BUREAU OF RECLAMATION

CRFS 2022 Spring Meeting

LC Basin Region Operations Update

Boulder Canyon Operations Office

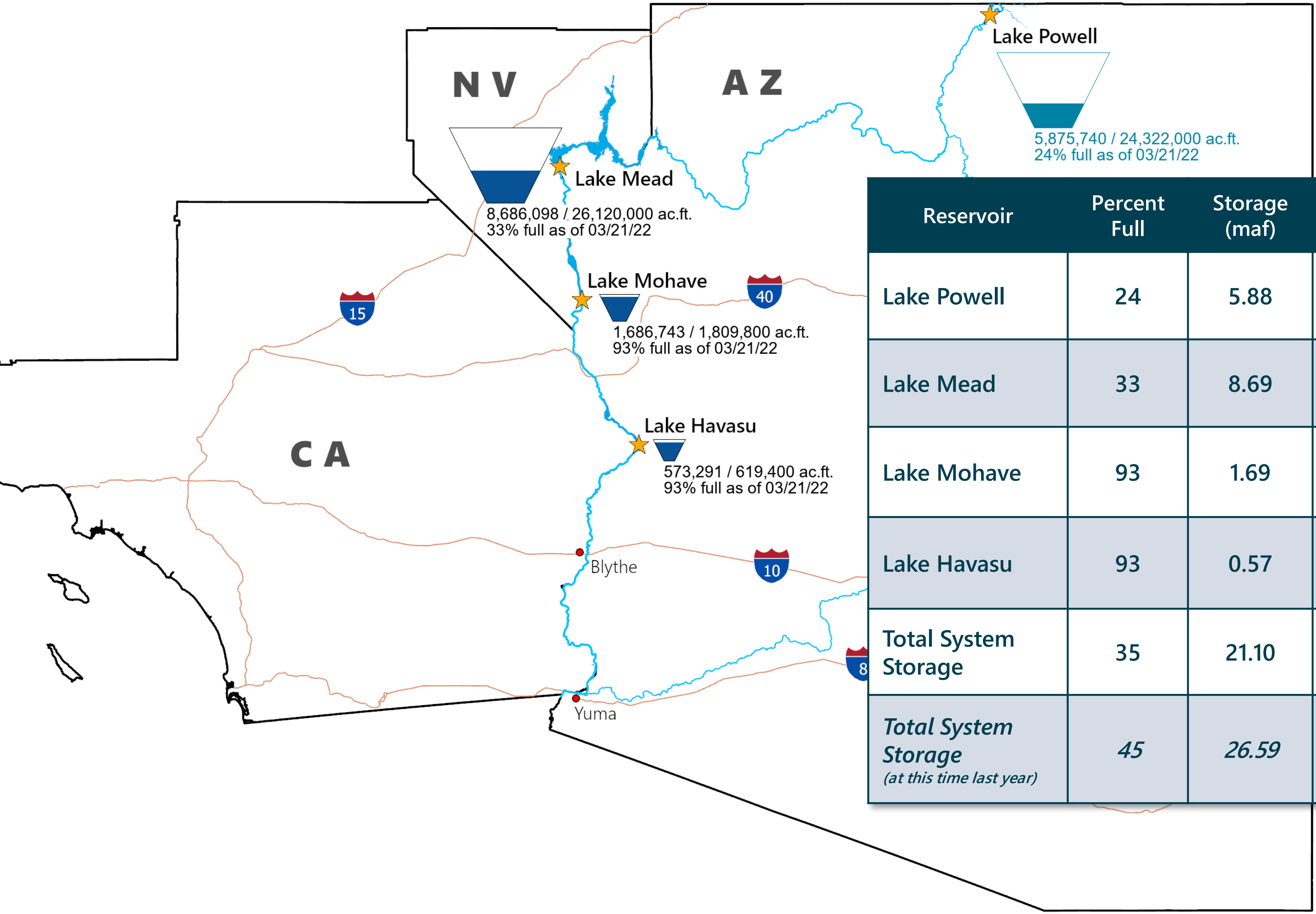
March 24, 2022

Overview

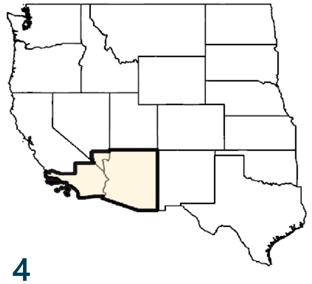
- Current Conditions and Projected Operations
- New Initiatives
  - Mead/Mohave evaporation
  - Experimental monsoon season forecasts

Lower Colorado River Basin Current Conditions and Projected Operations

Lower Colorado Basin System Conditions (as of March 21, 2022)



Reservoir	Percent Full	Storage (maf)	Elevation (feet)
Lake Powell	24	5.88	3,524.17
Lake Mead	33	8.69	1,063.44
Lake Mohave	93	1.69	642.56
Lake Havasu	93	0.57	447.65
Total System Storage	35	21.10	-
Total System Storage (at this time last year)	*45*	*26.59*	-

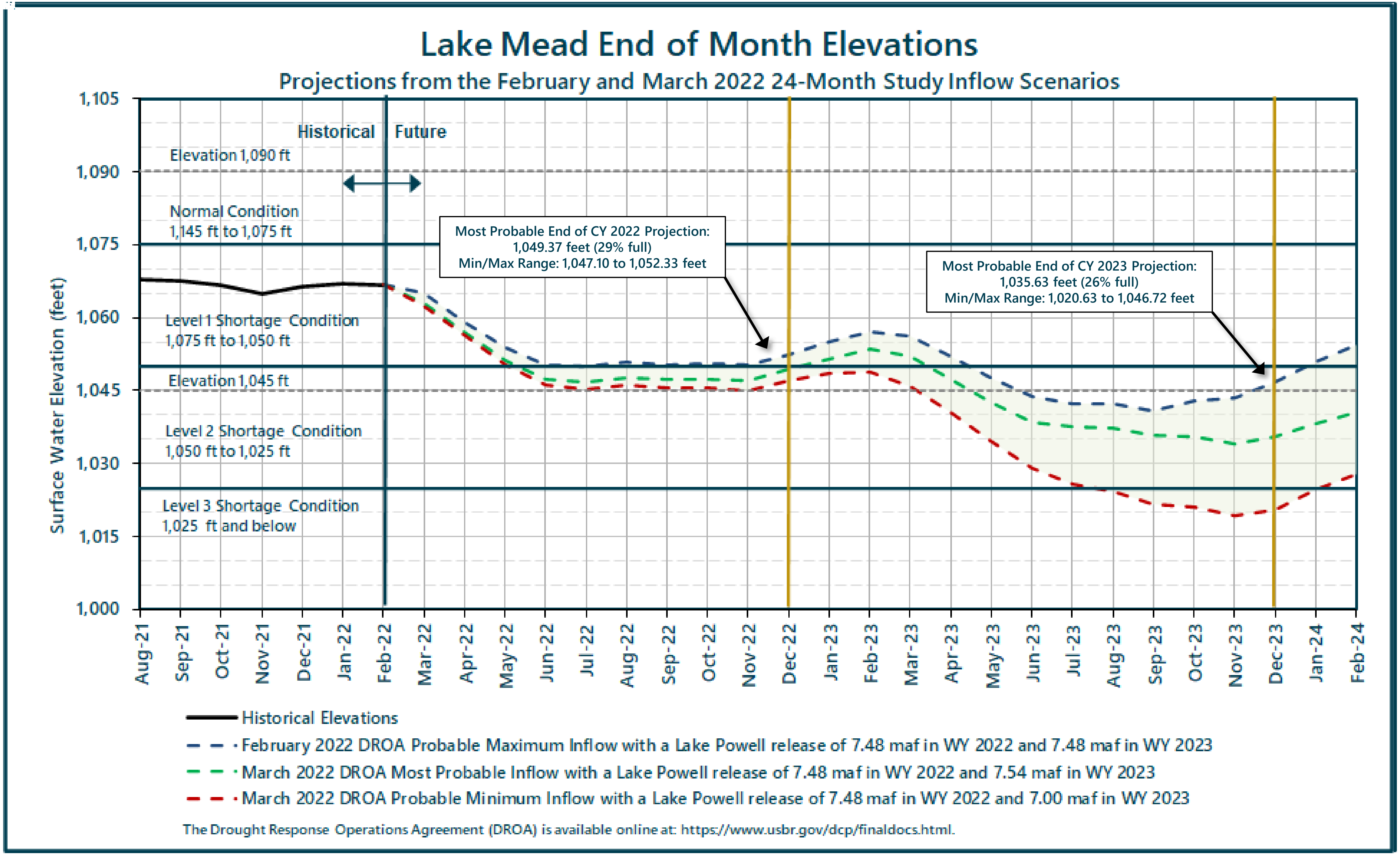


Lower Basin Side Inflows – WY/CY 2022[1,2]
Intervening Flow from Glen Canyon to Hoover Dam

