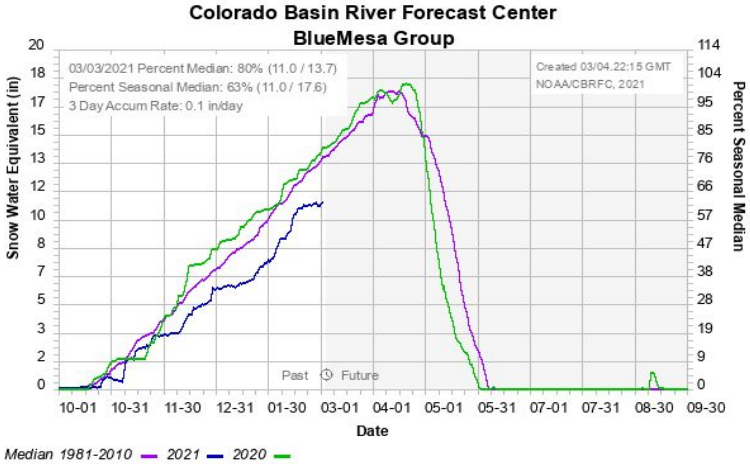
Forecast Range & (1-month Trend):
35 - 75% of average (0 - 5% decrease)

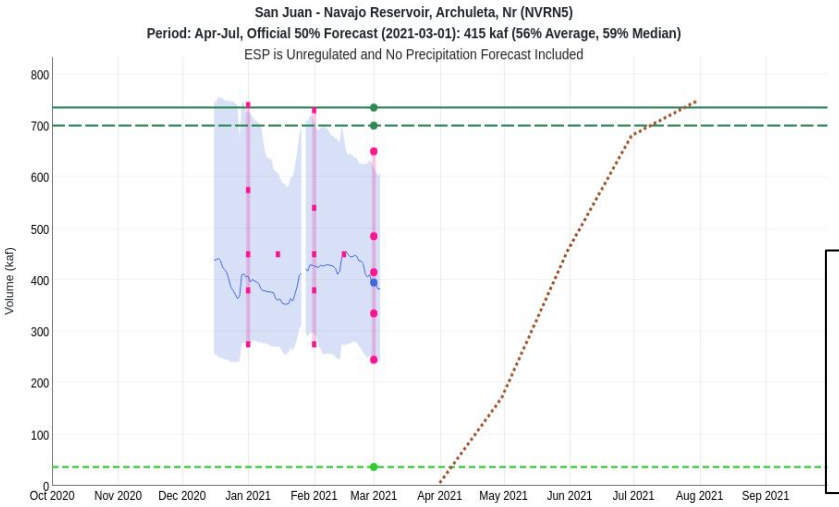


Southwest Colorado Water Supply Forecasts & Snow Conditions



2021/03/01:
Min 2002: 156.55
Average: 675
Median: 575
ESP: 461
Official 10: 660
Official 30: 560
Official 50: 460
Official 70: 395
Official 90: 330

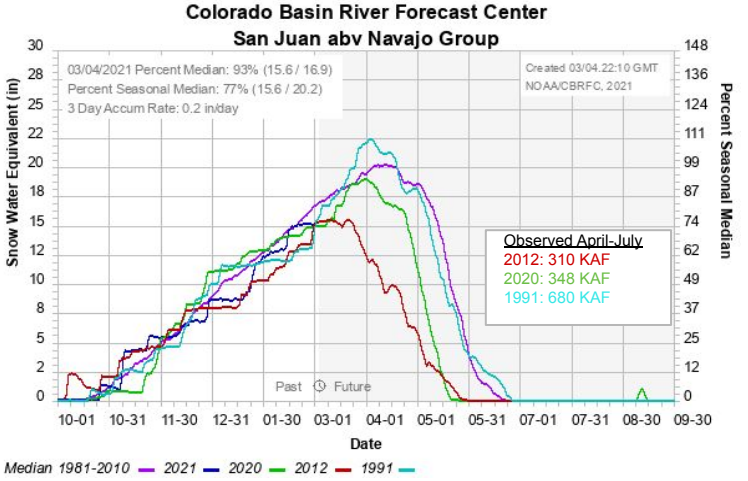




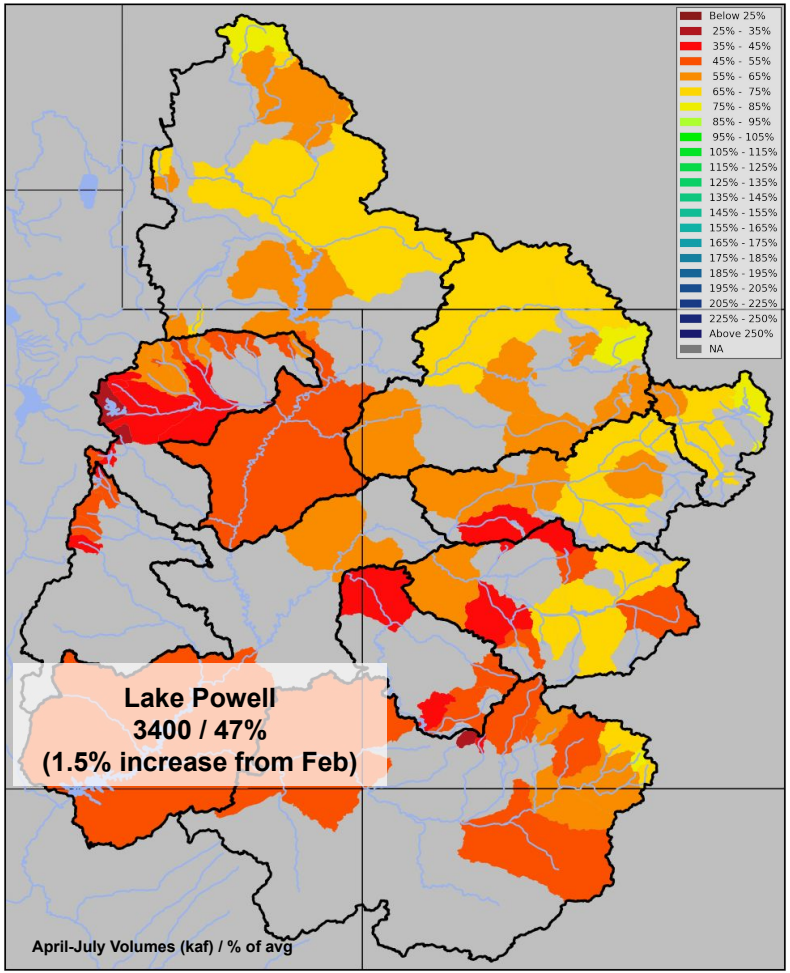
2021/03/01:
Min 2002: 36.74
Average: 735
Median: 700
ESP: 395
Official 10: 650
Official 30: 485
Official 50: 415
Official 70: 335
Official 90: 245

