

# Drought Update



[March 15, 2022]

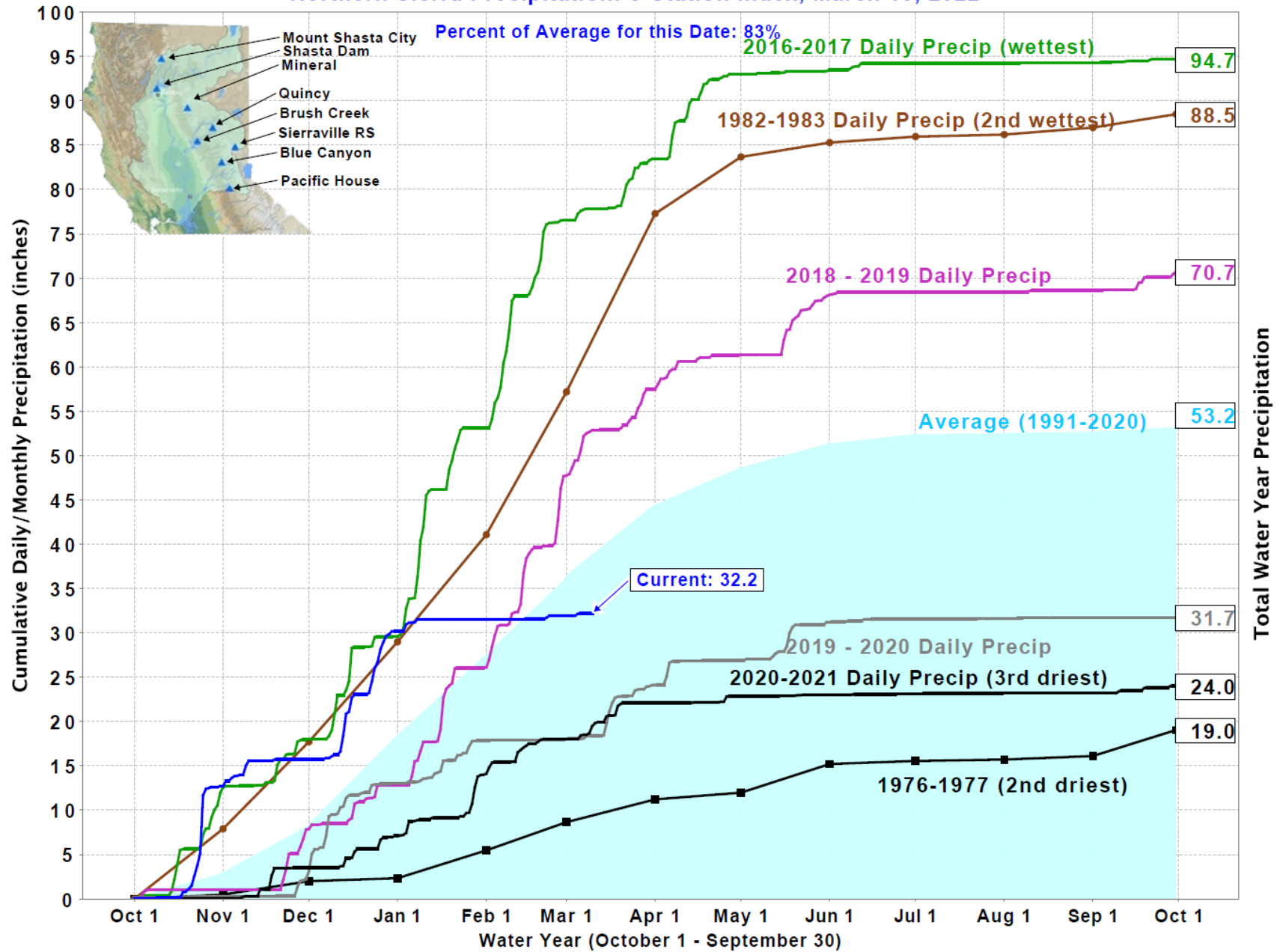
# Drought Update

- Current Hydrologic Conditions
- Watershed-Specific Drought Efforts (March is Water Data Month)
  - Bay-Delta
  - Mill & Deer Creeks
  - Russian River
  - Scott & Shasta Rivers
- Drinking Water
- Other Actions