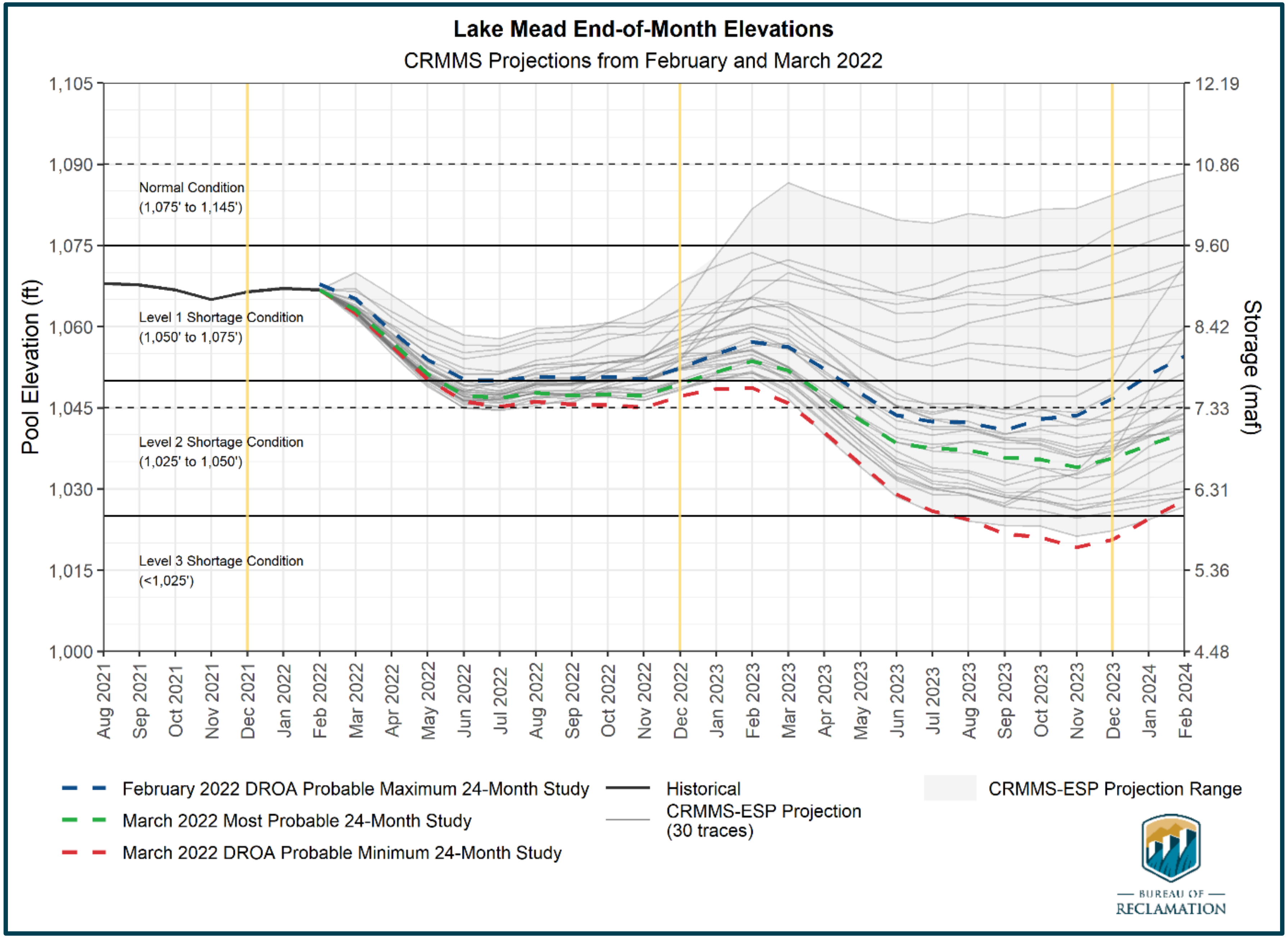
	Month in WY/CY 2022	5-Year Average Intervening Flow (kaf)	Observed Intervening Flow (kaf)	Observed Intervening Flow (% of Average)	Difference From 5-Year Average (kaf)
Observed	October 2021	58	80	138%	22
	November 2021	71	42	60%	-29
	December 2021	67	64	96%	-3
	January 2022	95	65	68%	-30
	February 2022	97	61	62%	-36
Projected	March 2022	111			
	April 2022	81			
	May 2022	50			
	June 2022	29			
	July 2022	64			
	August 2022	81			
	September 2022	71			
	October 2022	58			
	November 2022	71			
	December 2022	67			
	WY 2022 Totals	876	800	91%	-76
	CY 2022 Totals	876	810	92%	-67

[1] Values were computed with the LC's gain-loss model for the most recent 24-month study.

[2] Percents of average are based on the 5-year mean from 2016-2020.



Lake Mead End of Month Elevations
Projections from the February and March 2022 24-Month Study Inflow Scenarios
Surface Water Elevation (feet)
1,105
1,090
1,075
1,060
1,045
1,030
1,015
1,000
Historical
Future
Elevation 1,090 ft
Normal Condition
1,145 ft to 1,075 ft
Level 1 Shortage Condition
1,075 ft to 1,050 ft
Elevation 1,045 ft
Level 2 Shortage Condition
1,050 ft to 1,025 ft
Level 3 Shortage Condition
1,025 ft and below
Most Probable End of CY 2022 Projection:
1,049.37 feet (29% full)
Min/Max Range: 1,047.10 to 1,052.33 feet
Most Probable End of CY 2023 Projection:
1,035.63 feet (26% full)
Min/Max Range: 1,020.63 to 1,046.72 feet
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Dec-22
Jan-23
Feb-23
Mar-23
Apr-23
May-23
Jun-23
Jul-23
Aug-23
Sep-23
Oct-23
Nov-23
Dec-23
Jan-24
Feb-24
Historical Elevations
February 2022 DROA Probable Maximum Inflow with a Lake Powell release of 7.48 maf in WY 2022 and 7.48 maf in WY 2023
March 2022 DROA Most Probable Inflow with a Lake Powell release of 7.48 maf in WY 2022 and 7.54 maf in WY 2023
March 2022 DROA Probable Minimum Inflow with a Lake Powell release of 7.48 maf in WY 2022 and 7.00 maf in WY 2023
The Drought Response Operations Agreement (DROA) is available online at: https://www.usbr.gov/dcp/finaldocs.html.



CRMMS 2-Year Probabilistic Projections are available online at: https://www.usbr.gov/lc/region/g4000/riverops/crmms-2year-projections.html

Projected Lake Mead Operational Tiers

Based on 24-Month Study Inflow Scenarios

Inflow Scenario	CY 2022 Operating Condition	CY 2023 Jan 1, 2023 Projections
Feb Probable Maximum	Tier 1 Shortage Condition[1] + Water Savings Contributions[2]	Tier 1 Shortage Condition + Water Savings Contributions[2] Elévation: 1,052.33 ft
Mar Most Probable		Tier 2 Shortage Condition + Water Savings Contributions[2] Elévation: 1,049.37 ft
Mar Probable Minimum		Tier 2 Shortage Condition + Water Savings Contributions[2] Elévation: 1,047.10 ft

[1]The 2022 operating tier was determined with the August 2021 Most Probable 24-Month Study and is documented in the 2022 AOP.

[2]Water savings contributions consistent with the 2019 Colorado River Drought Contingency Plans and Section IV of IBWC Minute No. 323.