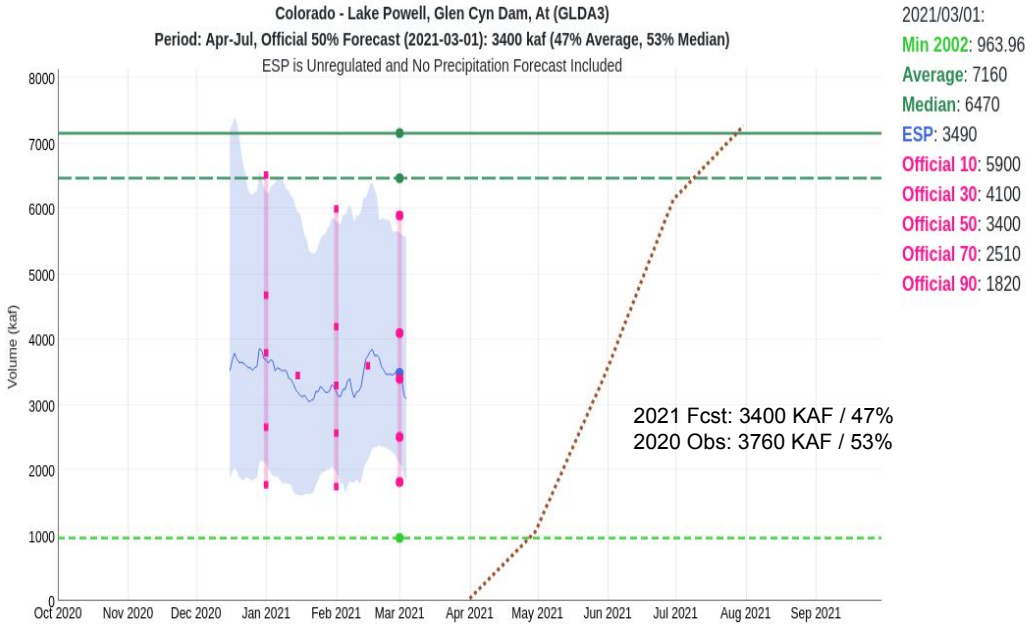
Forecasts in the San Juan River basin decreased from early February.

March and early April weather are critical for the final water supply outcome.



Mar 1st Water Supply Forecasts: Upper Colorado (Lake Powell)





Lake Powell summarizes the hydrologic conditions throughout the Upper Colorado River Basin.

5 Lowest Historical Years: April-July Volume / % avg

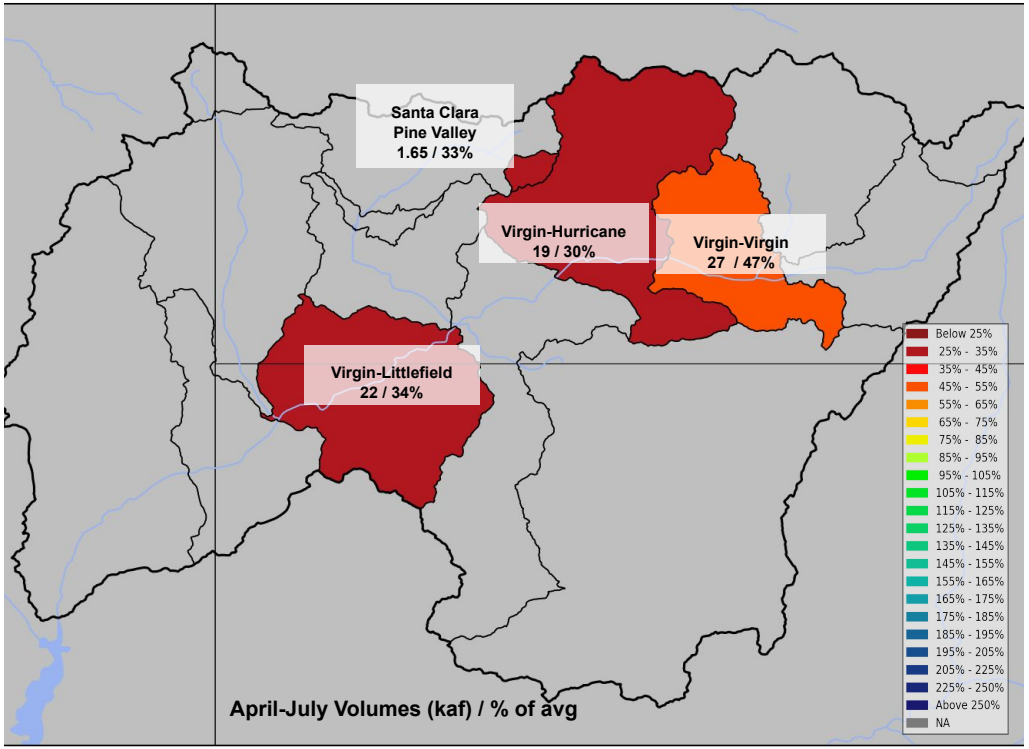
2002: 946 KAF / 13%
1977: 1208 KAF / 17%
2012: 2063 KAF / 29%
2013: 2558 KAF / 36%
2018: 2602 KAF / 36%

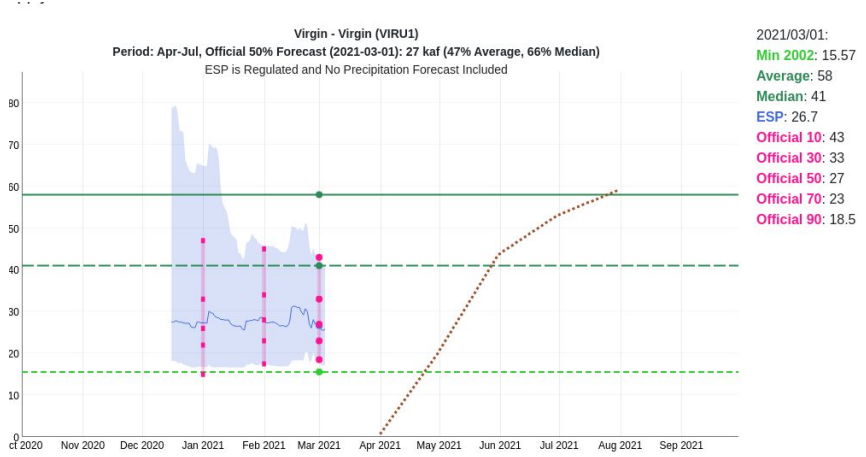
*Currently a ~30% chance to be in the bottom five

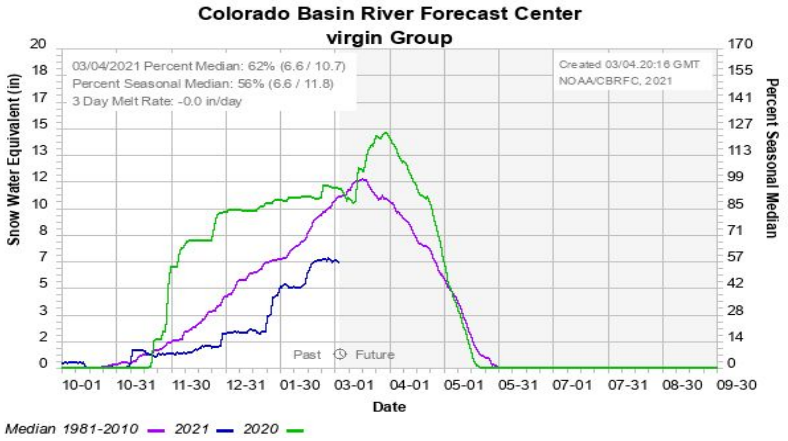
Mar 1st Water Supply Forecasts: Virgin River Basin

Forecast Range & (1-month Trend):