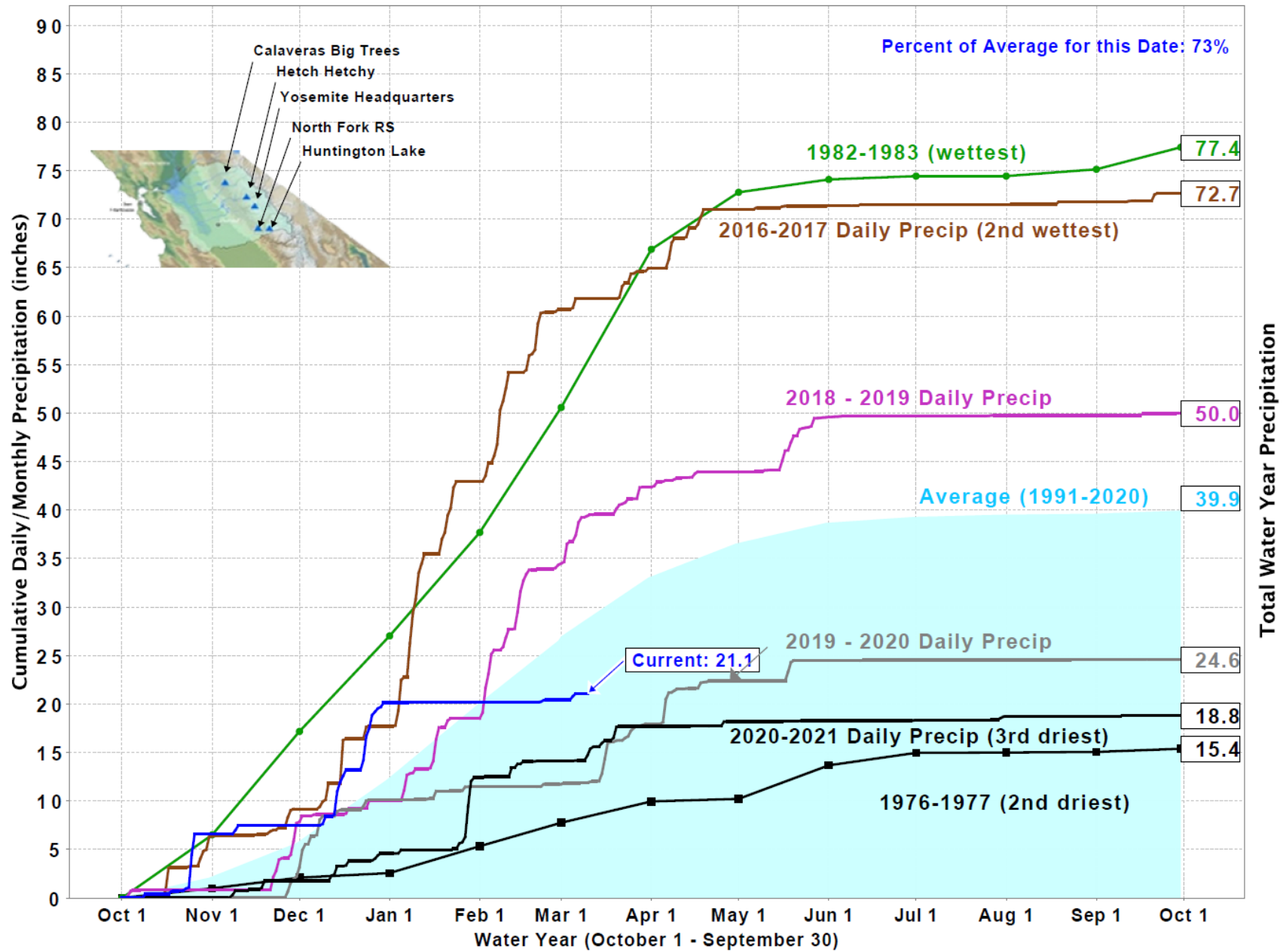
# Hydrologic Conditions Update

- Department of Water Resources & U.S. Bureau of Reclamation
- Division update – hydrologic conditions
- Watershed specific information
- Enforcement update

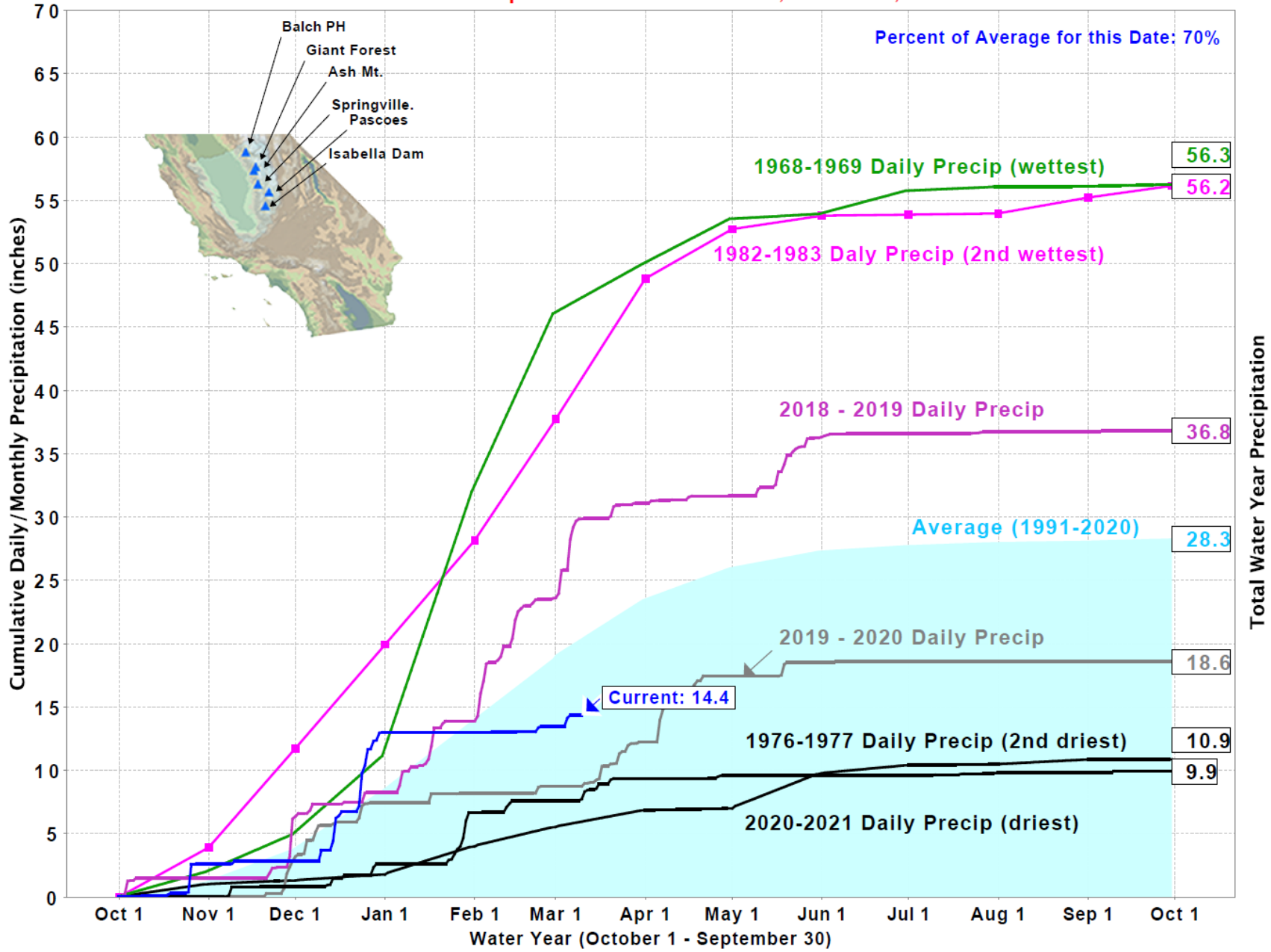
# Northern Sierra Precipitation: 8-Station Index, March 10, 2022