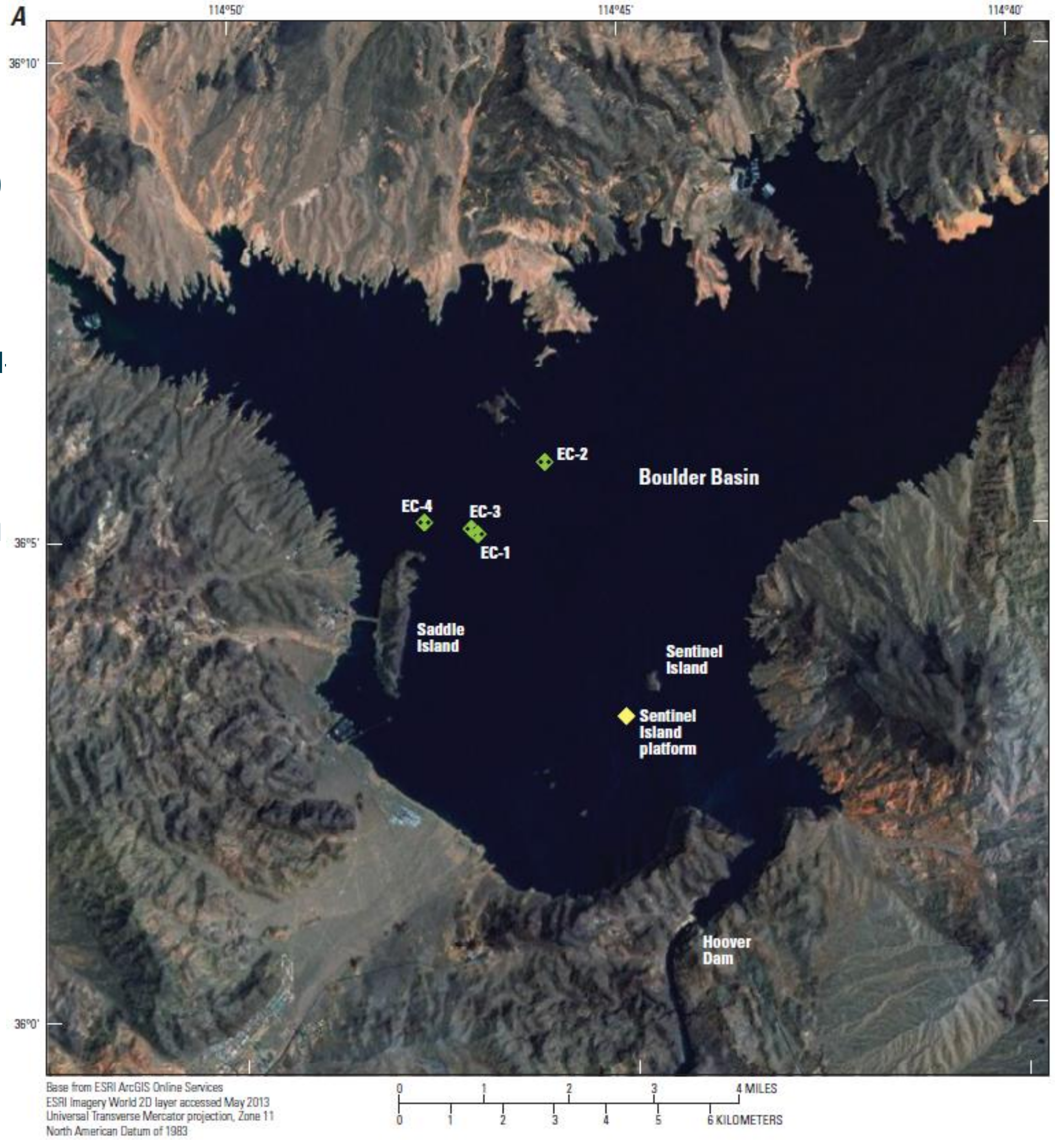
Lower Colorado River Basin Initiatives

Lake Mead and Lake Mohave Evaporation Update

USGS Study; implementation in April 2022

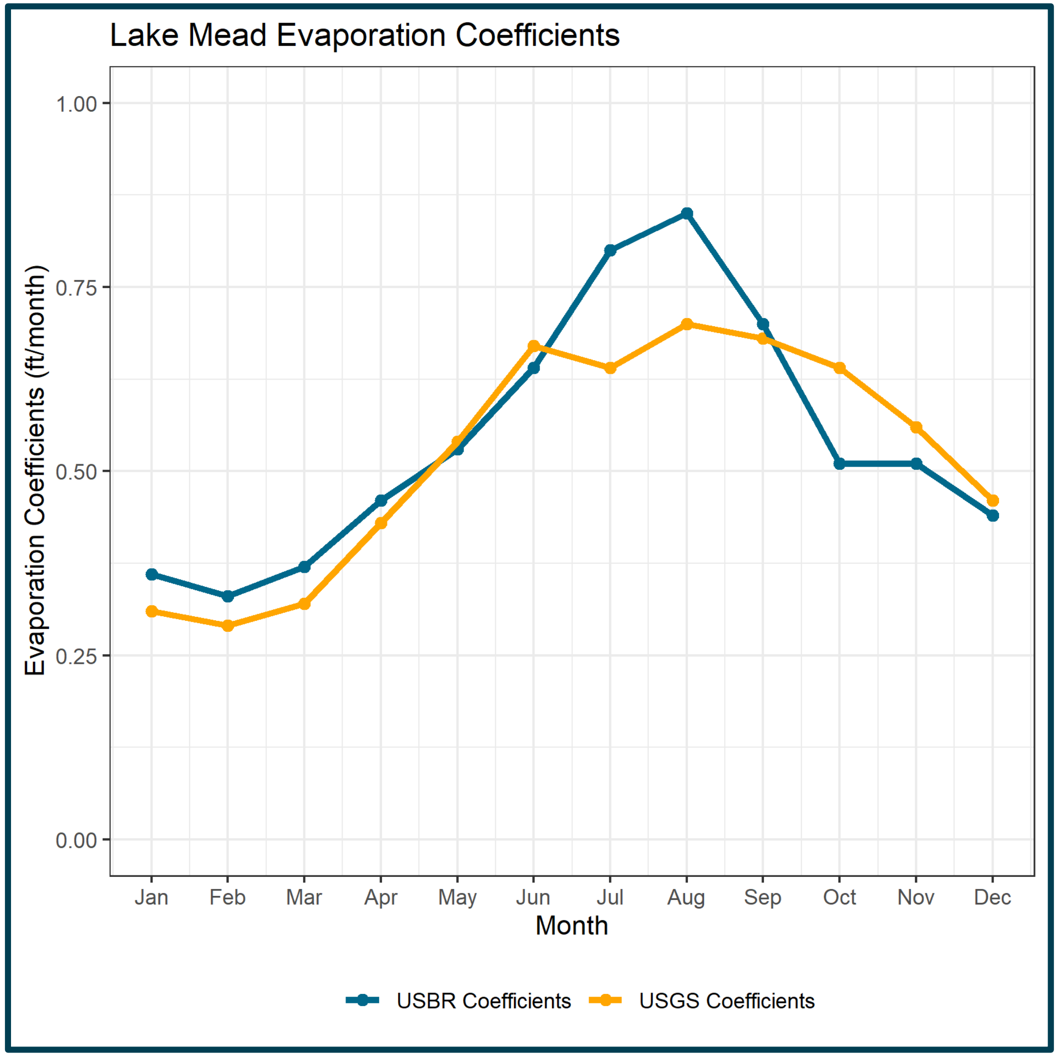
Evaporation Study Background

- Two observation stations were set up
  - Lake Mead (began in FY10 and is still in operation)
  - Lake Mohave (began in FY13 and ran through May 2019)
- Two technical reports have been published by the USGS and are available online
  https://www.usgs.gov/centers/nevada-water-science-center/science/evaporation-lake-mead-and-lake-mohave-lower-colorado?qt-science_center_objects=0#qt-science_center_objects
- Reclamation LCB completed a technical report explaining how the new evaporation information impacts operations models
  - Sensitivity runs using CRSS and CRMMS
  - Technical report underwent Reclamation Peer Review process; Both reports will be published online
- Operational Rollout in April 2022
  - Implement in LCHDB computations (backfill to beginning of WY 2022)
  - Implement in operational model runs