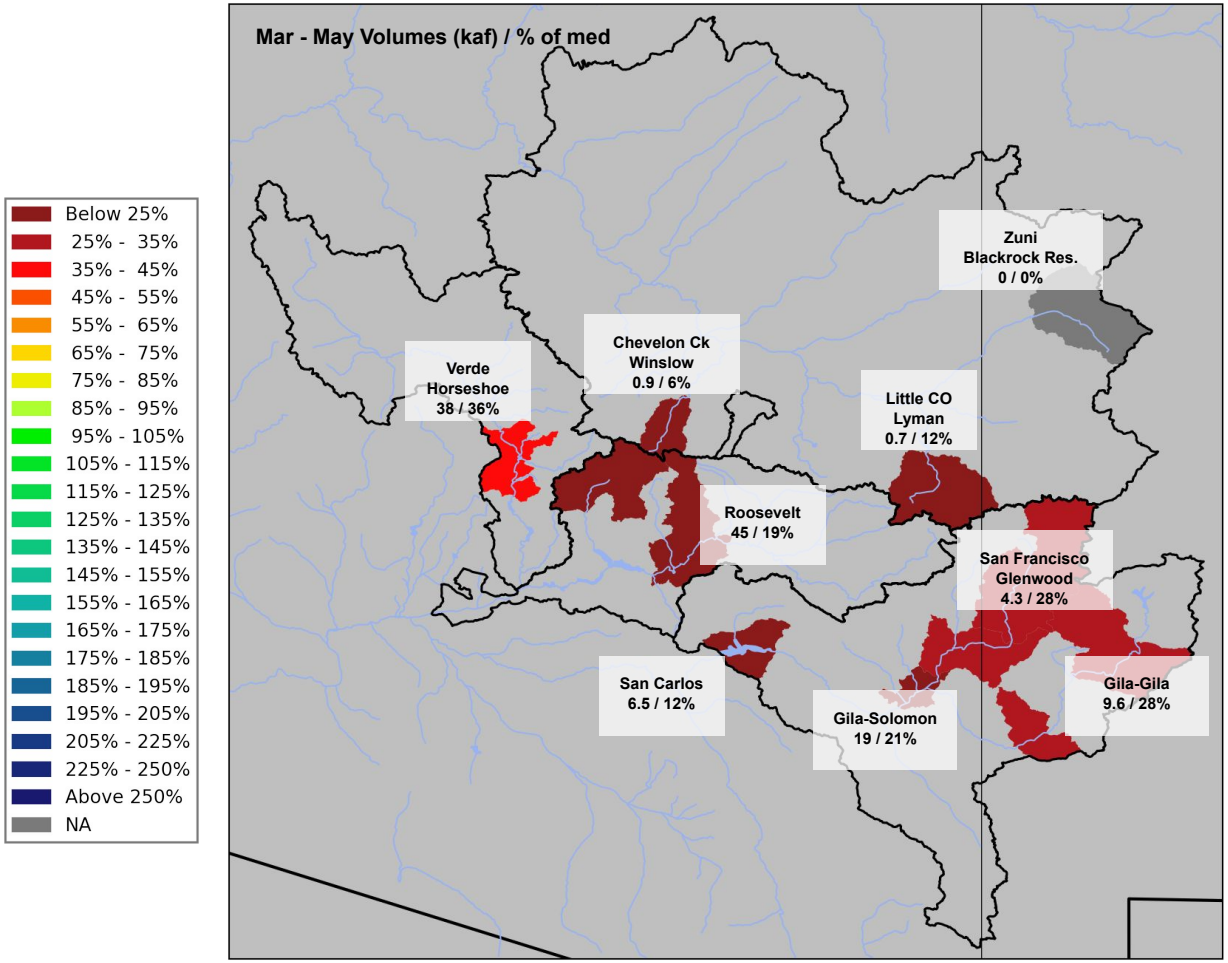
30 - 45% avg (0 - 5% decrease)







Mar 1st Water Supply Forecasts: Lower Colorado River Basin



March - May Forecast Period
Volume (kaf) / % of 1981-2010 Median

Forecast Ranges

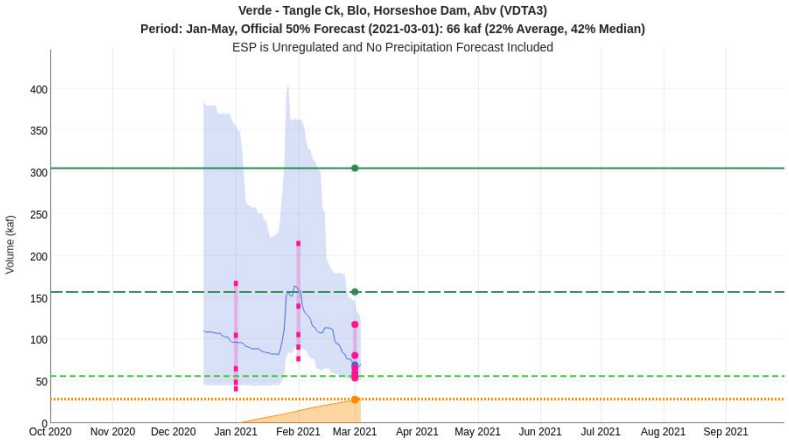
Little Colorado: 0 - 15%

Upper Gila: 10 - 30%

Salt: 10 - 20%

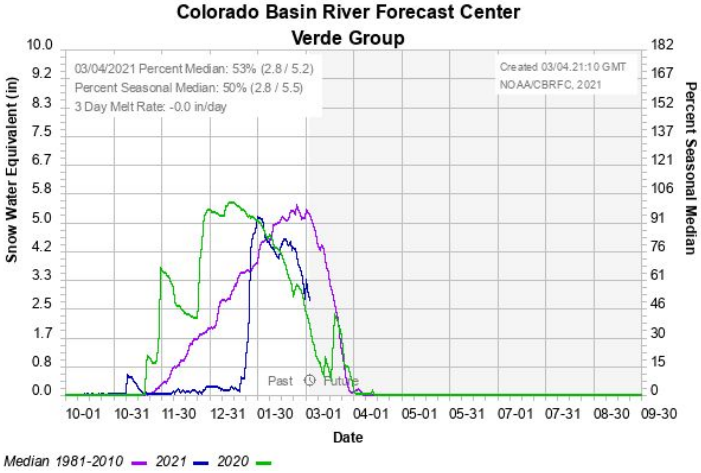
Verde: 35%

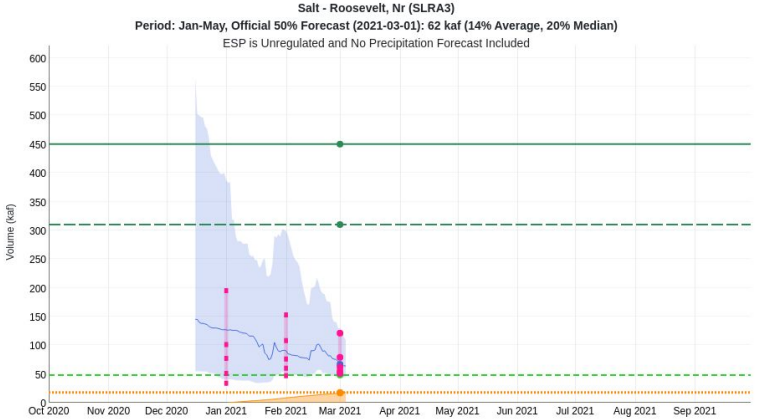
Lower Colorado Water Supply Forecasts & Snow Conditions



2021/03/01:
Min 2002: 56.33
Average: 305
Median: 157
Observed
Accumulation: 27.6
Observed Total: 28.7
ESP: 69.5
Official 10: 118
Official 30: 81
Official 50: 66
Official 70: 60
Official 90: 54