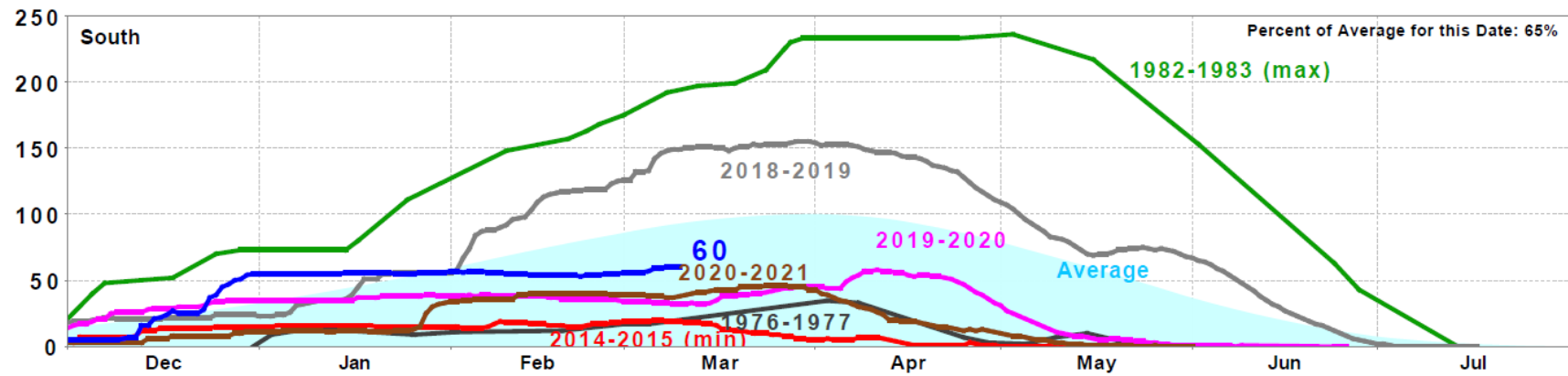
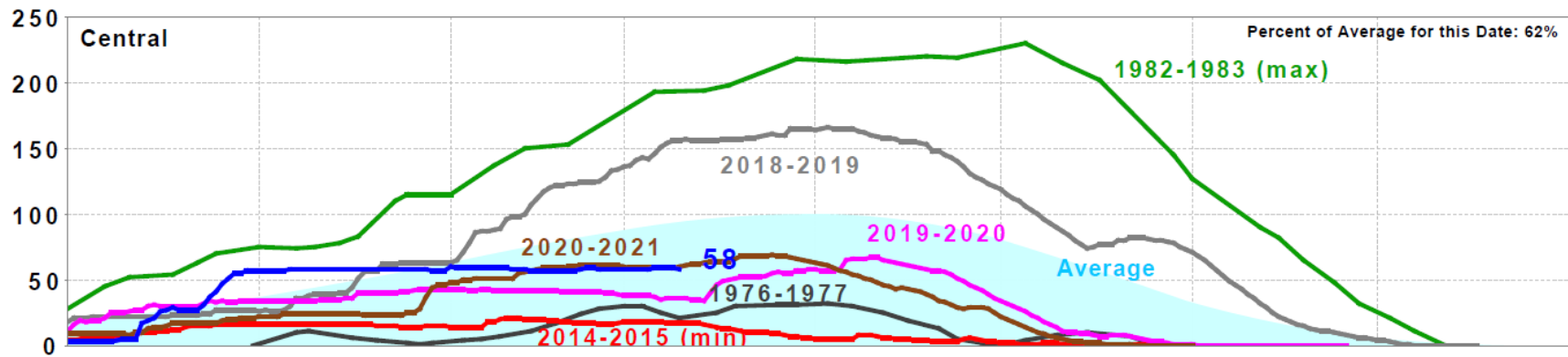
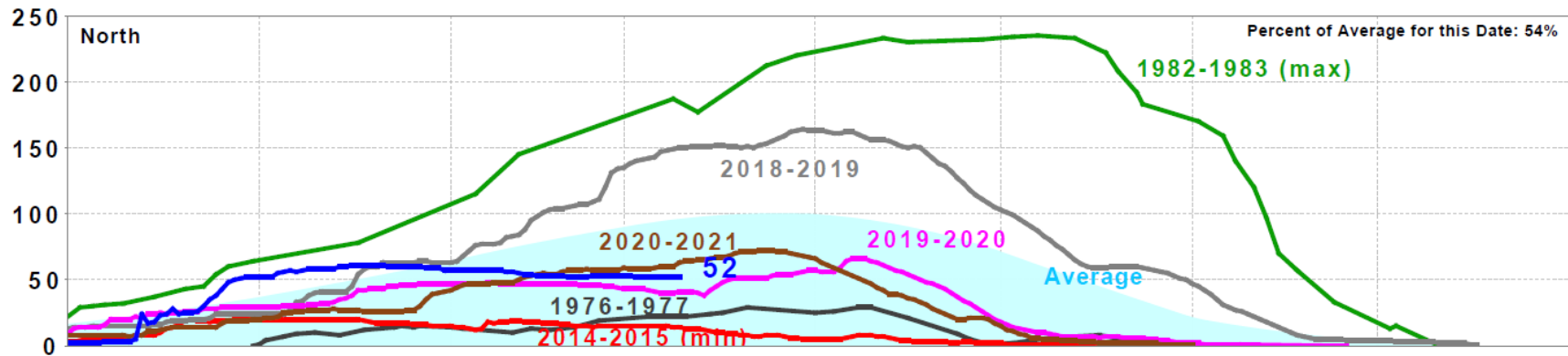
# San Joaquin Precipitation: 5-Station Index, March 10, 2022



