NOAA's Colorado Basin River Forecast Center

Update on Powell to Mead Intervening Flows

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Outline

- Review of Powell-to-Mead intervening flow, or Lake Mead Local (LML) flow
- LML verification over the past 4 years
- New CBRFC forecasting method going forward



Background

- Reclamation has traditionally used a moving 5-Year average to forecast intervening flows in its 24-Month Study
 - Derived using a water balance
 - Residual term
- The CBRFC has forecasted intervening flows, but has not reconciled differences with Reclamation flows until recently
 - Physically based
 - Methodology has been inconsistent with Reclamation needs



Hydrology between Mead and Powell

- Baseflow appears constant
 - Havasu Creek as an indicator of baseflow between Powell and Mead
 - Gain between Powell and Grand Canyon, Grand Canyon and Diamond Fork
- Virgin River Contribution
 - Snowmelt March June
 - Occasional rain events in winter
 - Summer thunderstorms
- Little Colorado River contribution
 - Snowmelt February April
 - Occasional rain events in December March
 - Summer thunderstorms
- Other Streams
 - Summer thunderstorms

CBRFC Method to Measure LML

- Add Mead release, storage change, evaporation
- Add SNWA withdrawals, then subtract Las Vegas wastewater (Account for SNWP Use)
- Subtract a *lagged* Powell release

 $LML_{CBRFC} = Mead_{Release} + \Delta Mead_{Storage} + Evap_{CBRFC} + SNWP_{Use} - Powell_{lagged Release}$





Resolving CBRFC and BOR Methods

 $LML_{BOR} = Mead_{Release} + \Delta Mead_{Storage} + Evap_{BOR} + \Delta Bank_{BOR} + SNWP_{Use} - Powell_{unlagged Release}$ $LML_{CBRFC} = Mead_{Release} + \Delta Mead_{Storage} + Evap_{CBRFC} + SNWP_{Use} - Powell_{lagged Release}$

 $LML_{BOR} - LML_{CBRFC} = (Evap_{BOR} - Evap_{CBRFC}) + \Delta Bank_{BOR} - (Powell_{unlagged Release} - Powell_{lagged Release})$

 $LML_{BOR} = LML_{CBRFC} + (Evap_{BOR} - Evap_{CBRFC}) + \Delta Bank_{BOR} + (Powell_{lagged Release} - Powell_{unlagged Release})$



SLCESPAZ

NATIONAL WEATHER SERVICE COLORADO BASIN RIVER FORECAST CENTER SALT LAKE CITY, UTAH October 16, 2018

The following are updated forecasts for the Lake Mead Local (or intervening flow).

Forecasts include monthly values for October - December.

October 1-15 OBSERVED (EST.) DATA: (From USGS gage data) - values in KAF -

(Colorado Diamond Ck 372.1 + Muddy River 1.1 + Virgin River 5.5 - BOR Powell Release 310.0) ~ 68.7 KAF

FORECASTS (using the Ensemble Prediction System):

* All Forecasts are the 50% exceedance probability value *

Lake Mead Intervening Flow:

October - December Forecasts

October 79 KAF (105% of average) November 55 KAF (96% of average) December 60 KAF (98% of average)

Lake Mead Adjusted Intervening Flow:

October - December Forecasts

October 70.0 KAF November 43.1 KAF December 73.2 KAF

Equation Used for Adjusted Flow:

Inflow(BOR) = Inflow(NWS) + Evap(BOR) - Evap(NWS) + BankStorageChange(BOR)

Tributaries:

Virgin River nr Littlefield Oct 9.3 KAF (86% of median or 83% of average) Nov 9.9 KAF (86% of median or 83% of average) Dec 12.4 KAF (102% of median or 75% of average) Little Colorado nr Cameron Oct 20.8 KAF (1793% of median or 306% of average) Nov 1.9 KAF (552% of median or 51% of average) Dec 2.7 KAF (477% of median or 62% of average) Paria Creek nr Lees Ferry Oct 2.3 KAF (181% of median or 116% of average) Nov 1.2 KAF (96% of median or 90% of average) Dec 1.3 KAF (103% of median or 90% of average) * All Forecasts are the 50% exceedance probability value *

LML Forecast Product

 – 3 Month forecast issued at beginning of month, along with mid-month update

Tributary forecasts for Virgin,
Little Colorado, and Paria

 CBRFC and adjusted BOR forecasts

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LML Verification

- Monthly verification since December 2014 (approx. 45 months, or almost 4 water years). Computed mean absolute error (MAE) and bias stats at each lead time out to 3 months.
- In addition, verified the 3-month total intervening flow forecasts.
- **CBRFC** refers to the CBRFC ESP method. **BOR** is the Bureau of Reclamation forecasts.
- *Climo* refers to the 1980-2010 CBRFC climatology.
- **CBRFC New**: Use Climo in the summer/fall. Use CBRFC ESP method in the winter/spring.

Seasonal MAE at Month0



Seasonal Bias at Month0



MAE/Bias for Month0



3-Month Total MAE



Running 3-Month

Total Aug - Oct MAE 44.9 44 29.8 29.8 ■ BOR ■ CBRFC ■ Climo ■ CBRFC New

Aug - Oct Period (from Aug 1 fcst)

Verification Summary

- The CBRFC ESP method does best in the spring, because it accounts for the snow state preceding the spring melt. However, the method struggles compared to climatology during the summer/fall season.
- The BOR forecasts have the largest MAE, except summer. The biases are generally small.
- *CBRFC New* is the best performing "model". On a monthly and seasonal basis, it ranks near the top in accuracy with an overall small bias. For this reason, it will be the primary CBRFC forecasting method going forward.



LML Fcst Matrix

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Month Issued	Jan	Feb	Mar		CBRFC	LML Fcst	t Metho	onth						
				Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Jan	ESP	ESP	ESP	ļ										
Feb		ESP	ESP	ESP										
Mar			ESP	ESP	ESP									
Apr				ESP	ESP	81-10 Avg								
May					ESP	81-10 Avg	81-10 Avg							
Jun						81-10 Avg	81-10 Avg	81-10 Avg						
Jul							81-10 Avg	81-10 Avg	81-10 Avg		·			
Δυσ								81-10 Avg	81-10 Avg	81-10 Avg				
Son									81-10	81-10	81-10			
Sep									Avg	81-10	Avg 81-10	565		
Oct										Avg	Avg 81-10	ESP		
Nov											Avg	ESP	ESP	
Dec												ESP	ESP	ESP

New Forecast Points



*In the process of adding new forecast points that has the potential to improve LML modeling. Importance of keeping these gages active into the future.