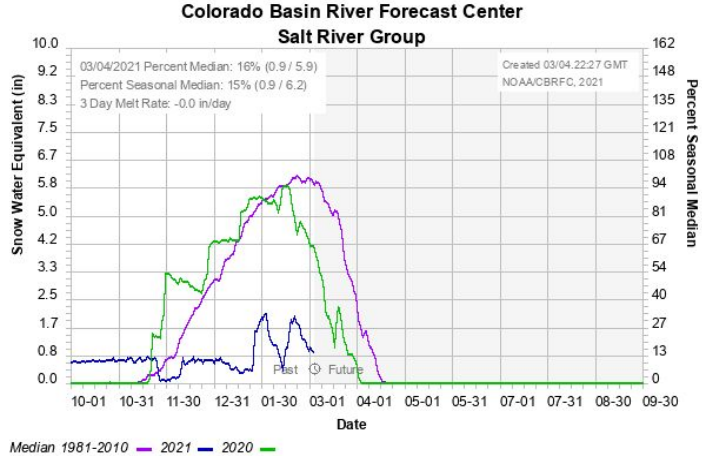
Forecasts in the Verde River basin decreased as a result of well below normal February precip.





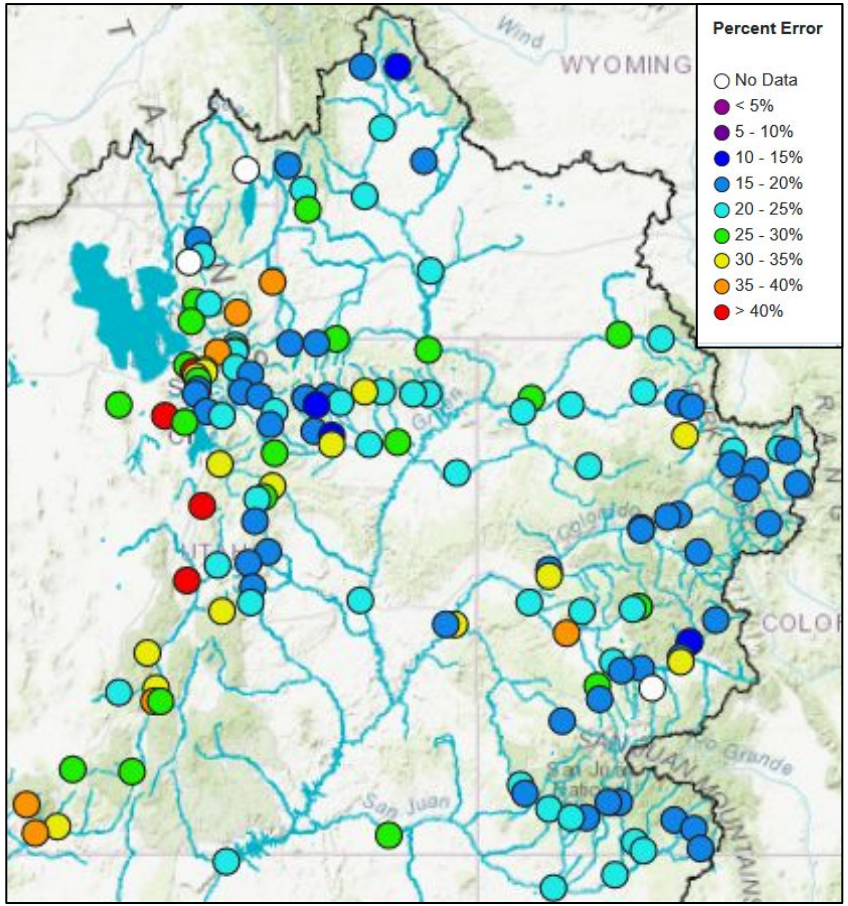
2021/03/01:
Min 2002: 48.18
Average: 450
Median: 310
Observed
Accumulation: 16.9
Observed Total: 17.8
ESP: 66.9
Official 10: 121
Official 30: 79
Official 50: 62
Official 70: 55
Official 90: 51

Jan-May forecast period; start showing accumulated volume on Jan 1st.



Historical (1981-2010) Forecast Verification

March Forecast Error: April-July Volume



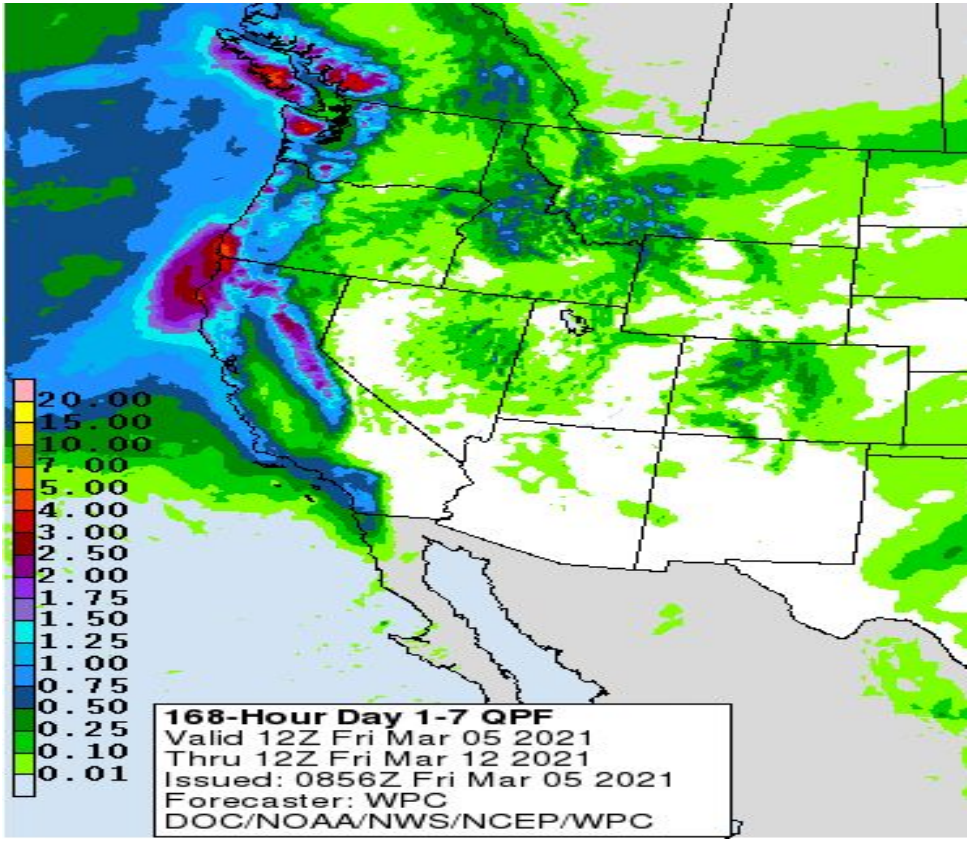
Location	Avg Mar Forecast Error
Green River - Warren Bridge	15%
Fontenelle Reservoir	22%
Yampa River - Deerlodge	23%
Blue River - Dillon Reservoir	16%
Colorado River - Cameo	17%
Blue Mesa Reservoir (Gunnison)	18%
McPhee Reservoir (Dolores)	22%
Navajo Reservoir (San Juan)	22%
Lake Powell	24%
Virgin River at Virgin	31%

Forecasts are better than just going with average
Error tends to decrease each month into the spring

Where Forecasts are Better:
- -Headwaters
- -Primarily snow melt basins
- -Known diversions / demands