### Tulare Basin Precipitation: 6-Station Index, March 10, 2022



# California Snow Water Content, March 10, 2022, Percent of April 1 Average



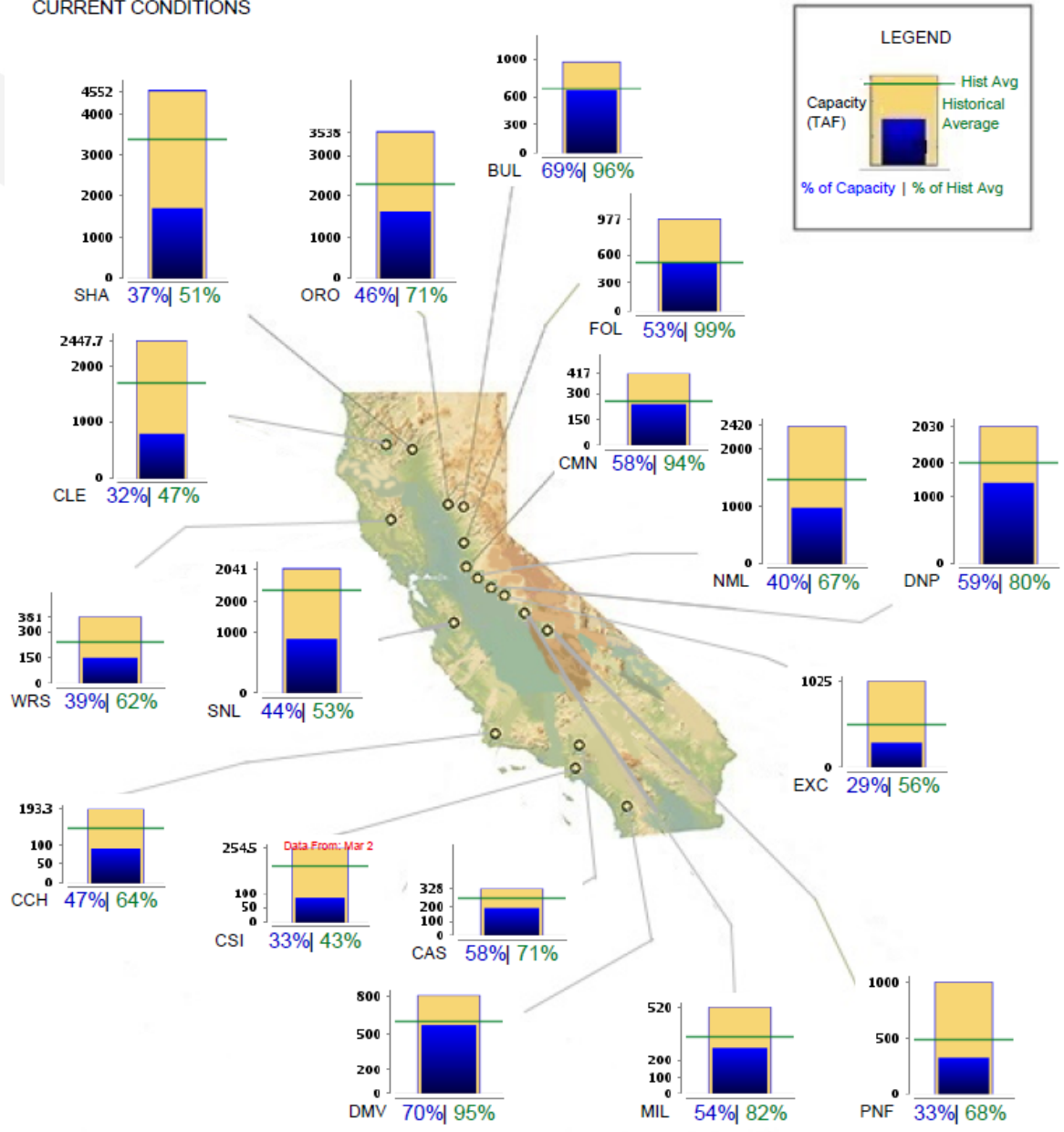
Statewide Percent of April 1: 57%

Statewide Percent of Average for Date: 60%

# CALIFORNIA MAJOR WATER SUPPLY RESERVOIRS

## CURRENT CONDITIONS

Midnight - March 9, 2022



Updated 03/10/2022 10:18 AM



# Bulletin 120 and Water Year Forecast

Updated 3/8/2022

- Sacramento River Index
  - 50% Exceedance Forecast – 4.8 (Critically Dry Year)
  - 90% Exceedance Forecast – 4.0 (Critically Dry Year)
- San Joaquin River Index
  - 50% Exceedance Forecast – 2.0 (Critically Dry Year)
  - 90% Exceedance Forecast – 1.3 (Critically Dry Year)

