CBRFC Water Supply Webinar
November 8, 2012

CBRFC Staff
(Kevin Werner, Ashley Nielson, Brenda Alcorn, Stacie Bender, Tracy Cox, Greg Smith, Brent Bernard)

These slides: http://www.cbrfc.noaa.gov/present/present2012.cgi
Outline

• 2012 Year in review
• 2013 Look ahead
  – Climate forecasts
  – CBRFC update
2012 Year in Review

• Climate forecasts
• Precipitation, Temperature, and Snowfall Review
• Water Supply and Peak Flow Flow Forecast Verification
La Niña develops when stronger than normal trade winds push warm water farther west.

Enhanced upwelling makes surface waters in the western Pacific cooler than normal.
La Nina

Sources: cpc.ncep.noaa.gov and iri.columbia.edu/climate/ENSO
CPC Precipitation Outlooks
Seasonal Precipitation, October 2011 - September 2012
(Averaged by Hydrologic Unit)

% Average
- > 150%
- 120 - 150%
- 110 - 129%
- 100 - 119%
- 90 - 99%
- 70 - 89%
- 50 - 69%
- < 50%
- Not Reported

Prepared by
NOAA, National Weather Service
Colorado Basin River Forecast Center
Salt Lake City, Utah
www.water.weather.gov
March, April, May, and June were extremely dry. Over many basins, these three months combined were among the driest AMJs on record.

Source: www.prism.oregonstate.edu
March-July Temperature Departures from Average Maximum/Minimum

Maximum Departures

Degrees (F)
- Above 9
- 7-9 Above
- 5-7 Above
- 3-5 Above
- 1-3 Above
- Normal
- 1-3 Below
- 3-5 Below
- 5-7 Below
- 7-9 Below
- Below 9
- Not Reported
Snow
Snow

Snow

Web Reference:
Storms

SNOTEL percentile rankings for 2012 for all

Web Reference: http://www.cbrfc.noaa.gov/snow/raster/
Snow: Upper Green Basin (Fontenelle)

Snow: Duchesne Basin

Colorado Basin River Forecast Center
Duchesne River Group

To Date: 2% (0.0 / 2.6)
Seasonal: 0% (0.0 / 14.3)
Melt rate -0.0 in/day averaged over last 3 days.

Web Reference: http://www.cbrfc.noaa.gov/station/sweplot/sweplot.cgi??open
Snow: Yampa Basin

Colorado Basin River Forecast Center
Yampa abv Maybell Group

To Date: 7% (0.4 / 5.7)
Seasonal: 2% (0.4 / 22.2)

Melt rate -0.2 in/day
averaged over last 3 days.


Web Reference: http://www.cbrfc.noaa.gov/station/sweplot/sweplot.cgi???open
DRY LAKE (drlc2)

Inches of Snow Water Equivalent (SWE)

Plot Created May 4, 07:57 MDT by the Colorado Basin River Forecast Center (NWS/NOAA)
Snow: Colorado Mainstem (above Cameo)

Colorado Basin River Forecast Center
Upper Colorado Mainstem Group

Snow Water Equivalent (in)

To Date: 2% (0.1 / 3.6)
Seasonal: 0% (0.1 / 16.9)
Accumulation rate 0.0 in/day averaged over last 3 days.

Average 1981-2010  2012  2011

Snow: Gunnison Basin

To Date: 9% (0.3 / 2.8)
Seasonal: 1% (0.3 / 18.6)
Melt rate -0.0 in/day averaged over last 3 days.

Average 1981-2010: blue line
2012: green line
2011: red line
2002: blue line
1990: yellow line
Snow:
San Juan Basin

Colorado Basin River Forecast Center
San Juan Basin Group

To Date: 24% (0.9 / 3.5)
Seasonal: 4% (0.9 / 20.2)

Melt rate -0.0 in/day
averaged over last 3 days.

Created 06/05/15 05:59 UTC
NOAA/CBRFC, 2012


Web Reference: http://www.cbrfc.noaa.gov/station/sweplot/sweplot.cgi??open
Snow:
Six Creeks in Salt Lake County

Colorado Basin River Forecast Center
Six Creeks Headwaters Group

To Date: 0% (0.0 / 4.1)
Seasonal: 0% (0.0 / 25.1)
Accumulation rate: 0.0 in/day averaged over last 3 days.