Where Forecasts are Worse:
- -Lower elevations (rain or early melt)
- -Downstream of diversions / irrigation
- -Little is known about diversions / demands

Upcoming Weather: WPC March 5-12 Precipitation Outlook



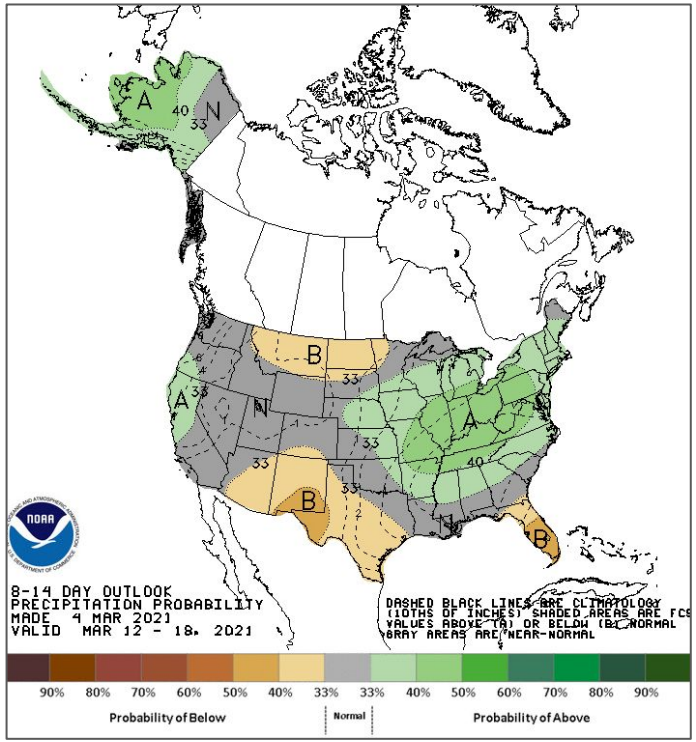
- Ridge builds today and remains in place through early next week. Dry conditions and temps will be 5-10 degrees above normal.

- Large scale trough develops by next Tues-Thurs (March 9-11). Cooler temps are likely. Weather models are currently forecasting modest precip amounts.

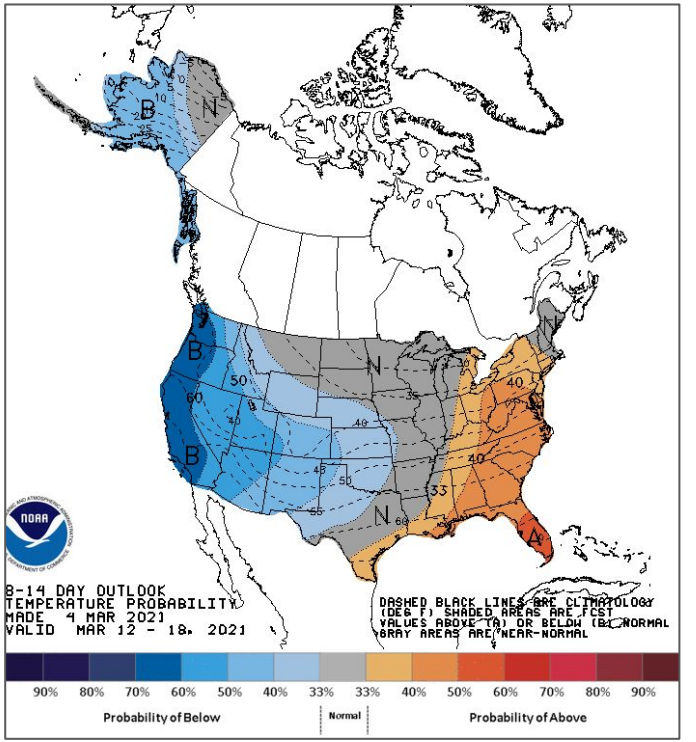
Upcoming Weather: 8-14 Day Outlook (March 12-19)

Model uncertainty is quite high in the 8-14 day period. While there is elevated odds for below normal temperatures across our region, there is little signal for precipitation odds.

Precipitation Outlook



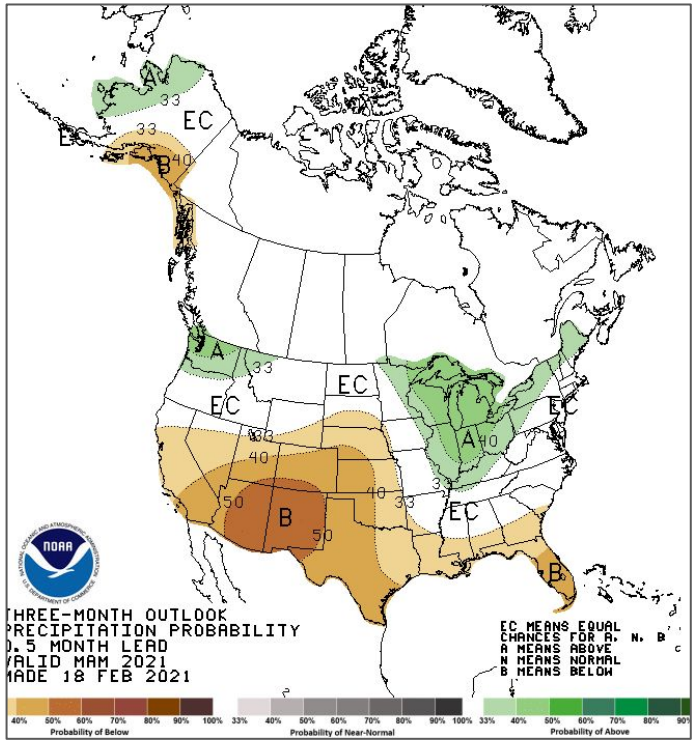
Temperature Outlook



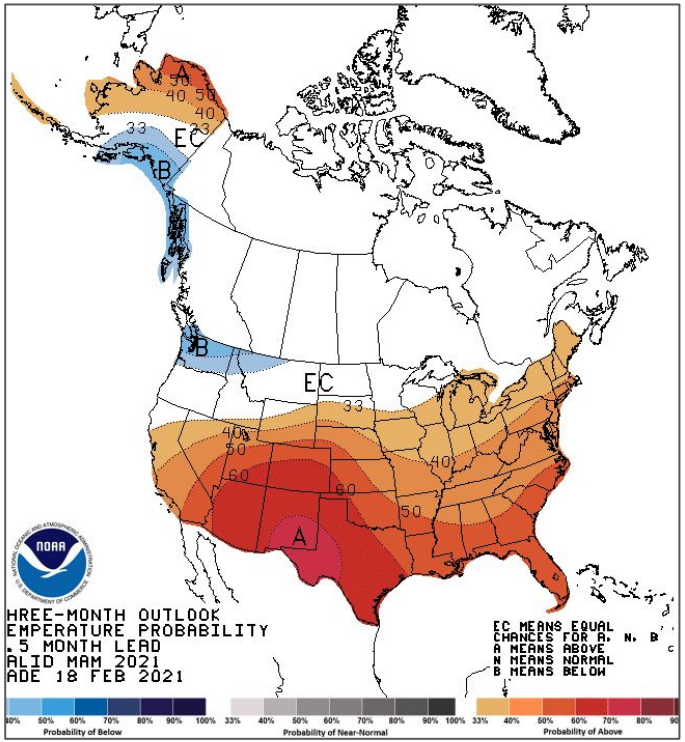
CPC Seasonal Outlook for Spring (March-May)

Elevated odds of below normal precipitation across especially the southern half of Utah/Colorado and the Lower Basin. Weaker precip signal further north.

