NOAA’s Colorado Basin River Forecast Center

2016 Water Supply Verification Briefing

Colorado Basin River Forecast Center

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Overview

• Take Away Points
• Background
• 2016 Observed Volumes vs. Forecasts
  – Upper Colorado River Basin
  – Great Basin
  – Lower Colorado River Basin
• Forecast Drivers
• Accuracy and Performance
• Summary
The Take Away

- Overall, CBRFC forecasts performed well throughout much of the basin this season
  - Dry and warm February and March conditions, coupled with dry soil moisture conditions, impeded runoff
  - An unusually wet May negatively impacted forecast performance in the Green River Basin
- Great Basin forecasts were impacted by early runoff in March, but some areas in the north did benefit from May precipitation
- Lower Colorado River Basin did not realize forecasted wet El Niño conditions
ESP Probabilistic Forecasts

- Start with current conditions (from the daily model run)
- Apply precipitation and temperature from each historical year (1981-2010)
- A forecast is generated for each of the years (1981-2010*) as if, going forward, that year will happen
- This creates 30 possible future streamflow patterns. Each year is given a 1/30 chance of occurring

Current hydrologic states:
- River / Res. Levels
- Soil Moisture
- Snowpack

Past <- Future Time

*We are updating this to 1981-2015
Communicating Forecasts

Blue - Dillon Res (DIRC2)
2016-06-01 Apr-Jul Official 50% Forecast: 170 kaf (104% of average)
ESP is Unregulated and No Precipitation Forecast Included

Max/Min
ESP 90%
ESP 30-70%
ESP 10-30%
ESP w/o Obs**
Observed
Normal Accumulation
Average
Median

Trace Ensemble for
BLUE - DILLON RES
Forecast Period: 2016-01-01 - 2016-09-01 Simulation date: 2016-01-01

<table>
<thead>
<tr>
<th>Exceedance Probabilities</th>
<th>Conditional Simulation (KAF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>90%</td>
<td>108</td>
</tr>
<tr>
<td>80%</td>
<td>122</td>
</tr>
<tr>
<td>70%</td>
<td>132</td>
</tr>
<tr>
<td>60%</td>
<td>140</td>
</tr>
<tr>
<td>50%</td>
<td>150</td>
</tr>
<tr>
<td>40%</td>
<td>156</td>
</tr>
<tr>
<td>30%</td>
<td>174</td>
</tr>
<tr>
<td>20%</td>
<td>182</td>
</tr>
<tr>
<td>10%</td>
<td>203</td>
</tr>
</tbody>
</table>
2016 Forecast Progression: Lake Powell

Colorado - Lake Powell- Glen Cyn Dam- At (GLDA3)
2016-06-15 Apr-Jul Official 50% Forecast: 6600 kaf (92% of average)
ESP is Unregulated and No Precipitation Forecast Included

Raw Model Guidance in Blue
Official Forecast in Red

10% chance of exceeding
50% chance of exceeding
90% chance of exceeding

30% chance of exceeding
70% chance of exceeding

The latest (2016-07-30) 50% ESP forecast is 6445 kaf.
Plot Created 2016-06-18 13:00:13, NOAA / NWS / CBRFC
**Purple ESP forecasts do not include observed and are not total runoff.

Observed flow
More Success:
- Runoff primarily due to snowmelt
- Higher elevations
- High quality/density of data

Less Success:
- Unknown diversions
Red indicates current year forecast had a higher error than the ESP model.

Blue indicates that the current year forecast had lower error than the ESP model.
If we were to simply forecast average every time,

Our mean forecast error is better than forecasting average.

2016 Error (yellow lines)
April – July 2016
Observed Volume
% of Average

**Bear – UT/WY Stateline:** 114 KAF/102%

**Weber – Oakley:** 98 KAF/83%

**Provo – Woodland:** 77 KAF/77%

**Flaming Gorge:** 1,050 KAF/107%

**Yampa – Deerlodge:** 1,500 KAF/120%

**Colorado – Cameo:** 2,280 KAF/97%

**Blue Mesa:** 600 KAF/89%

**McPhee Reservoir:** 240 KAF/81%

**Navajo Reservoir:** 560 KAF/76%

**Lake Powell:** 6,610 KAF/92%
April – July
Observed Volume
% of Average

Virgin - Virgin: 42 KAF/55%

January – May
Observed Volume
% of Median

Verde - Horseshoe: 98 KAF/62%
Salt - Roosevelt: 210 KAF/68%
Gila - Gila: 49 KAF/88%
Dry soil moisture conditions in Fall 2015 leading into the snowpack accumulation season.
2016 Water Year Climate

- Water Year precipitation shows above average precipitation in parts of the Green River Basin through the runoff periods
  - A relatively wet start through January
  - Followed by a dry, warm period in February
  - March continued to be dry and warm in the San Juan River Basin
  - Series of storms in April and May in the Green and Colorado Headwater regions greatly impacted total runoff
2016 Water Year Climate

Dry February, Mixed March

Wet April and May (especially)
2016 Water Year Climate

Relatively cool start to the year

Cool May

Warm February and March
2016 Climate Impacts to Verification
2016 Climate Impacts to Verification
2016 Climate Impacts to Verification
Green River Basin

Monthly Precipitation - April 2016
(Averaged by Basin)

% Average
- >500%
- 300-500%
- 200-300%
- 150-200%
- 130-150%
- 110-130%
- 100-110%
- 90-100%
- 70-90%
- 50-70%
- 30-50%
- 0-30%

Monthly Precipitation - May 2016
(Averaged by Basin)

% Average
- >500%
- 300-500%
- 200-300%
- 150-200%
- 130-150%
- 110-130%
- 100-110%
- 90-100%
- 70-90%
- 50-70%
- 30-50%
- 0-30%