# Other Reservoirs

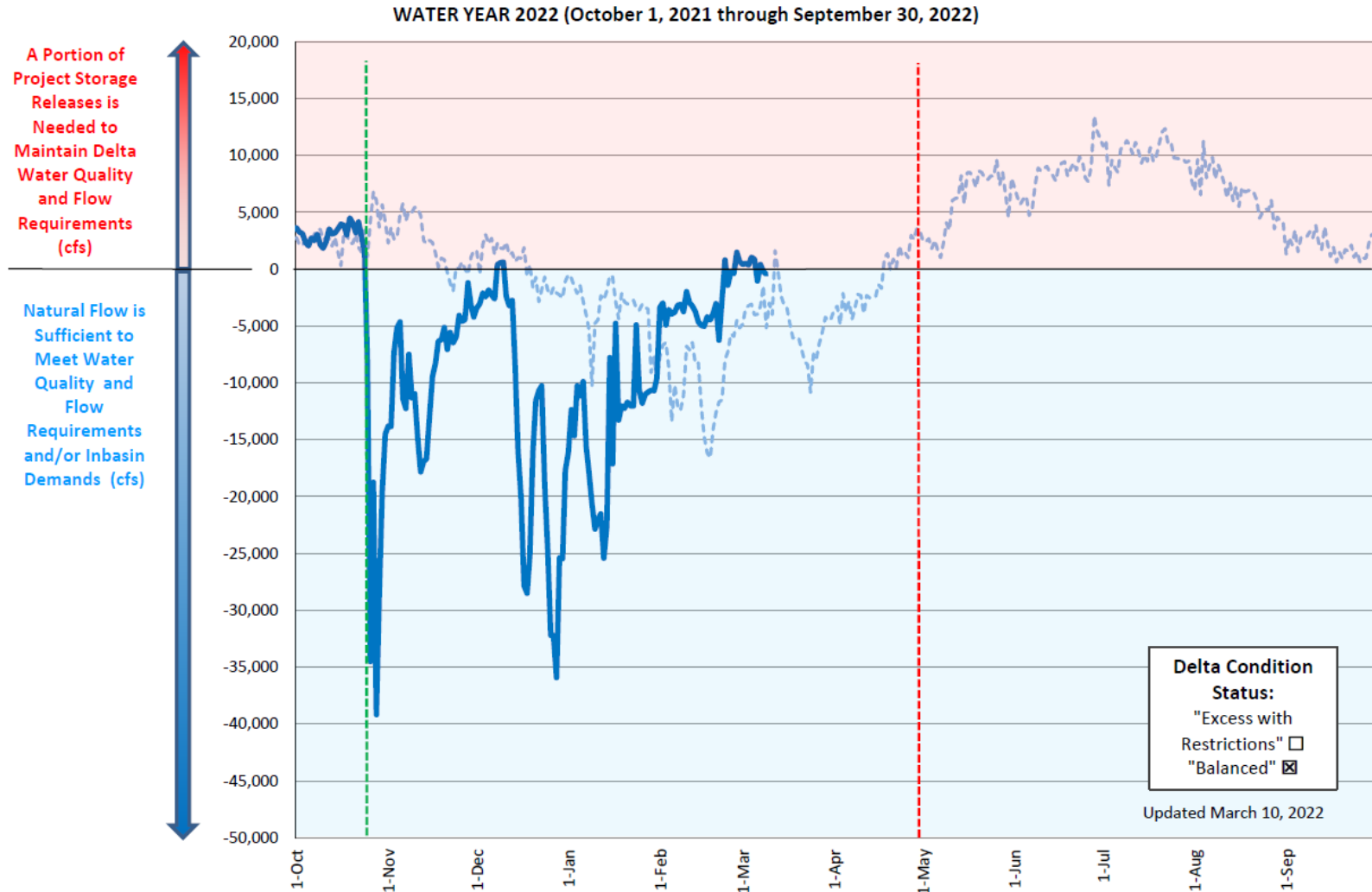
Updated 3/10/2022

- **Cachuma Reservoir:** 91,030 acre-feet full out of 193,305 acre-foot capacity (47% of capacity and 64% of average)
- **Diamond Valley Lake:** 568,798 acre-feet full out of 810,000 acre-foot capacity (70% of capacity)
- **San Luis Reservoir:** 897,030 acre-feet out of 2,041,000 acre-foot capacity (44% of capacity and 53% of average)

# TERM 91

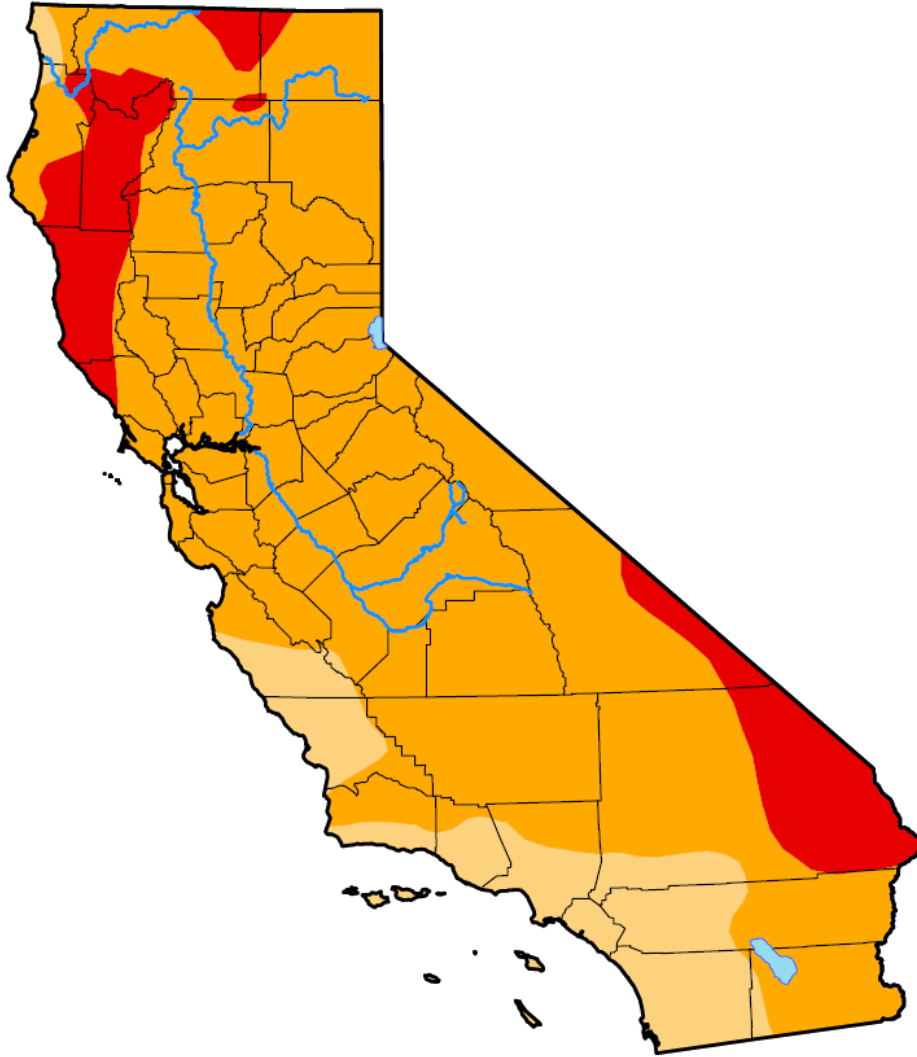
Not In Effect

- Water Year 2022 Delta Flows Available to Meet Water Quality and Flow Requirements
- Water Year 2021 Flows
- Term 91 Curtailment Begins Apr 29, 2021
- Term 91 Curtailment Suspended Oct 26, 2021



# U.S. Drought Monitor California

**March 8, 2022**  
(Released Thursday, Mar. 10, 2022)  
Valid 7 a.m. EST



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
<b>Current</b>	0.00	100.00	100.00	86.98	12.82	0.00
<b>Last Week</b> <i>03-01-2022</i>	0.00	100.00	100.00	86.98	12.82	0.00
<b>3 Months Ago</b> <i>12-07-2021</i>	0.00	100.00	100.00	92.43	80.28	28.27
<b>Start of Calendar Year</b> <i>01-04-2022</i>	0.00	100.00	99.30	67.62	16.60	0.84
<b>Start of Water Year</b> <i>09-28-2021</i>	0.00	100.00	100.00	93.93	87.88	45.66
<b>One Year Ago</b> <i>03-09-2021</i>	0.75	99.25	90.89	58.59	29.54	3.75

Intensity:



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:

Brian Fuchs  
National Drought Mitigation Center



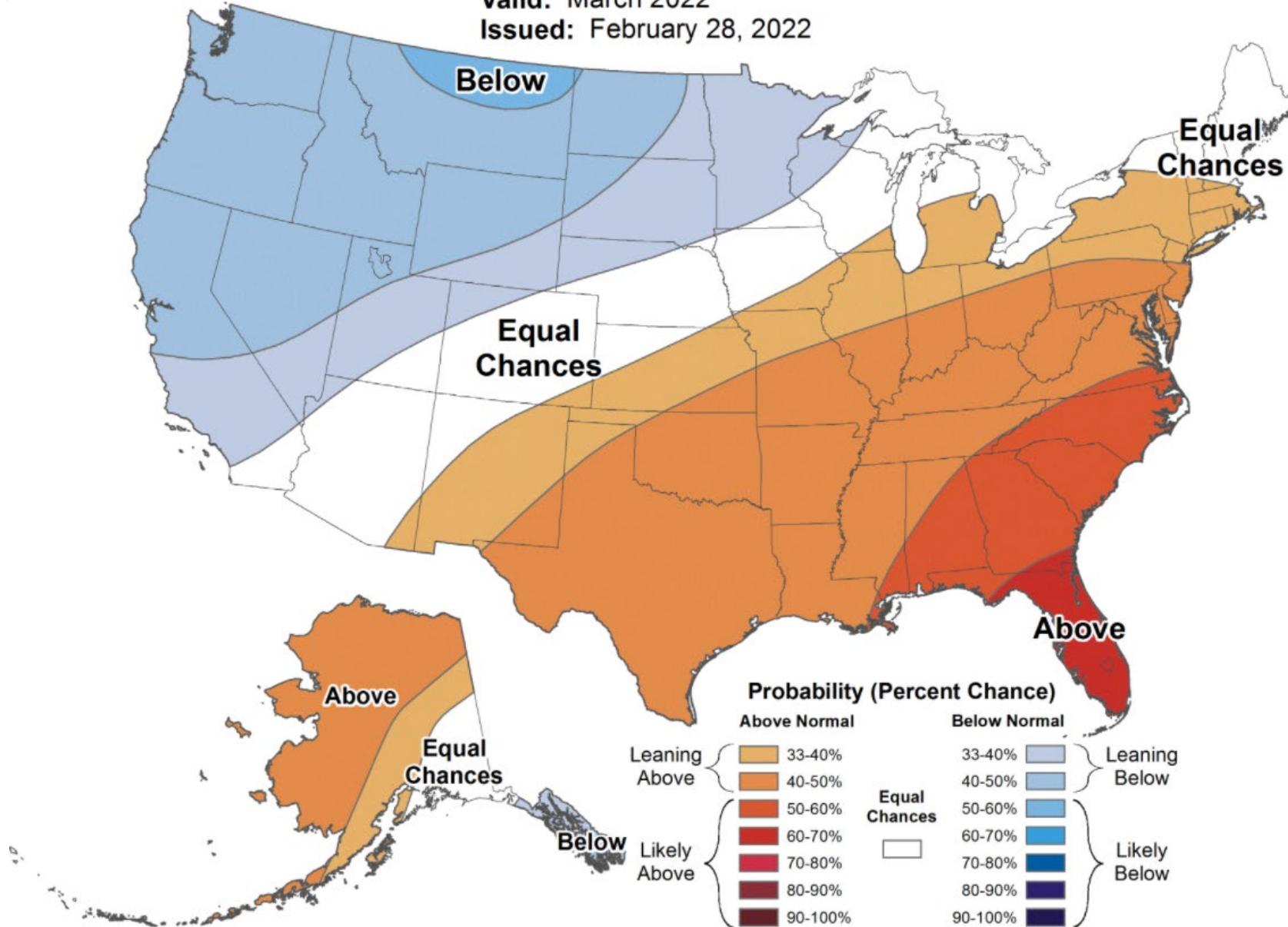
[droughtmonitor.unl.edu](https://droughtmonitor.unl.edu)