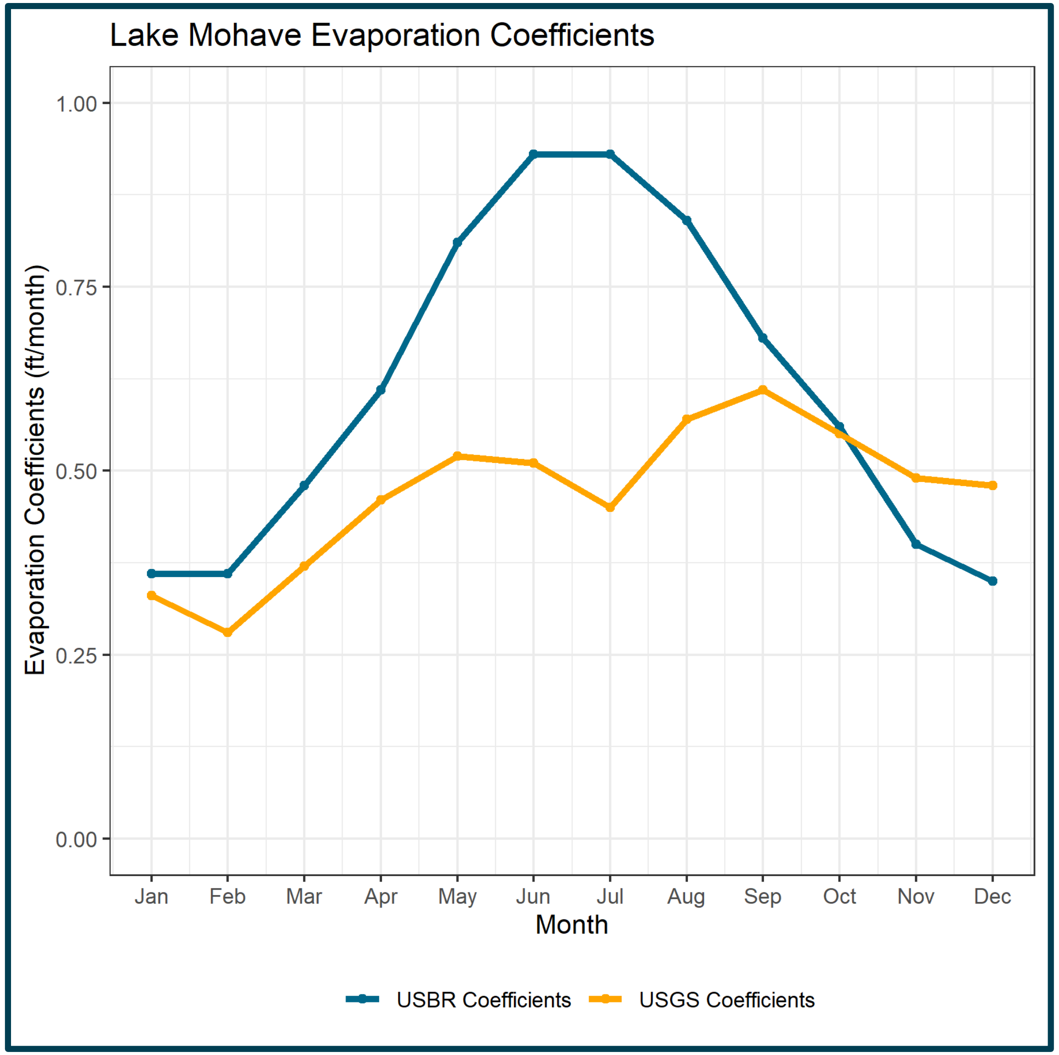
Lake Mead in Southern Nevada (USGS, 2013)

Lake Mead Results



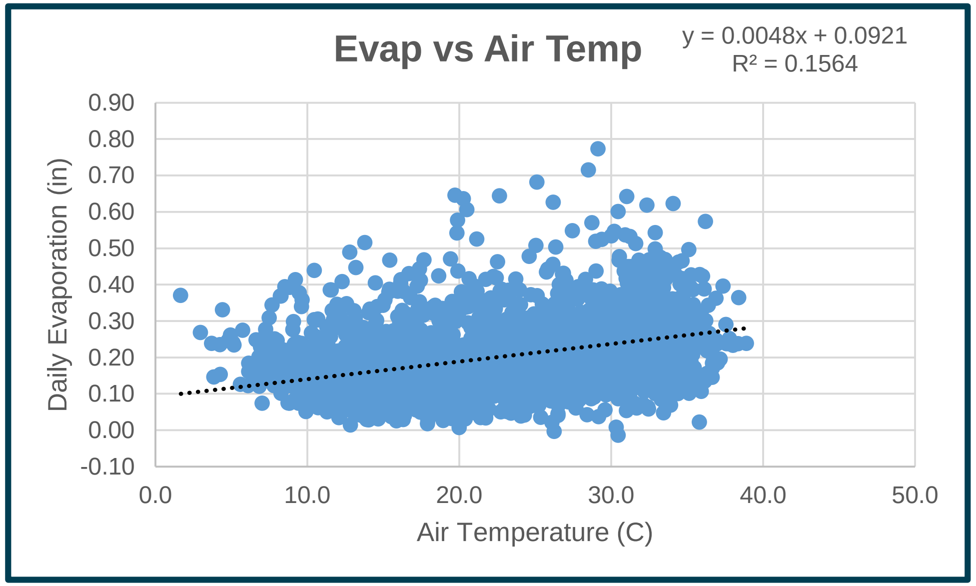
Lake Mead		
Month	**USGS Coefficient (ft/month)**	**USBR Coefficient (ft/month)**
Jan	0.31	0.36
Feb	0.29	0.33
Mar	0.32	0.37
Apr	0.43	0.46
May	0.54	0.53
Jun	0.67	0.64
Jul	0.64	0.80
Aug	0.70	0.85
Sep	0.68	0.70
Oct	0.64	0.51
Nov	0.56	0.51
Dec	0.46	0.44
Total/Year	**6.26**	**6.50**

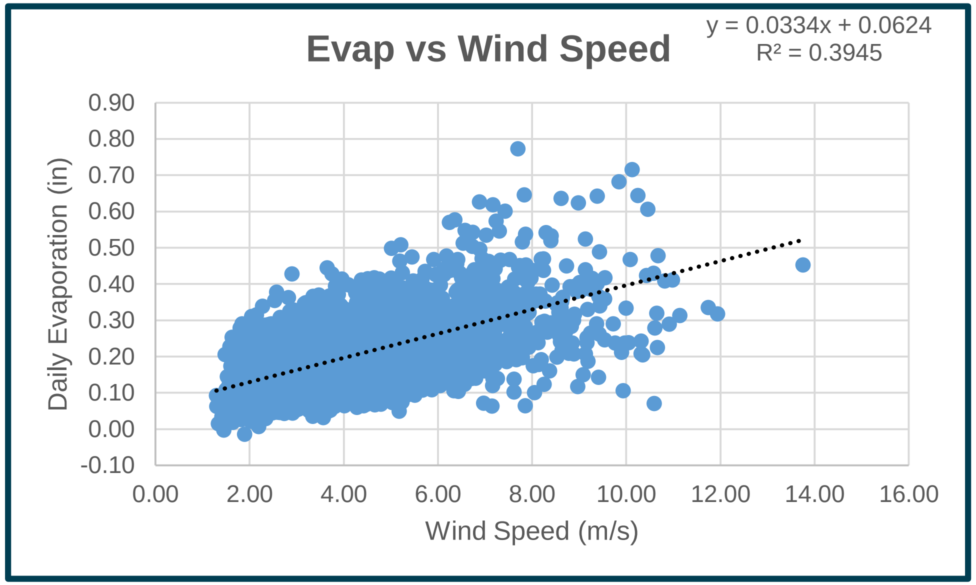
Lake Mohave Results

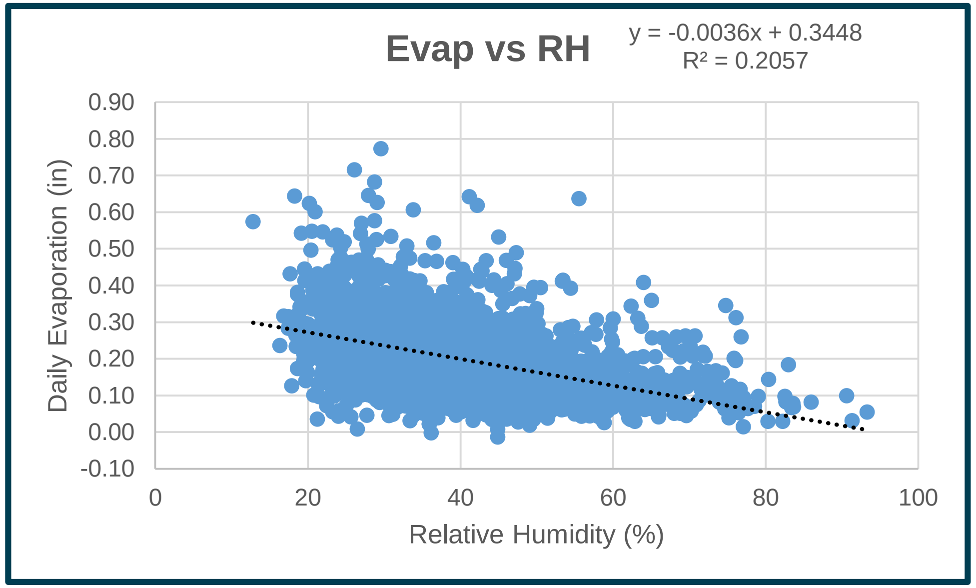


Lake Mohave		
Month	**USGS Coefficient (ft/month)**	**USBR Coefficient (ft/month)**
Jan	0.33	0.36
Feb	0.28	0.36
Mar	0.37	0.48
Apr	0.46	0.61
May	0.52	0.81
Jun	0.51	0.93
Jul	0.45	0.93
Aug	0.57	0.84
Sep	0.61	0.68
Oct	0.55	0.56
Nov	0.49	0.40
Dec	0.48	0.35
Total/Year	**5.62**	**7.31**