Most sites in top 5 of historical record
Upper Green: Flaming Gorge Reservoir

Increases due to wet May
(Observed flow + new snow)

April-July Observed
1047 KAF
(107%)
Regulated Flow from Viva Naughton, Meeks Cabin, Stateline, and Big Sandy Reservoirs and Henry’s Fork

Typically this area does not contribute significant flows to Flaming Gorge inflow
Average % Contribution = ~25%
2016 % Contribution=~ 40%
Yampa River: Yampa nr Deerlodge

Yampa - Deerlodge Park (YDLC2)
2016-06-01 Apr-Jul Official 50% Forecast: 1650 kaf (133% of average)
ESP is Unregulated and No Precipitation Forecast Included

The latest (2016-07-30) 50% ESP forecast is 1502 kaf.
Plot Created 2016-06-13 11:01:15, NOAA / NWS / CBRFC
**Purple ESP forecasts do not include observed and are not total runoff.
Higher elevation areas (~11,000+ Ft) have lower snow (as a percent of normal) compared to lower elevation areas.
SNOTEL Group Above Blue Mesa Reservoir

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Blue Mesa Group

- Warm/Dry Feb-Mar
- Wetter/Cooler Apr-May
- Cool May: Slower melt throughout May
- Wet December

Jan 1st
Model performed fairly well with forecast errors below historical mean error levels. Possibly too little high elevation snow in the model late in the season due to the cool May.

Gunnison - Blue Mesa Res (BMDC2)
2016-06-15 Apr-Jul Official 50% Forecast: 600 kaf (89% of average)
ESP is Unregulated and No Precipitation Forecast included

The latest (2016-07-30) 50% ESP forecast is 605 kaf.
Plot Created 2016-08-17 07:55:25, NOAA / NWS / CBRFC
**Purple ESP forecasts do not include observed and are not total runoff.**
Very strong start to the snowpack

Dry warm Feb-Mar

Dry warm Feb-Mar
Model performed as expected and initial states adequate, the dry Feb-Mar period had the greatest impact and was caught by the model. Peak runoff timing an issue.

Observed 241 KAF / 81% avg

The latest (2016-07-30) 50% ESP forecast is 241 kaf.
Plot Created 2016-08-17 07:34:26, NOAA / NWS / CBRFC

**Purple ESP forecasts do not include observed and are not total runoff.**
San Juan above Navajo Res SNOTEL Group

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NVRN5 San Juan Group

- Early February Storm
- Good Start
- Dry Warm Feb-Mar
- Melt slowed due to cooler May

Median 1981-2010
2016
Model performed as expected and initial states were adequate, the dry Feb-Mar period had the greatest impact and was caught by the model.

San Juan - Navajo Res- Archuleta- Nr (NVRN5)
2016-06-15Apr-Jul Official 50% Forecast: 545 kaf (74% of average)
ESP is Unregulated and No Precipitation Forecast Included

Model response to early February storm

Did not chase model increase due to dry / warm weather pattern on horizon

Observed 566 KAF / 77% avg

The latest (2016-07-17) 50% ESP forecast is 571 kaf.
Plot Created 2016-07-17 07:51:43, NOAA / NWS / GBRFC
**Purple ESP forecasts do not include observed and are not total runoff.**
Lake Powell Upstream Forecasts

Green – Green River, UT

Colorado – Cisco, nr

San Juan – Bluff, nr
### Lake Powell

#### 2016 Forecasts

<table>
<thead>
<tr>
<th>Month</th>
<th>KAF</th>
<th>%AVG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>6400</td>
<td>89%</td>
</tr>
<tr>
<td>Feb</td>
<td>6700</td>
<td>94%</td>
</tr>
<tr>
<td>Mar</td>
<td>5700</td>
<td>80%</td>
</tr>
<tr>
<td>Apr</td>
<td>5300</td>
<td>74%</td>
</tr>
<tr>
<td>May</td>
<td>5500</td>
<td>77%</td>
</tr>
<tr>
<td>Jun</td>
<td>6500</td>
<td>91%</td>
</tr>
<tr>
<td><strong>Obs</strong></td>
<td>6610</td>
<td>92%</td>
</tr>
</tbody>
</table>

Great Basin forecasts performed well

- Early runoff in March was not captured in April through July totals
- Low elevation basins in particular showed early runoff

- Late spring precip benefitted northern areas
Bear at Utah/Wyoming Stateline

April 1st Forecast was 94kaf
Notice the wet weather during May and then a snow Adjustment in June.

Final Obs Vol 114 kaf/ 102%
April 1st Forecast was 94 kaf

Final Obs Vol 96 kaf/ 87%

The latest (2016-07-30) 50% ESP forecast is 97 kaf.

Plot Created 2016-08-04 14:52:14, NOAA / NWS / CBRFC

**Purple ESP forecasts do not include observed and are not total runoff.**
• Strong El Niño Event occurred
  – Correlation with higher flows in the Lower Colorado River Basin
  – Past El Niño events are weighted in our Lower Basin Forecasts
• Precipitation expected during an El Niño event did not occur
Salt River: 215 KAF for Jan-May 69% median

The latest (2016-05-30) 50% ESP forecast is 210 kaf.

Plot Created 2016-08-24 07:20:41, NOAA/NWS/CBRFC

**Purple ESP forecasts do not include observed and are not total runoff.**
Upper Gila

Gila River:
49 KAF for Jan-May
88% median
Virgin River: 42 KAF for Apr-Jul 72% average
• Overall, Hydrologic Model performed well
  – Model states entering the winter were good!
  – Dry and Warm February and March significantly impacted runoff
  – Late season storms brought increased water supply, but impacted forecast performance

• El Niño did not pan out in the Lower Colorado River Basin