# Monthly Temperature Outlook



Valid: March 2022  
Issued: February 28, 2022

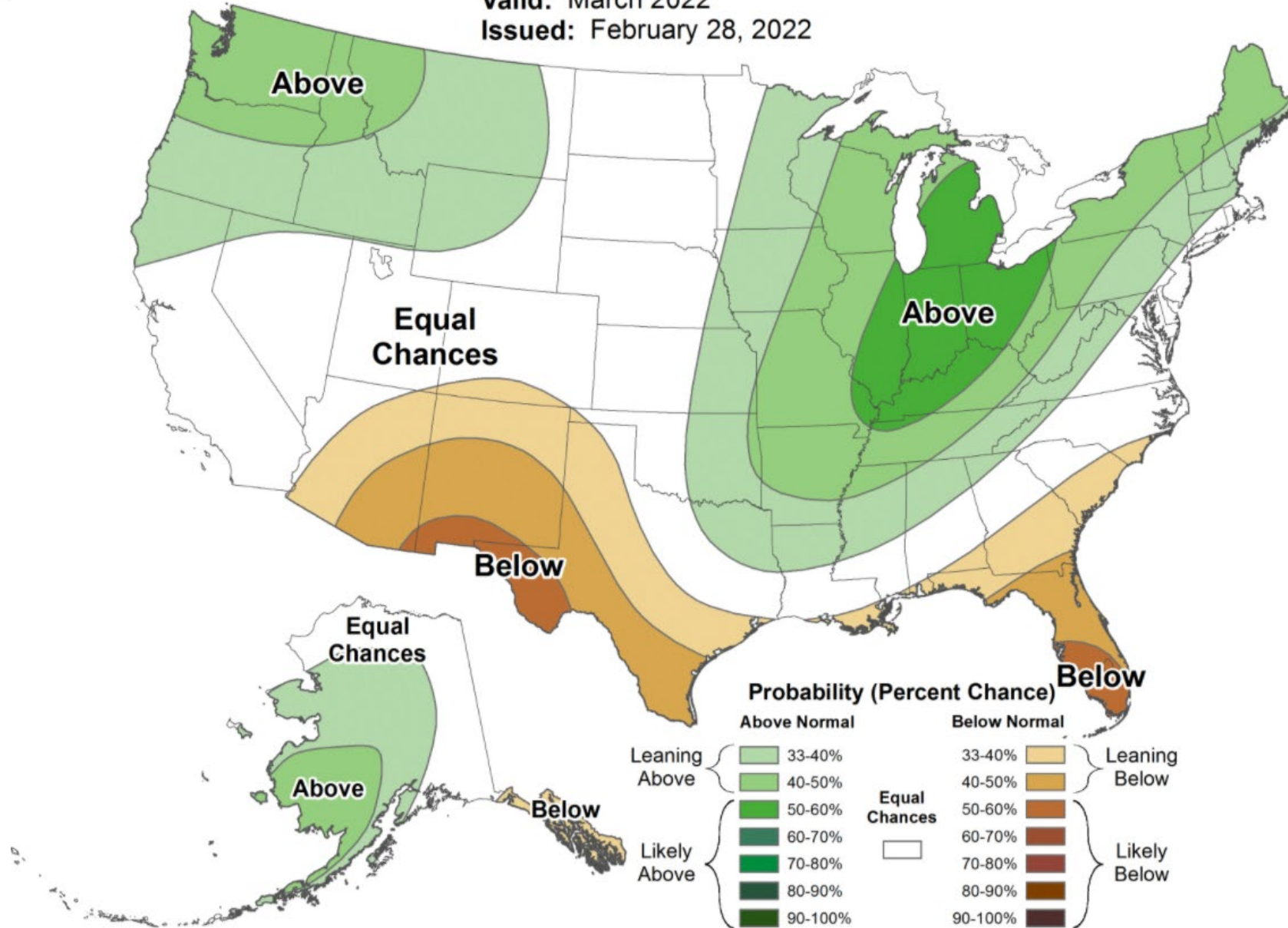




# Monthly Precipitation Outlook



Valid: March 2022  
Issued: February 28, 2022

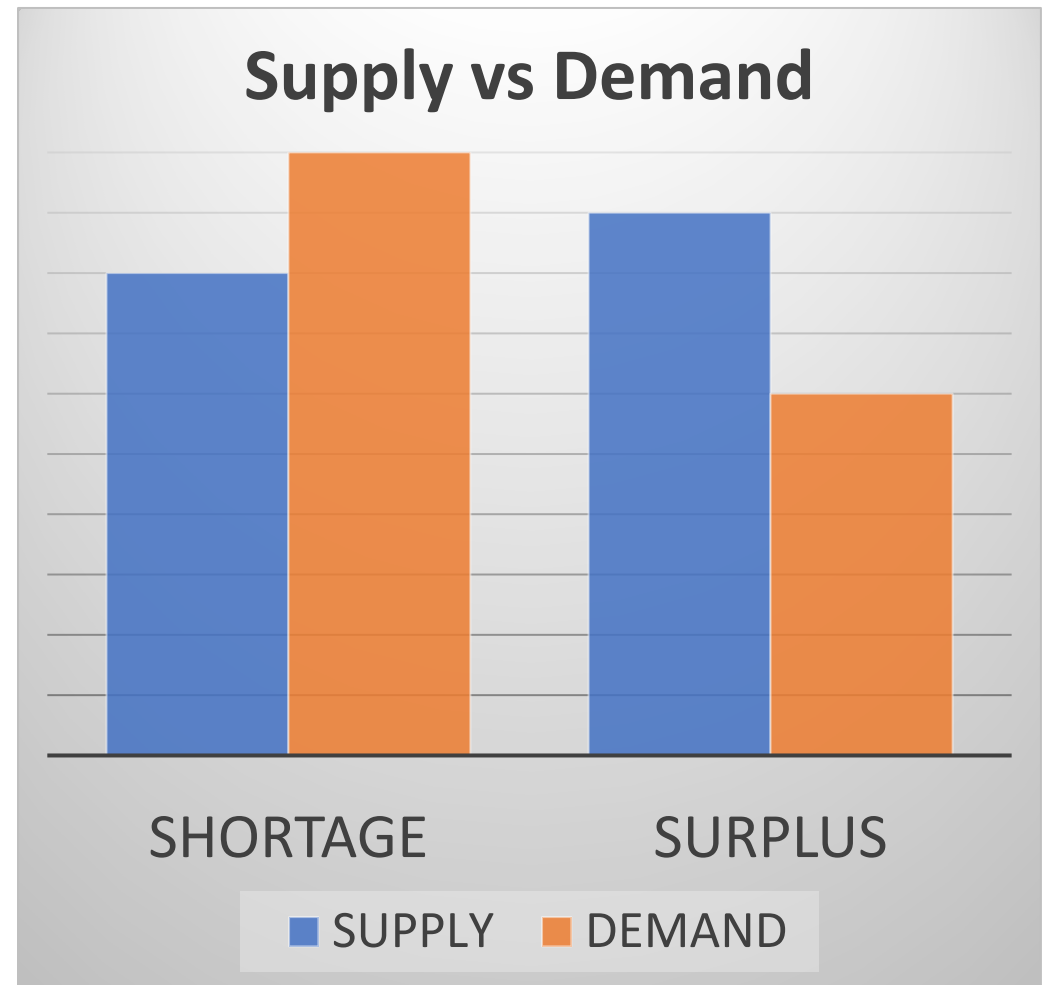


# March is Water Data Month!

- Additional slides this meeting on:
  - Updating Water Rights Data for California (UPWARD)
  - The data of drought decisions
  - How drought data is used
  - Drought Water Rights Allocation Tool (DWRAT) in the Russian River

# Elements of Water (Un)Availability Analysis

- **How much** water is available?
- **When** is the water available?
- **Where** is the water available?
- **How many** water right diversions are there?
- **Where** are the diversions?
- **How much** are they diverting?
- **When** are they diverting?
- What is the relative **priority** in the event of a shortage?





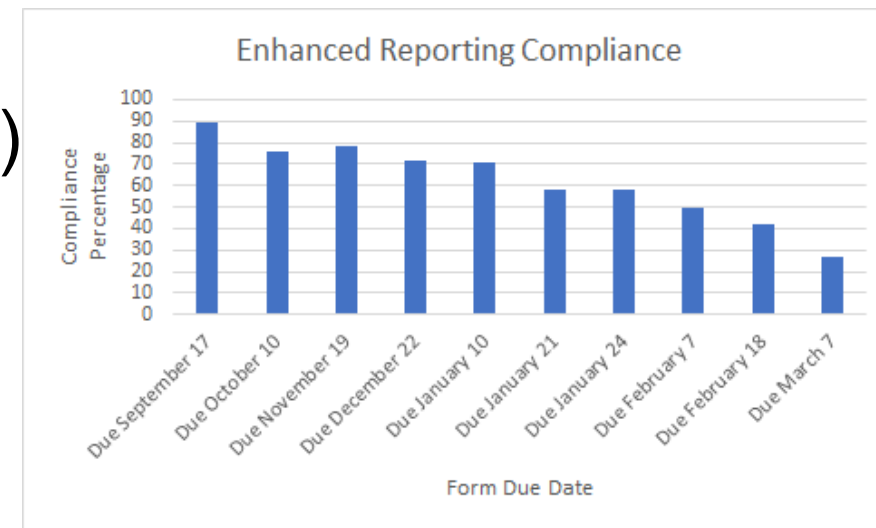
# Updating Water Rights Data (UPWARD)