Average 1981-2010
2012
2011
1981
1979

Created: 06/05/18 04 UTC
NOAA/CBRFC, 2012

Snow: Bear River Basin

Colorado Basin River Forecast Center
Bear River Drainage Group

To Date: 3% (0.1 / 3.0)
Seasonal: 0% (0.1 / 19.1)
Melt rate -0.0 in/day averaged over last 3 days.


TOWER (towc2)

Inches of Snow Water Equivalent (SWE)

Plot Created June 5, 10:10 MDT by the Colorado Basin River Forecast Center (NWS/NOAA)
Ranking of 2012's Peak Annual SWE for Upper Colorado
Ranking of 2012's Melt Date for Upper Colorado

Number of SNOTEL sites

SNOTEL Ranking (0 = Lowest)
Ranking of 2012's Peak Annual SWE Date for Upper Colorado
Official coordinated NOAA/NRCS forecasts are plotted on the map. Forecasts are issued on the date selected above. The forecast valid period varies depending on the typical timing of runoff.
Green River Basin

- Dry everywhere
- Extreme dryness in Yampa, Duchesne
FLAMING GORGE RES, FLAMING GORGE DAM, AT (GRNU1)

Forecast Period: Apr - Jul (Apr Forecast Streamflow)

<table>
<thead>
<tr>
<th>Month</th>
<th>Forecast</th>
<th>Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>190 KAF</td>
<td>110 KAF</td>
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<tr>
<td>Feb</td>
<td>310 KAF</td>
<td>290 KAF</td>
</tr>
<tr>
<td>Mar</td>
<td>375 KAF</td>
<td>365 KAF</td>
</tr>
<tr>
<td>Apr</td>
<td>240 KAF</td>
<td>230 KAF</td>
</tr>
<tr>
<td>May</td>
<td>64 KAF</td>
<td>54 KAF</td>
</tr>
<tr>
<td>June</td>
<td>11 KAF</td>
<td>11 KAF</td>
</tr>
</tbody>
</table>

Streamflow - GREEN - FLAMING GORGE RES, FLAMING GORGE DAM, AT (GRNU1)

Mean Absolute Error - GREEN - FLAMING GORGE RES, FLAMING GORGE DAM, AT (GRNU1)

Forecast Period: Apr - Jul

<table>
<thead>
<tr>
<th>Month Forecast Issued</th>
<th>Mean Absolute Error (KAF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec</td>
<td>90</td>
</tr>
<tr>
<td>Jan</td>
<td>117</td>
</tr>
<tr>
<td>Feb</td>
<td>150</td>
</tr>
<tr>
<td>Mar</td>
<td>80</td>
</tr>
<tr>
<td>Apr</td>
<td>80</td>
</tr>
<tr>
<td>May</td>
<td>100</td>
</tr>
<tr>
<td>June</td>
<td>110</td>
</tr>
</tbody>
</table>
Yampa nr Maybell

Streamflow - YAMPA - MAYBELL, NR (MBLC2)
Forecast Period: Apr - Jul (Mar Forecast Streamflow)

Mean Absolute Error - YAMPA - MAYBELL, NR (MBLC2)
Forecast Period: Apr - Jul
# 2011 Green River Basin Records