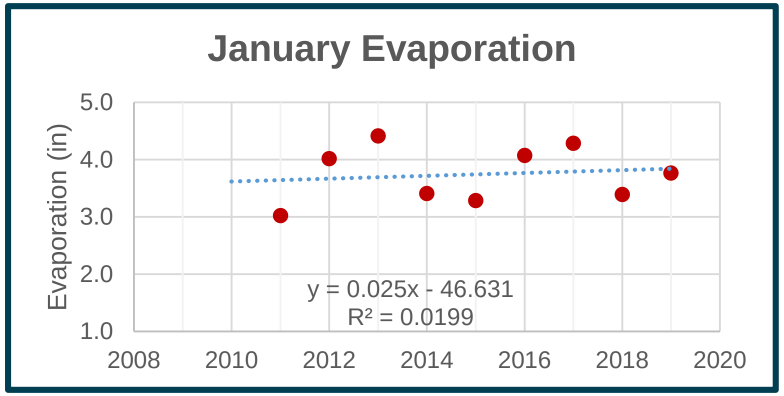
Evaporation Influencers

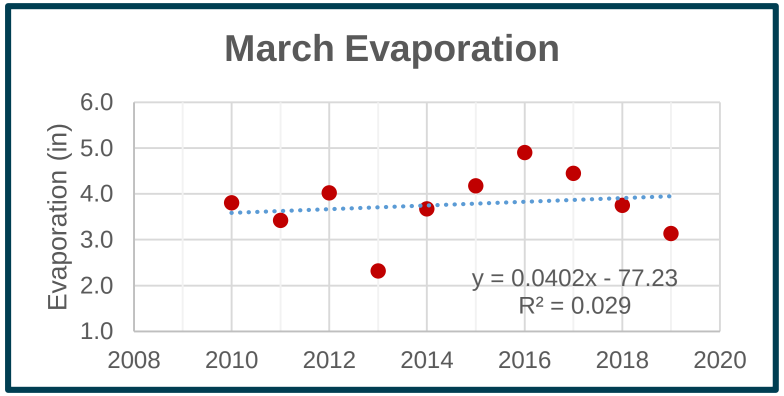


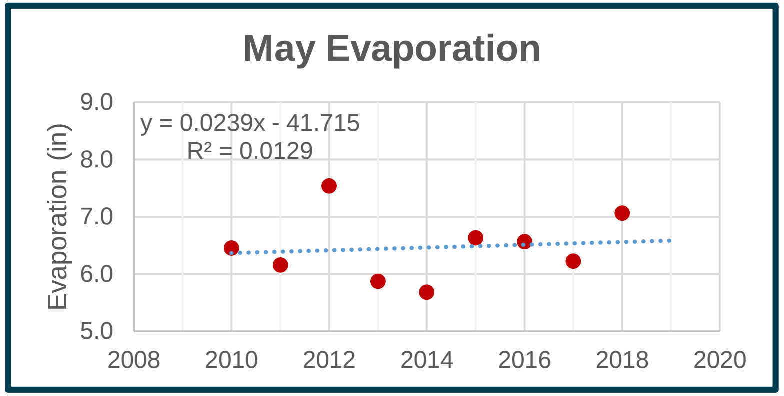


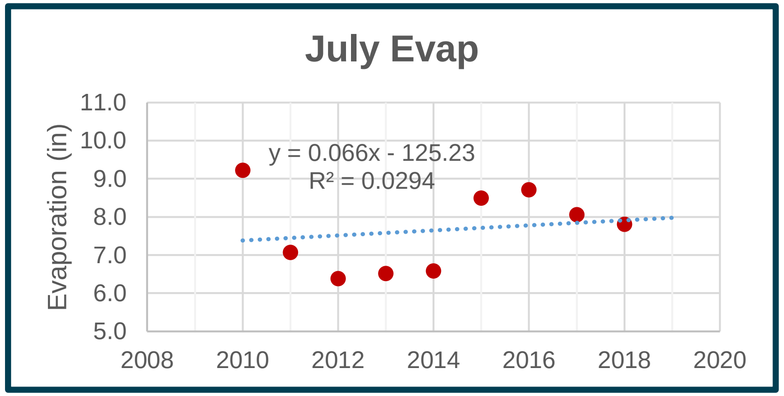


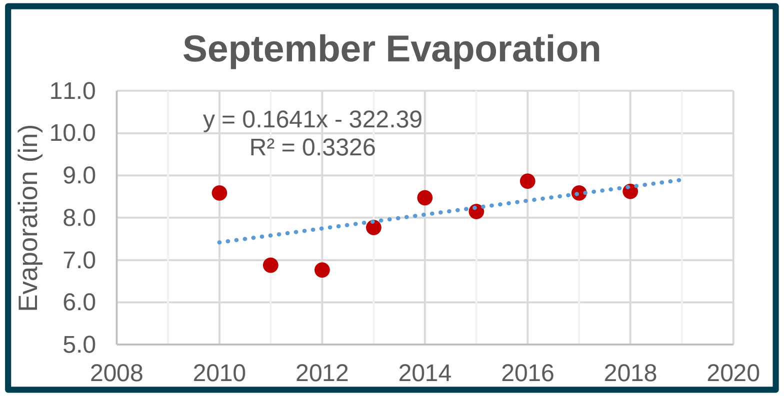
Lake Mead Monthly Evaporation Trends

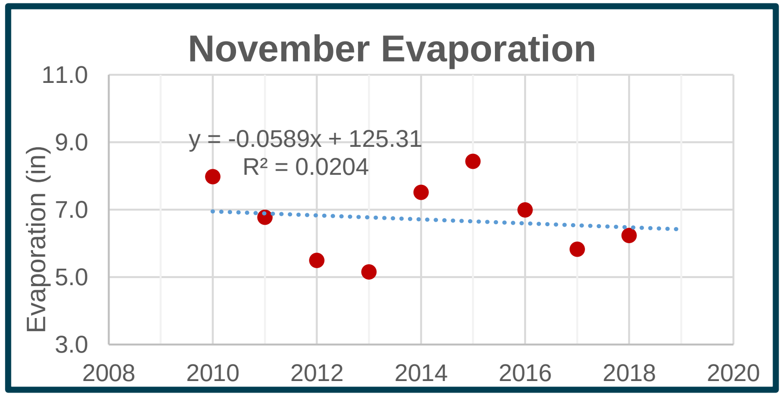






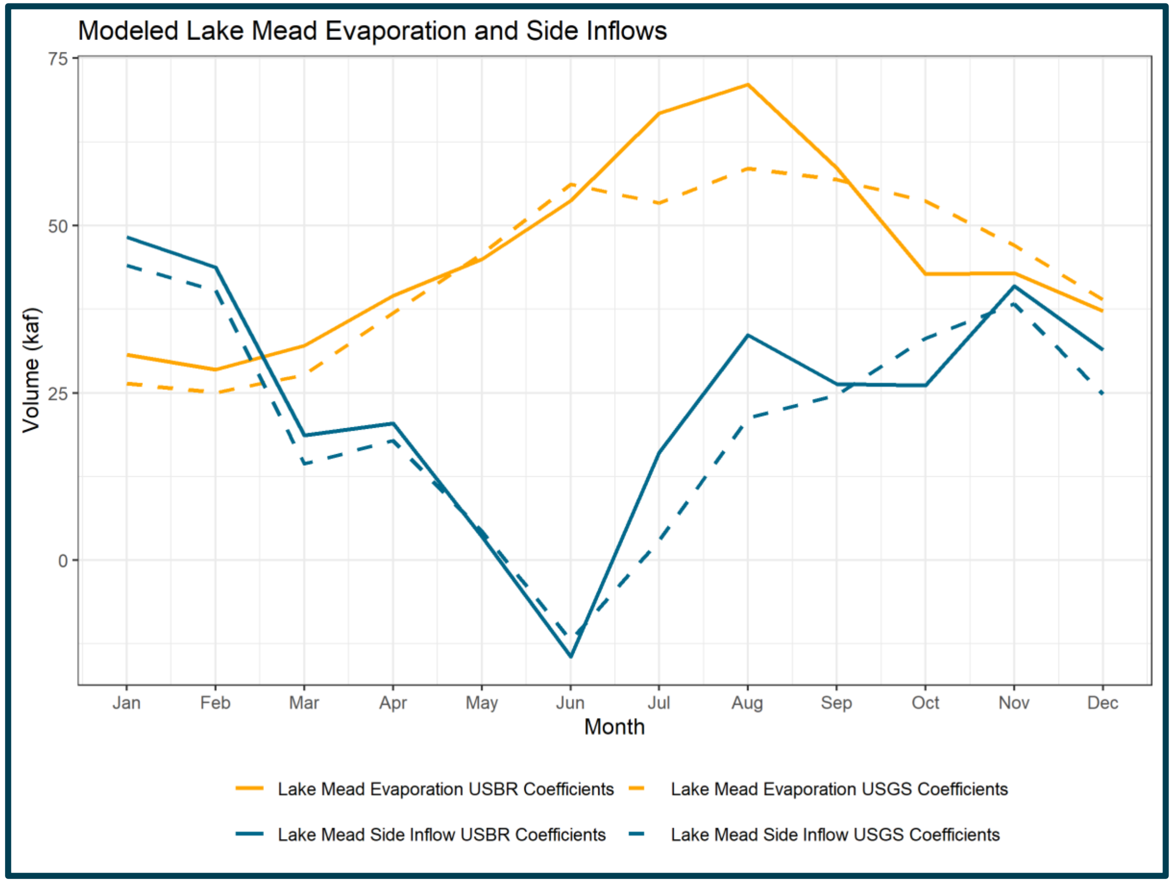




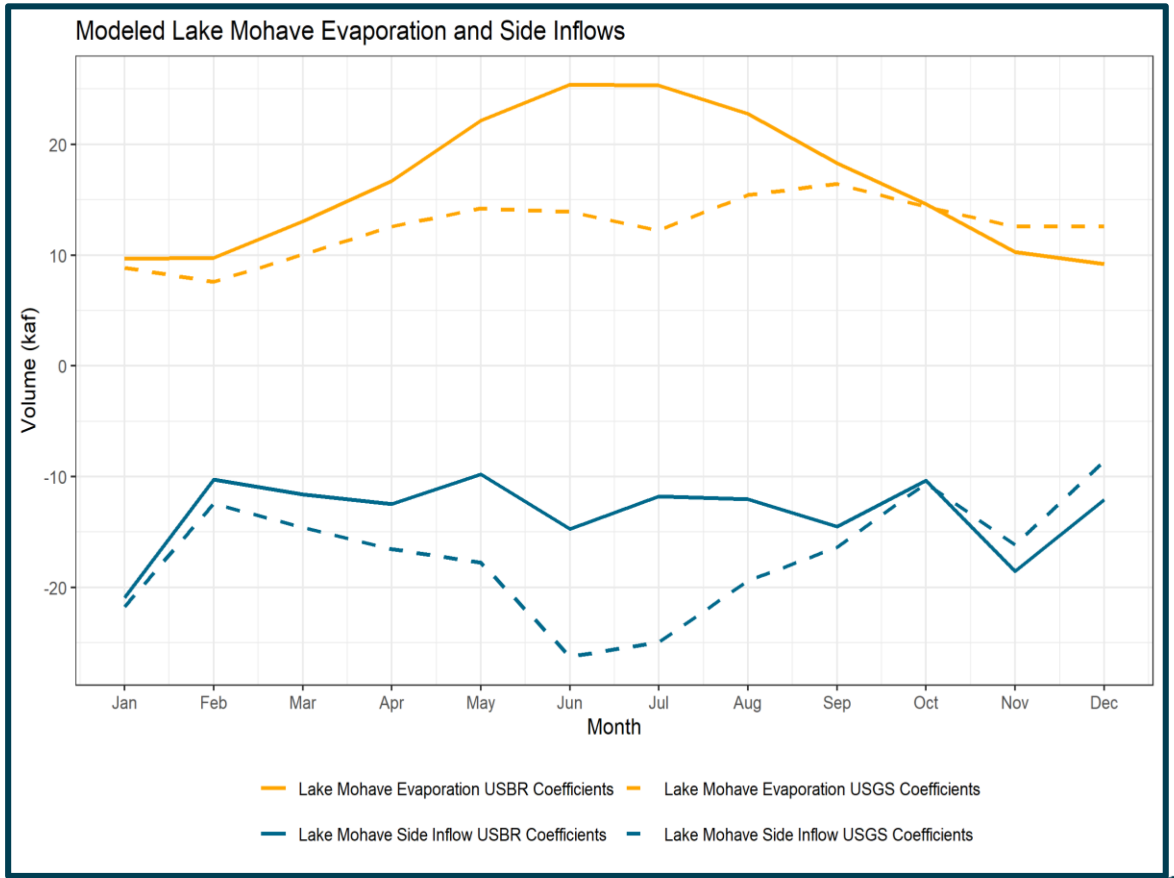


Mead and Mohave Evap and Side Inflows

Lake Mead



Lake Mohave



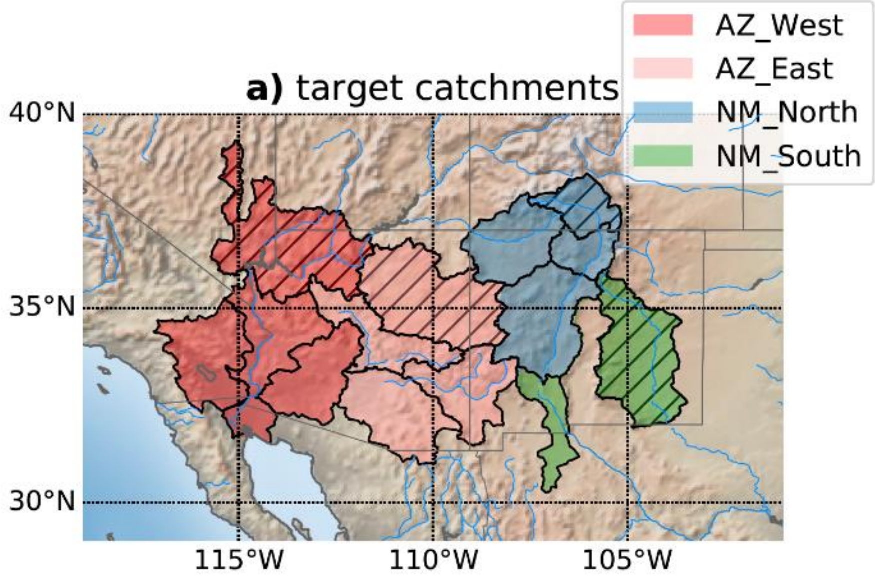
Intervening flow = $\text{Outflow}_{\text{Downstream}} + \Delta\text{Storage} + \text{CU} +$ **Evap** $+ \Delta\text{Bank} - \text{Outflow}_{\text{Upstream}}$

Monsoon Season Weather Types and Experimental Forecasts:

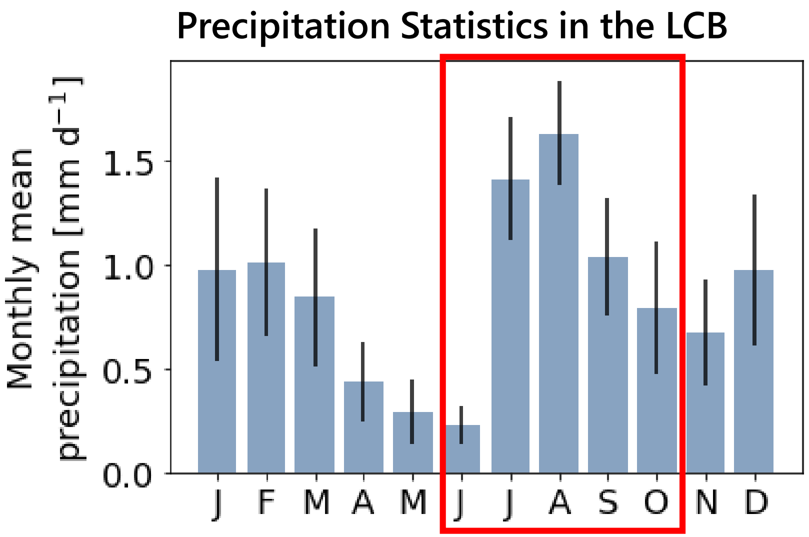
NCAR research project with Andreas Prein and Erin Towler;
inspired by similar project in Albuquerque Area Office
(S&T Project 1782 https://www.usbr.gov/research/projects/detail.cfm?id=1782)

Monsoon Precipitation Research Project

- Purpose: Characterize monsoon precipitation patterns and predictability in Arizona
  - Currently no forecasts are provided for the LCB downstream of Lake Mead
  - Seasonal predictions of monsoon precipitation would be useful for LCB operations
    - Northern and eastern parts of Arizona receive monsoon precipitation that contribute to intervening flows into Lake Mead
    - Water demands downstream of Lake Mead, and thus daily and monthly operations, are heavily influenced by monsoon precipitation in western Arizona downstream of Lake Mead.
- Task 1: Develop Weather Types for Arizona
- Task 2: Evaluate the WT skill in seasonal ensemble forecasts (NMME and ECMWF)
- Task 3: Develop Predictive Statistical Models
- Task 4: Knowledge Transfer and experimental forecasts at LC River Operations
- Next Steps: Analyze how to best utilize the experimental forecasts to project intervening flows below Mead for operations