Precipitation Outlook



Temperature Outlook



Summary

- Near record (very dry) antecedent soil moisture conditions entering the water year 2021 snow accumulation & runoff season

- Snowpack (SWE) conditions improved over the northern half of the basin during February
  - Current SWE conditions are below to near normal in the Upper Colorado and well below normal in the Lower Colorado

- March water supply forecasts (% of normal):
  - Upper Colorado: 35-80%
  - Lower Colorado: 0-35%

- Snow accumulation typically runs through early to mid-April in runoff producing areas
  - Less chance for significant snow accumulation, especially in the southern basins, as we move further into Spring
  - *March into early April can be a pivotal time period for water supply.*

- Weather models indicating a typical spring pattern through the middle of the month with periods of warm/dry intermixed with periods of cool/wet. Model uncertainty tends to increase during the transition to Spring.

- Currently no indication of an extended warm and dry period which is good news for water supply.

- Given the dry conditions, a wet spring will be needed to see near average water supply volumes.

CBRFC Hydro Science Update - Post Fire Streamflow Forecasting

CBRFC post fire decision support role

Python/GIS fire tool development

Hydrologic model considerations

Pre/post fire streamflow simulations

CBRFC Decision Support Role

- Be proactive and transparent in addressing stakeholder concerns related to how streamflow forecasts may be influenced by recent fire activity.
  - Communicate model limitations: forecasting flash flooding still extremely challenging

- Determine if hydrologic model parameters need to be adjusted in basins significantly impacted by recent fire activity to account for changes in runoff timing, magnitude, and efficiency.
  - 10-day streamflow forecasts vs. water supply forecasts vs. peak flow forecasts
  - Snowmelt runoff vs. rain-on-snow events vs. rain events

- Forecasting challenge: How will the timing and magnitude of runoff change after a fire?
  - Numerous basins impacted to varying degrees
    - Burn coverage
    - Burn severity
    - 2021: Very dry soils + fire impacts

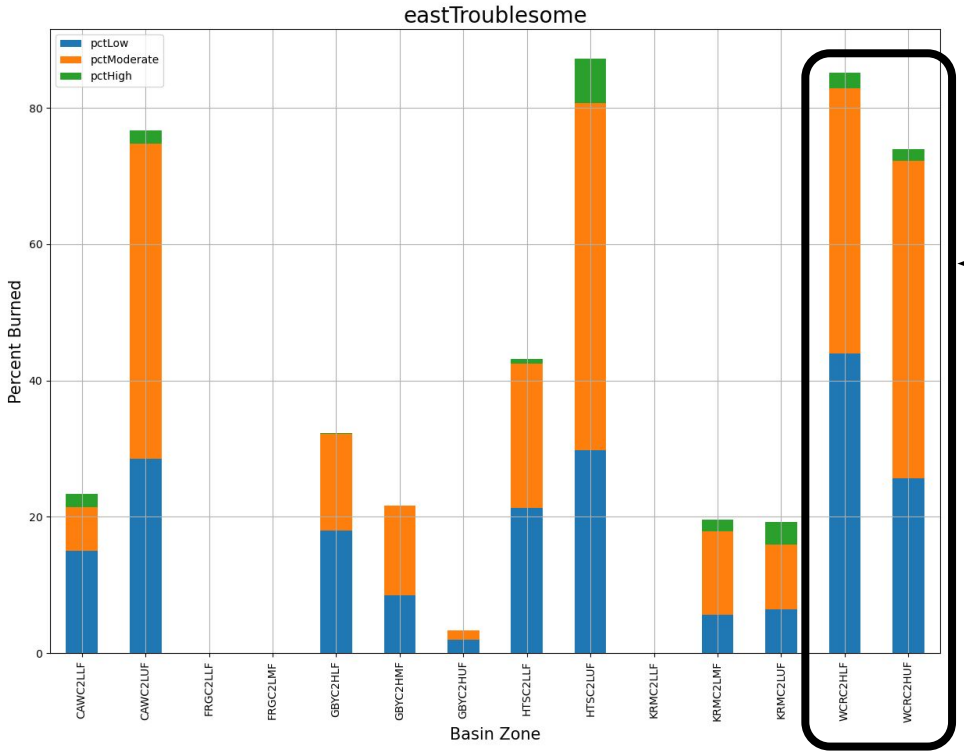
- Continually evaluate CBRFC hydrologic model performance in fire affected basins
  - Model verification - are the model parameter adjustments improving the streamflow forecast?
  - Compare any hydro forecaster intervention in both burned & nearby unburned basins.
    - Example: spatial snowmelt rate analysis

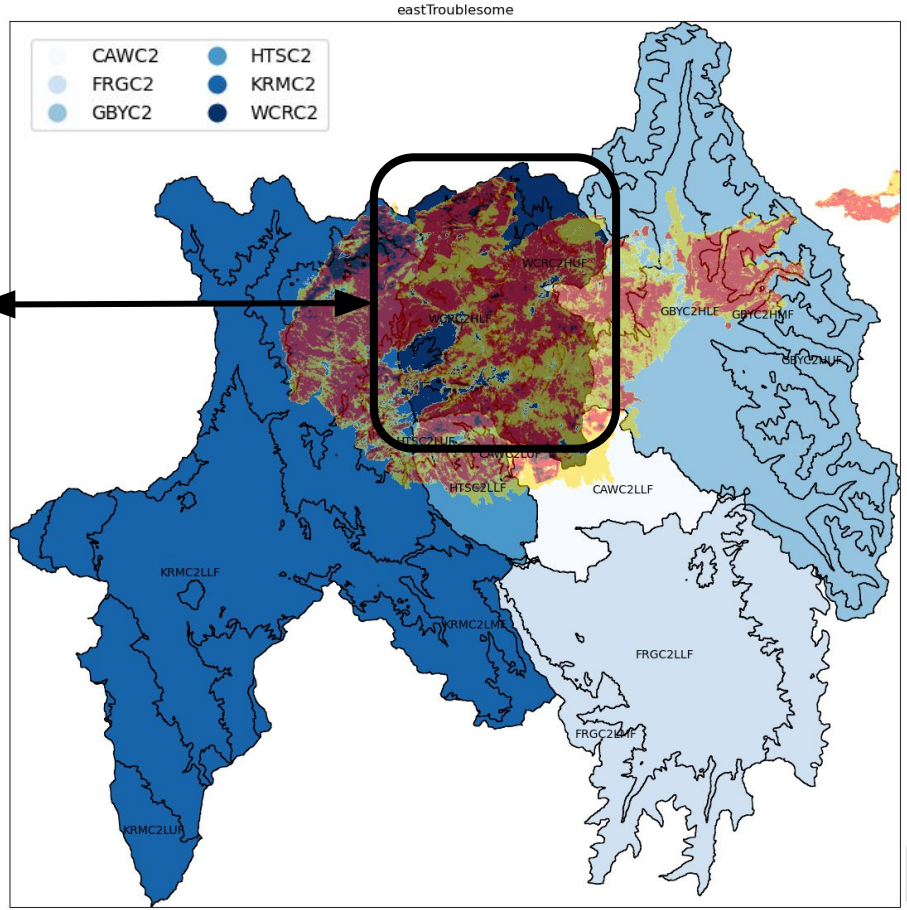
- Stakeholder/RFC collaboration
- Document/database

Python/GIS Fire Tool Development

- Python/GIS Fire Tool
  - Goal: quickly ingest/process burn data and consider impacts to CBRFC streamflow forecasting efforts.
  - Input: geo tiff or .shp file of burn area / severity
    - source: Burned Area Reflectance Classification (BARC)
      - a satellite-derived data layer of post-fire vegetation condition.
      - The BARC has four classes: high, moderate, low, and unburned.
  - Outputs
    - Maps (various scales)
    - Plots (broken down by CBRFC elevation zone)
      - Size of fire (mi^2)
      - % of elevation zone burned & burn severity (low, moderate, high)
    - Tables
      - Tabular data of plots (html, .csv)
    - Shapefiles of burn areas
  - Future development:
    - Type of vegetation burned (forest, shrub, etc..)