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>NEW RECORD</th>
<th>OLD RECORD</th>
<th>% DIFF</th>
<th>OLD RECORD YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Fork of Smiths Fork</td>
<td>64</td>
<td>57</td>
<td>12%</td>
<td>1983</td>
</tr>
<tr>
<td>Blacks Fork nr Robertson</td>
<td>202</td>
<td>125</td>
<td>62%</td>
<td>1975</td>
</tr>
<tr>
<td>Yampa abv Stagecoach</td>
<td>69</td>
<td>56</td>
<td>23%</td>
<td>1997</td>
</tr>
<tr>
<td>Yampa at Steamboat Springs</td>
<td>507</td>
<td>506</td>
<td>0%</td>
<td>1984</td>
</tr>
<tr>
<td>Elk nr Milner</td>
<td>742</td>
<td>552</td>
<td>34%</td>
<td>1917</td>
</tr>
<tr>
<td>Elk Head nr Hayden</td>
<td>171</td>
<td>119</td>
<td>44%</td>
<td>1997</td>
</tr>
<tr>
<td>Yampa at Maybell</td>
<td>1988</td>
<td>1921</td>
<td>3%</td>
<td>1984</td>
</tr>
<tr>
<td>Little Snake nr Slater</td>
<td>353</td>
<td>281</td>
<td>26%</td>
<td>1984</td>
</tr>
<tr>
<td>Little Snake at Dixon</td>
<td>775</td>
<td>754</td>
<td>3%</td>
<td>1984</td>
</tr>
<tr>
<td>Little Snake at Lily</td>
<td>881</td>
<td>790</td>
<td>12%</td>
<td>1984</td>
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<tr>
<td>White River nr Meeker</td>
<td>521</td>
<td>519</td>
<td>0%</td>
<td>1984</td>
</tr>
<tr>
<td>West Fork Duchesne</td>
<td>44</td>
<td>38</td>
<td>16%</td>
<td>1986</td>
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<tr>
<td>Duchesne nr Tabiona</td>
<td>217</td>
<td>189</td>
<td>15%</td>
<td>1952</td>
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<tr>
<td>Upper Stillwater-Rock Creek</td>
<td>153</td>
<td>136</td>
<td>13%</td>
<td>1986</td>
</tr>
<tr>
<td>Rock Creek</td>
<td>186</td>
<td>158</td>
<td>18%</td>
<td>1986</td>
</tr>
<tr>
<td>Strawberry nr Solider Springs</td>
<td>158</td>
<td>137</td>
<td>15%</td>
<td>1986</td>
</tr>
<tr>
<td>Lake Fork- Moon Lake</td>
<td>127</td>
<td>112</td>
<td>13%</td>
<td>2005</td>
</tr>
<tr>
<td>Yellowstone nr Altonah</td>
<td>125</td>
<td>114</td>
<td>10%</td>
<td>2005</td>
</tr>
<tr>
<td>Duchesne-Myton</td>
<td>824</td>
<td>766</td>
<td>8%</td>
<td>1952</td>
</tr>
<tr>
<td>Duchesne-Randlett</td>
<td>1011</td>
<td>942</td>
<td>7%</td>
<td>1983</td>
</tr>
<tr>
<td>Green River-Green River, UT</td>
<td>64905856*</td>
<td></td>
<td>11%</td>
<td>1983</td>
</tr>
</tbody>
</table>

**RED**=Single Month Volume > April-July
Average

*POR after regulation

White/Yampa=10/10
Duchesne=10/16
<table>
<thead>
<tr>
<th>Location</th>
<th>April-July Volume (KAF)</th>
<th>% Average</th>
<th>2012 L-H</th>
<th>Min (KAF)</th>
<th>Min Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yampa abv Stagecoach</td>
<td>3.52</td>
<td>15%</td>
<td>2/23</td>
<td>1.46</td>
<td>2002</td>
</tr>
<tr>
<td>Yampa at Steamboat Springs</td>
<td>105</td>
<td>40%</td>
<td>4/105</td>
<td>82</td>
<td>2002</td>
</tr>
<tr>
<td>Elk near Milner</td>
<td>173</td>
<td>54%</td>
<td>3/43</td>
<td>135</td>
<td>2002</td>
</tr>
<tr>
<td>Elkhead Creek abv Long Gulch</td>
<td>20.3</td>
<td>28%</td>
<td>2/17</td>
<td>14.8</td>
<td>2002</td>
</tr>
<tr>
<td>Yampa at Maybell</td>
<td>337</td>
<td>36%</td>
<td>4/96</td>
<td>261</td>
<td>1977</td>
</tr>
<tr>
<td>Little Snake nr Slater</td>
<td>73</td>
<td>47%</td>
<td>4/65</td>
<td>51</td>
<td>1977</td>
</tr>
<tr>
<td>Little Snake nr Savery</td>
<td>90</td>
<td>26%</td>
<td>1/23</td>
<td>90</td>
<td>2012</td>
</tr>
<tr>
<td>Little Snake nr Lily</td>
<td>111</td>
<td>32%</td>
<td>4/90</td>
<td>59</td>
<td>1934</td>
</tr>
<tr>
<td>White near Meeker</td>
<td>111</td>
<td>39%</td>
<td>4/108</td>
<td>81</td>
<td>1977</td>
</tr>
<tr>
<td>White near Watson</td>
<td>98</td>
<td>35%</td>
<td>4/84</td>
<td>72</td>
<td>1977</td>
</tr>
</tbody>
</table>

All April-July Volumes are in bottom five of historical records!
Upper Colorado Mainstem Basin

- Extreme dry
Dillon saw relatively poor forecasts
2012: 206 KAF (31% of average)
2012: 120 KAF (41% of average)
San Juan Basin

- Dry, but not quite as extreme as further north
2012: 230 KAF (55 % of average)
COLORADO - LAKE POWELL, GLEN CYN DAM, AT (GLDA3)
Water Year 2012, Forecast Period Apr-Jul (highlighted)