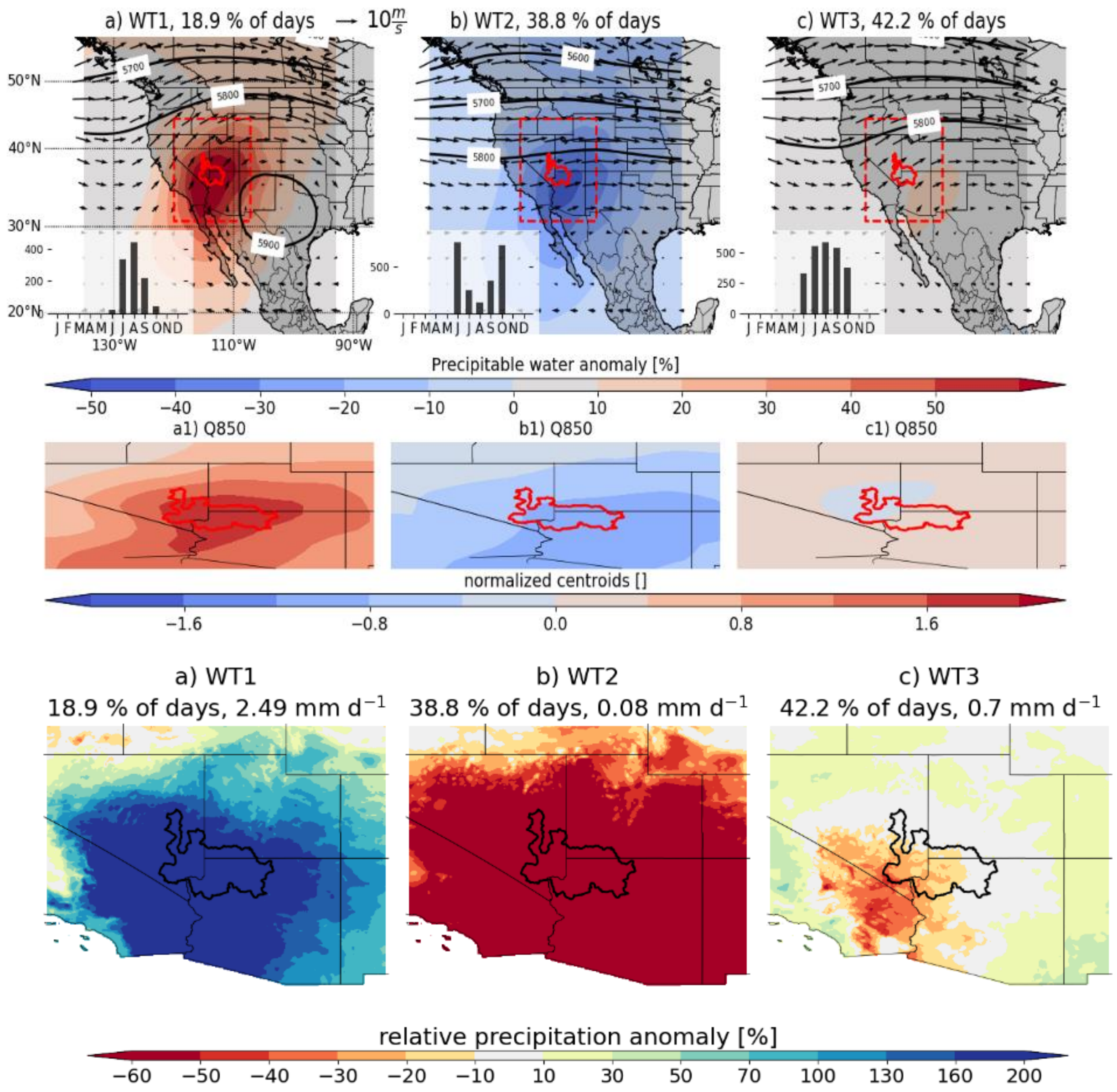


Source: A. Prein and E. Towler; NCAR

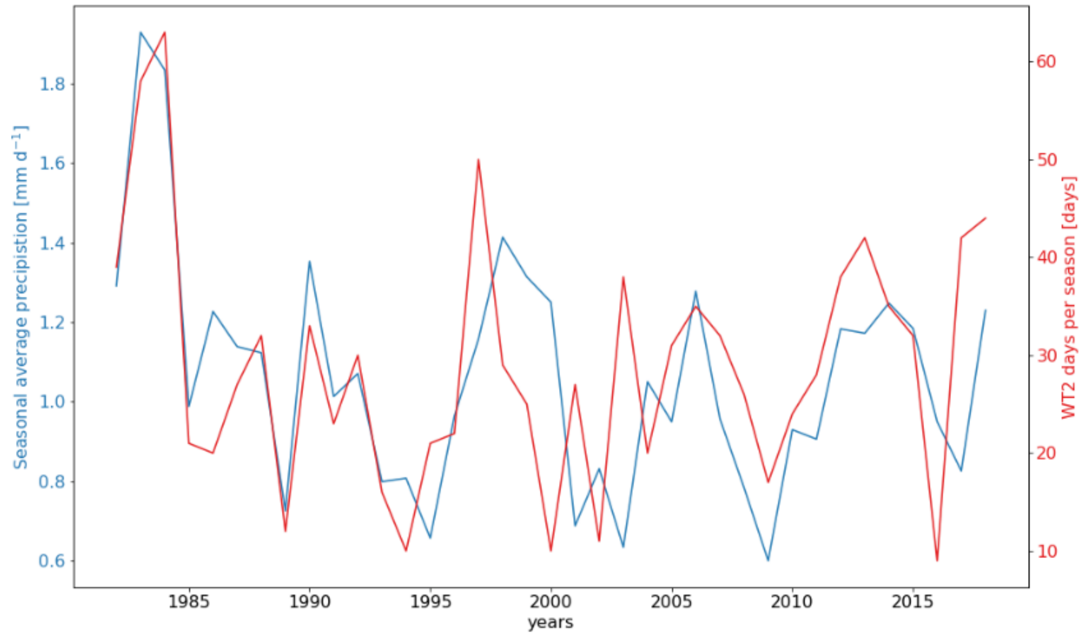


June-October 1982-2018 3WTs

Example: HUC 1501, Variable Q850

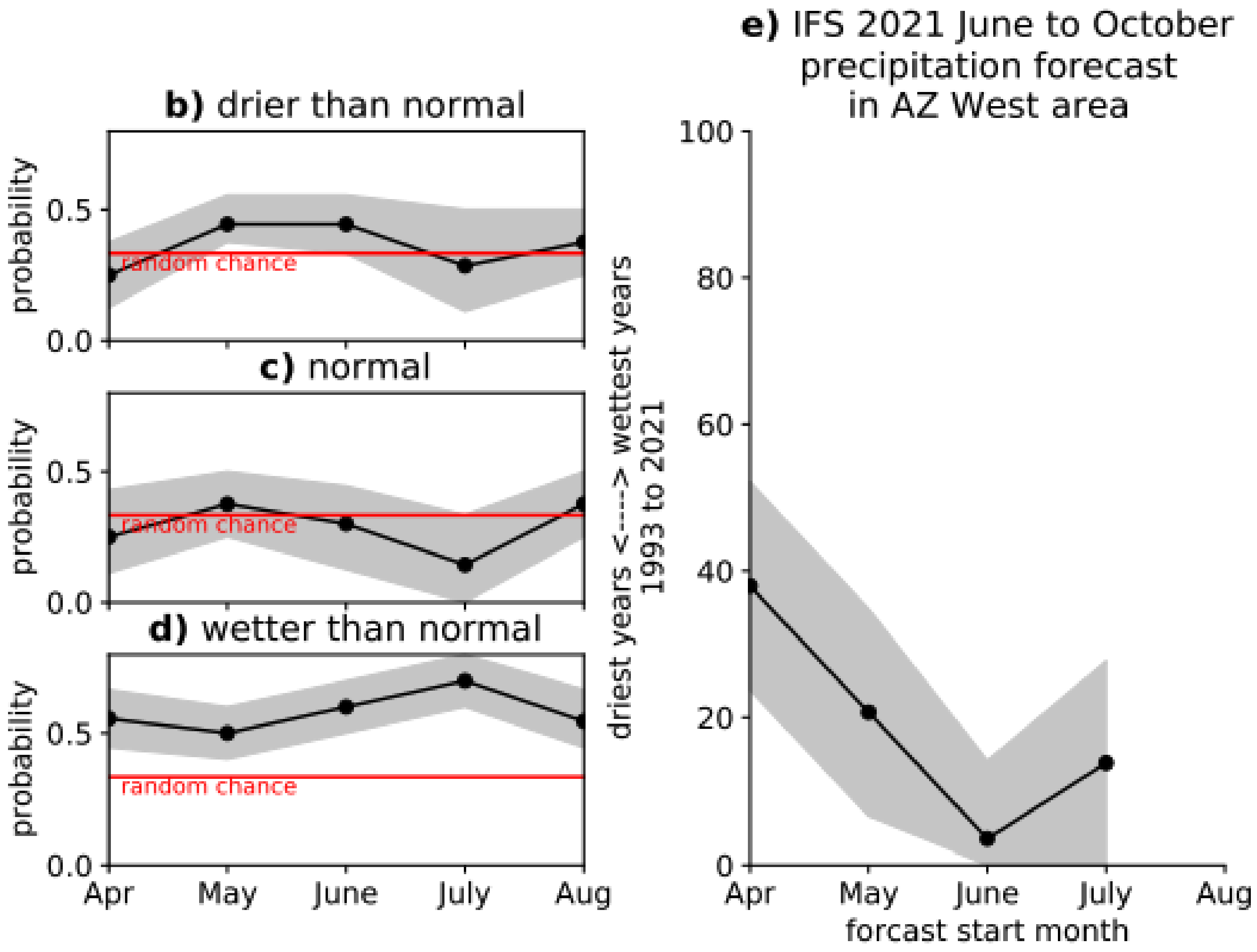


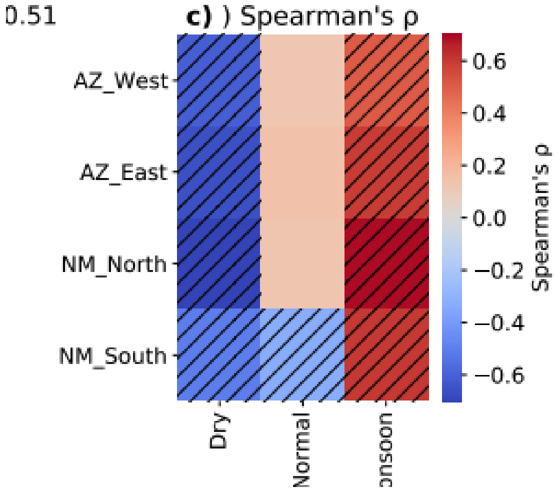
Relation between Seasonal Precipitation and Frequency of WTs



Source: A. Prein and E. Towler; NCAR

Prein et al. (in review) uses the historical relationship between WTs and precipitation… with the IFS to predict precipitation, then sorts result to get the probability of being in each category.





is significantly correlated
erage precipitation over the
red) between 1982 to 2018.
The Pearson correlation co-
regions and WTs. Hatching
).

Statistical prediction models can be represented as:

$$y = f(x) + e$$