Fire Tool Output Examples - East Troublesome Fire





Willow Creek basin (WCRC2)
-CBRFC water supply forecast point > model reservoir inflow/pool elev/outflow
-both elevation zones >70% burned

SAC-SMA Hydrologic Model Considerations

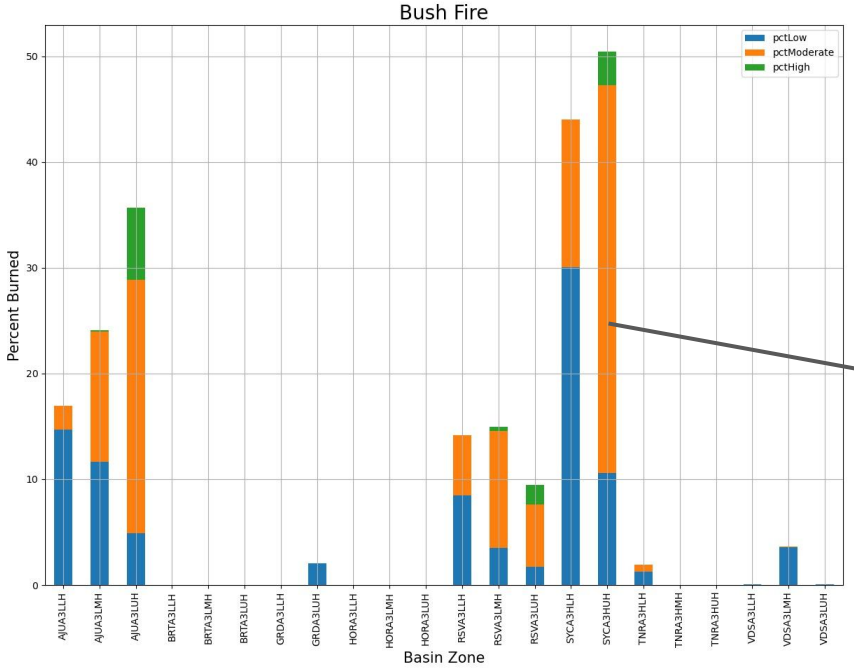
- A few CBRFC model adjustment options:
  - No change -> establish baseline verification using current model parameters
    - Analyze model performance at beginning of runoff season & compare with non-fire affected nearby basins; stay flexible during runoff season
  - Adjust UNIT-HG model
    - would not affect model simulated volume (only affects timing)
  - **Adjust soil moisture (SAC-SMA) model**
    - **will affect model water balance and both timing and magnitude of model simulated flow**
  - Define/configure new 'burn' zone in model
    - Most time consuming and complicated in an operational forecast setting

Relevant SAC-SMA Model Parameters:

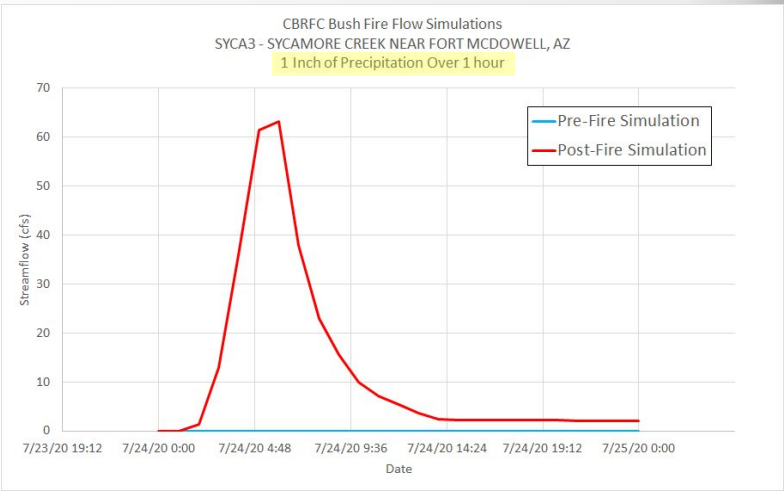
- **UZTWM** - upper soil zone layer tension water capacity (bucket size), units = millimeters
  - parameter indicates the amount of rain that must fall after a long dry period before any runoff is produced

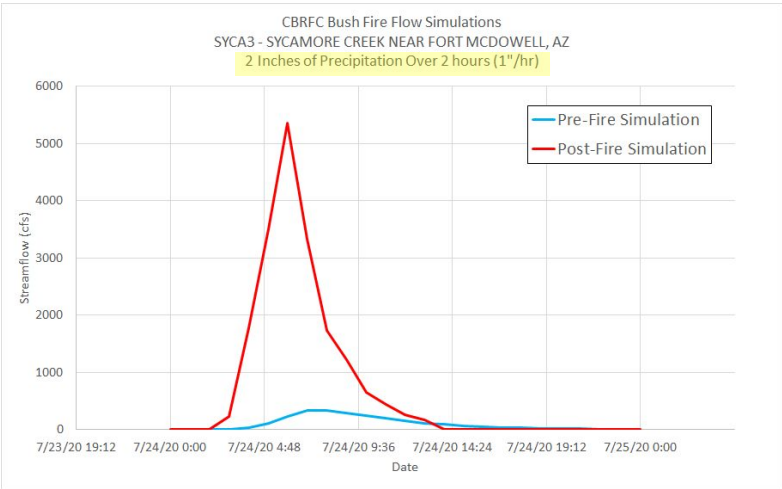
- **UZFWM** - upper soil zone layer free water capacity (bucket size), units = millimeters
  - primary function is to control when surface runoff occurs
  - surface runoff can only occur when the intensity rate of the rainfall or rain+melt is sufficient to fill the upper zone free water storage.