Forecast Period
HISTORY (1981-2010)
Period Minimum
Period Normal
NORMALS:
Monthly
Period Sum
OBSERVED:
Monthly (QCM, PZ2)
Period Sum
OFFICIAL FORECAST:
reasonable Maximum
Final
Reasonable Minimum
90%-10% (Final)
50%-10% (Final)

CBRFO/NWS/NOAA 10/15/12 16:25 UTC

Streamflow - COLORADO - LAKE POWELL, GLEN CYN DAM, AT (GLDA3)
Forecast Period: Apr - Jul (Apr Forecast Streamflow)

April Forecast

CBRFO/NWS/NOAA 10/15/12 16:25 UTC
Lower Colorado Basin

- Dry again

Phoenix dust storm
SUMMARY:

Early months: overforecast (especially January).

As season progressed: Precip dried out; fcsts dropped.

Fcsts issued in Apr, May, June: were closest to the volume that was eventually observed.

Least Erroneous Official WY12 Fcst: May
SALT RIVER – Forecast Performance the Last 21 Yrs

How did this year Compare?

1991-2012: Exclude 1993

Streamflow - SALT - ROOSEVELT, NR (SLRA3)
Forecast Period: Jan - May (Jan Forecast Streamflow)

This Year
VERDE-HORSHOE: 2011 CBRFC-NRCS COORDINATED FORECASTS

Progressive Forecast Period (Forecast Issue Date through May)

Volume in kAF
VERDE RIVER – Forecast Performance the Last ~ 21 Yrs


Streamflow - VERDE - BLO TANGLE CK, ABV HORSEHOE DAM (VDTA3)
Forecast Period: Jan - May (Jan Forecast Streamflow)

This Year

[Graph showing observed vs. forecasted streamflow volumes from 1991 to 2012, excluding 1980 and 1993, with a marked point for this year.]
All areas:

- Generally dry for an extended period, particularly in the Verde.
- La Nina conditions – continued from last year.
- Dry soil conditions entering the season definitely factored into this year’s forecast.
- Early season snowpack fizzled.
- Forecast guidance below average and declined over time.
- JAN errors tend to be less in dry years compared to wet years.
- Weighted ESP seemed to predict the much below average volume for this year.
Great Basin

- Dry
Weber River at Oakley, Utah

WEBER - OAKLEY, NR (CAWU1)
Water Year 2012, Forecast Period Apr-Jul (highlighted)

Streamflow Scatterplot
1991-2012
January Coordinated Forecast
April Coordinated Forecast
June Coordinated Forecast

2012 Ranked 6th lowest of 108 years

Volume (Kaf)

Forecast Period: Apr - Jul

Forecast Volume (KAF)

Observed Volume (KAF)

R^2 = 0.9928

R^2 = 0.7774

R^2 = 0.9429

57kaf,49%
Peak Flow Forecast Synopsis

• All 50% forecasts were (much) below flood stages
• All 10% forecasts below flood stage
• Upper Green had somewhat higher chances of river flows near bankfull reflecting near average snow pack in that drainage
2012 Summary

- Dry to extremely dry
- January – April forecasts consistent and consistently high throughout basin.
- As extreme dryness in April-June became increasingly evident, forecasts reflected that.
2013 Look Ahead

• Outlook and current situation:
  – Poor antecedent conditions
  – Climate Forecasts and ENSO

• CBRFC updates
  – Daily ESP
  – CBRFC official forecasts
  – Webinars
Soil Moisture

Utah State-wide Soil Moisture

Percent saturation is calculated using the weighted average of volumetric soil moisture content at 2, 8, and 20-inch depths. Saturation is estimated as 40% volumetric water content. The gray area represents the range in saturation values since 2005.
CBRFC
Model
soil moisture
11/1/11
CBRFC Model Soil Moisture 11/1/12
Base flows

Duration hydrograph of daily average streamflow for USGS 09188500
(Drainage Area: 460 square miles, Length of Record: 80 years)

East River at Almont, CO

Duration hydrograph of daily average streamflow for USGS 09239500
(Drainage Area: 588 square miles, Length of Record: 108 years)

Animas River at Durango, CO

Duration hydrograph of daily average streamflow for USGS 09112500
(Drainage Area: 289 square miles, Length of Record: 101 years)

Green at Warren Bridge, WY

Duration hydrograph of daily average streamflow for USGS 09361500
(Drainage Area: 592 square miles, Length of Record: 115 years)