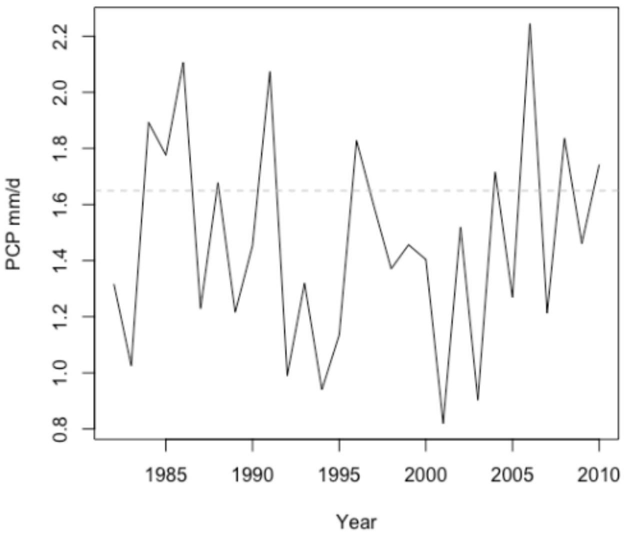
statistical model

predictors

sumWT0	sumWT1	sumWT2
68	43	42
75	43	35
82	48	23
57	74	22
77	52	24

PCP
0
0
1
1
1

Logistic regression (PCP is categorical)



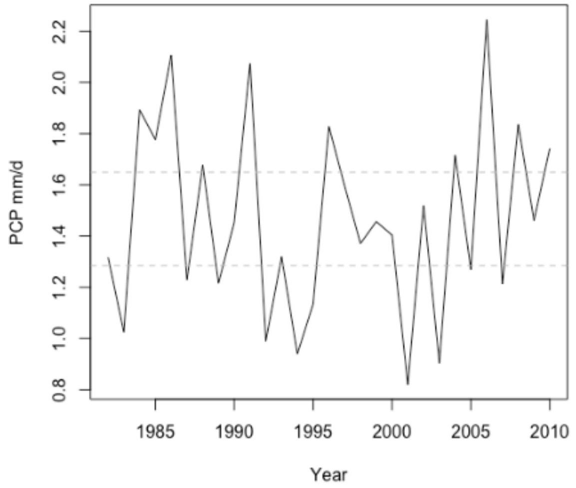
Above median

Q50 (median)

Below median

PCP
1
2
1
3
1

Multinomial regression (PCP is multi-categorical)



Above normal

Q66

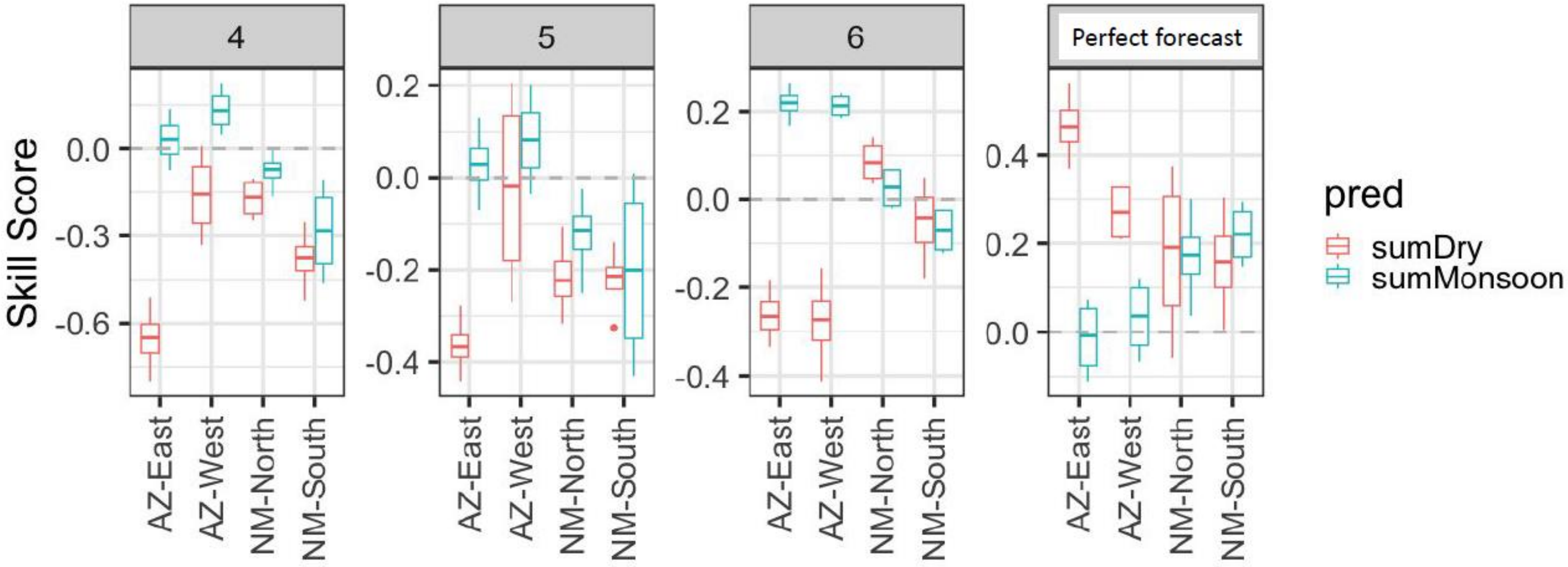
Normal

Q33

Below normal

Source: A. Prein and E. Towler; NCAR

Best predictor (dry vs wet days) varies by region…
But can be opposite of what is most skillful in ECMWF!



Source: A. Prein and E. Towler; NCAR

Lower Colorado River Operations

For further information: https://www.usbr.gov/lc/riverops.html

Email: bcoowaterops@usbr.gov

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