Pre/Post Fire Hydrologic Model Simulation Analysis - Lower Colorado



Basin upper elevation zone >50% burned





Model Upper Elevation Zone Changes

Parameter	Pre Fire	Post Fire
UZTWM	30	10
UZFWM	40	10

Pre/Post Fire Hydrologic Model Simulation Analysis - Upper Colorado

Upper zone

Parameter	Pre Fire	Post Fire
UZTWM	20	10
UZFWM	40	15

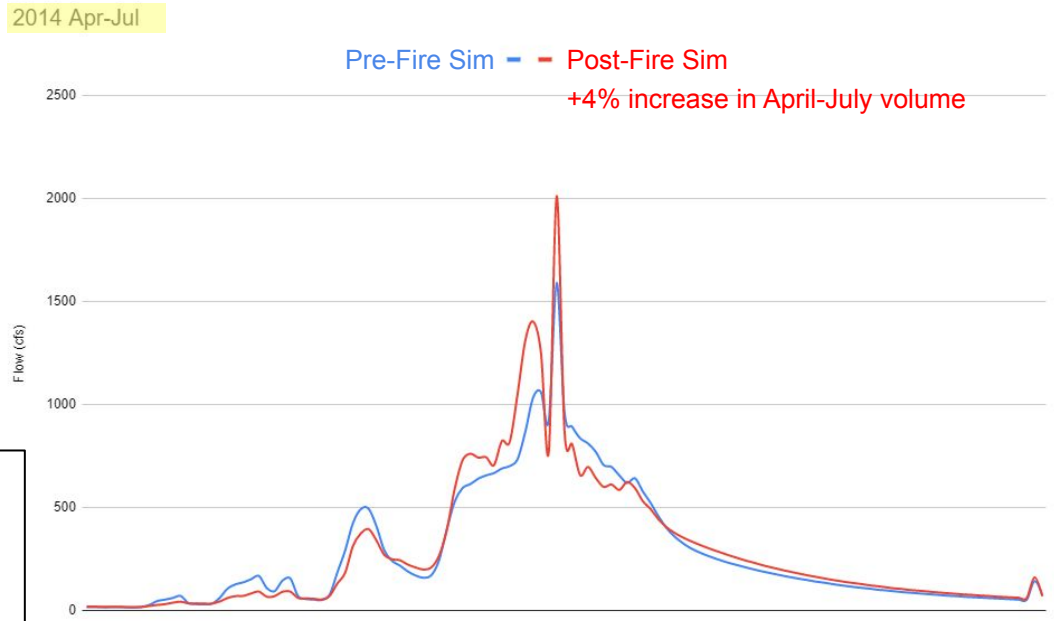
Lower zone

Parameter	Pre Fire	Post Fire
UZTWM	40	10
UZFWM	40	15

1981-2015 Simulation Analysis: April-July Volume

	PreFire	PostFire
Model Bias	-2.1%	+1.4%
Volume % Change		+0.2 to +10.3% Average: +3.6%

Willow Creek Reservoir Inflow Simulations



CBRFC Hydro/Fire Summary

- Developed Python/GIS tool
- Comparing pre vs. post fire model simulations in offline forecast system
- Operational SAC-SMA model parameter adjustments in basin zones that are > 50% burned.
  - Implementing before April 1, 2021
- Evaluate operational hydrologic model performance during spring runoff
- Develop best practices
- Stay proactive & transparent

2021 Water Supply Webinar Schedule

**All Times Mountain Time (MT)*

Colorado River Basin

~~Friday~~	~~Jan 8th~~	~~10 am~~
~~Friday~~	~~Feb 5th~~	~~10 am~~
~~Friday~~	~~Mar 5th~~	~~10 am~~
Wednesday	Apr 7th	10 am
Friday	May 7th	10 am

Great Basin

~~Friday~~	~~Jan 8th~~	~~11:30 am~~
~~Friday~~	~~Feb 5th~~	~~11:30 am~~
Friday	Mar 5th	11:30 am
Wednesday	Apr 7th	11:30 am
Friday	May 7th	11:30 am

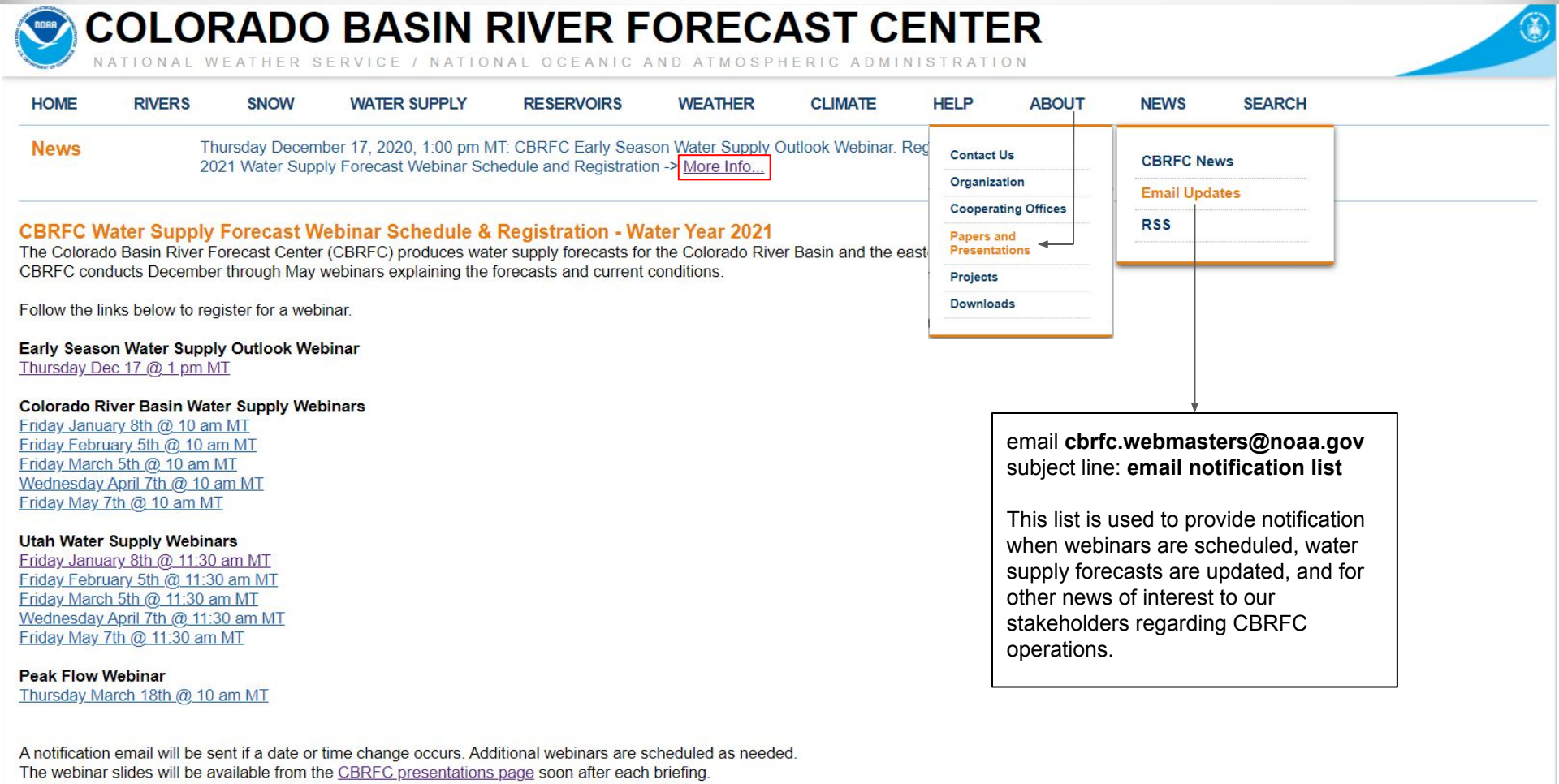
Peak flow forecast webinar Thursday, March 18th, 10 am MT

Additional briefings scheduled as needed

Webinar schedule & registration information has been posted to the CBRFC web page

https://www.cbrfc.noaa.gov/

CBRFC Webinar Registration & Email List



email **cbrfc.webmasters@noaa.gov**
subject line: **email notification list**

This list is used to provide notification when webinars are scheduled, water supply forecasts are updated, and for other news of interest to our stakeholders regarding CBRFC operations.

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CBRFC Water Supply Presentations
https://www.cbrfc.noaa.gov/present/present.php