Yampa River at Steamboat Springs, CO
Snow so far
• Series of three storms:
  – Storm #1
    • Today – Sunday
    • Cold temperatures
    • ~1” SWE widespread
  – Storm #2
    • Wed-Fri next week
    • Warmer
    • Smaller precip amounts mostly to the south
  – Storm #3
    • ~11 days out; very strong low. Details very uncertain
Weather forecasts become very uncertain further out in time.
ENSO Neutral

Sources: cpc.ncep.noaa.gov and iri.columbia.edu/climate/ENSO
National Multi Model Ensemble (NMME) current forecasts
ENSO and Streamflow

- Very low correlations in most of upper basin (right: Lake Powell)
- La Nina correlated with low streamflow in lower basin at around 0.2 – 0.3
- Weaker correlations for San Juan Basin with low streamflow and Upper Green with high streamflow
<table>
<thead>
<tr>
<th>Year</th>
<th>Volumes (kaf)</th>
<th>ENSO Status</th>
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<tbody>
<tr>
<td>1970</td>
<td>8037.76</td>
<td>neutral</td>
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<tr>
<td>1971</td>
<td>8180.35</td>
<td>la nina</td>
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<tr>
<td>1972</td>
<td>5494.26</td>
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<td>1973</td>
<td>11262.74</td>
<td>el nino</td>
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<td>1974</td>
<td>6915.13</td>
<td>la nina 2</td>
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<td>1975</td>
<td>9953.16</td>
<td>la nina 2</td>
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<td>1976</td>
<td>5297.75</td>
<td>la nina 3</td>
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<td>1977</td>
<td>1277.39</td>
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<td>1978</td>
<td>8678.09</td>
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<td>1979</td>
<td>11104.25</td>
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<td>1981</td>
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<td>5319.56</td>
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<td>3766.48</td>
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<td>11833.18</td>
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<td>2001</td>
<td>4320.62</td>
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<td>2002</td>
<td>1126.76</td>
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<td>2009</td>
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<td>neutral</td>
</tr>
<tr>
<td>2010</td>
<td>5795.43</td>
<td>el nino</td>
</tr>
</tbody>
</table>

Note: ENSO status: el nino, neutral, la nina.
La Nina and Streamflow

WBRW4 Streamflow-Climate Variability Relationship

NVRNS Streamflow-Climate Variability Relationship

VIRU1 Streamflow-Climate Variability Relationship

SLRA3 Streamflow-Climate Variability Relationship
What’s New at CBRFC

• Basin focal points / forecasters:
  – Brenda Alcorn (Upper Colorado)
  – Ashley Nielson (Green + Yampa / White)
  – Greg Smith (San Juan + Gunnison)
  – Brent Bernard (Great Basin)
  – Stacie Bender (Sevier + Virgin)
  – Tracy Cox (Lower Colorado)

• Other key staff members:
  – Michelle Stokes (Hydrologist In Charge)
  – Kevin Werner (Service Coordination Hydrologist) – on detail Nov-Apr
  – John Lhotak (Development and Operations Hydrologist)
  – Craig Peterson (Calibrations, Operations lead, etc)
  – Cass Goodman (IT Support, web development, etc)
  – Paul Miller (new senior hydrologist)
  – Vacant senior hydrologist
Forecast Changes

• NRCS/NWS evolving forecast coordination to forecast collaboration. Beginning this WY, each agency will publish their own forecasts which may be different from each other. This change will allow:
  • Daily forecast forecast updates
  • More rapid publication of monthly official forecast numbers (typically be second working day)
  • Scientific based (repeatable and testable) approach to forecasting
  • Routine integration of climate and weather forecasts
  • Forecaster explanation available for cases where forecasts deviate from ESP guidance.
Daily ESP

- Daily ESP will be operational by January 1, 2013.
- Testing is ongoing and we are shooting for daily ESP online by December 1, 2012. This will allow time for feedback and familiarization ahead of January 1.
Forecast Webinar Schedule

• Webinar schedule:
  – Dec 5 (repeat of this webinar with updated outlook)
  – January 8
  – Feb 6
  – Mar 6
  – Apr 4
  – May 6
  – Jun 7

• Webinars at 11am MT

• Additional webinars for peak flow and/or as conditions or requests warrant

• Note: Email list will be changing; NWS discontinued its contract with our current service provider. Details soon.
More Resources

www.cbrfc.noaa.gov

Forecasts
Verification
Soil moisture maps
Precipitation maps
Temperature maps
Presentations
NWS Water Supply Website

These slides: http://www.cbrfc.noaa.gov/present/present2012.cgi