Division maintains database of diversions as reported by diverters – key to building drought response actions, permitting, and public trust considerations

- **FY 2020-21 State Budget allocated funds to rebuild system**
- **Process is underway**
- [www.waterboards.ca.gov/upward](http://www.waterboards.ca.gov/upward)

# Delta Curtailments and Compliance Status

- **Curtailments Status Update** as of March 8<sup>th</sup>:
  - Current curtailments based on watershed-wide water unavailability
    - Curtailments in place for subset of project rights in Sacramento and San Joaquin River watersheds and Legal Delta
    - Projected to expand as dry conditions persist
    - Updates to continue on a weekly basis
- **Reporting Compliance** as of March 10<sup>th</sup>:
  - Compliance Certification Forms – compliance largely unchanged: 12,652 (~76%)
  - Enhanced Reporting – significant decreasing trend in compliance
    - Follow-up actions expected in the near future



# Data & Delta Watershed Curtailments

## Data drives the Water Unavailability Methodology for the Delta Watershed

### Forecasted Supply Data

- DWR's Bulletin 120
- CNRFC Full Natural Flow (FNF)

### Self-Reported Demand Data

- Annual Reports of Diversion and Use
- Enhanced Reporting of Demand



Determination of Water Unavailability by Priority of Right and Implementation of Curtailment

# Delta Curtailments & Data Transparency

- Water Unavailability Methodology is driven by **publicly available data**
- Division maintains multiple online, interactive tools and visualizations:
  - **Interactive Curtailment Status List** – Diverters can monitor the real-time curtailment status for their water right or claim
  - **Water Unavailability Visualization** – Diverters can visualize the impact of supply shortages by priority of right at the watershed and subwatershed scale
  - **PowerBI Compliance Tracker** – Diverters can monitor compliance with reporting requirements authorized under the emergency regulation

# Delta Interactive Curtailment Status List - Tableau

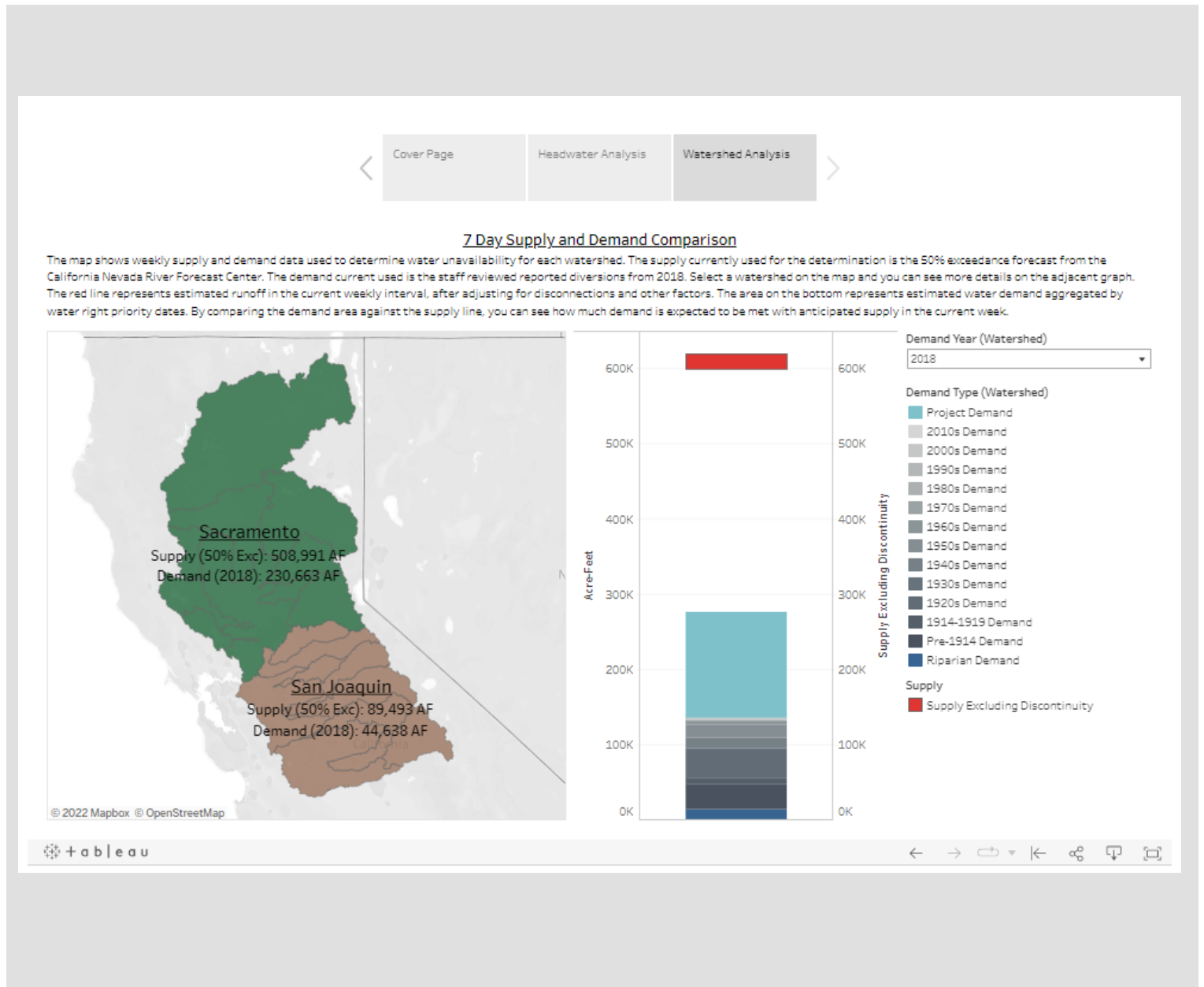
Filter by Water Right Type 
 Filter by Subwatershed 
 Filter by Legal Delta

(Updated 3/1/2022 - Curtailments Effective 3/2/2022)  
 Curtailment status should not be construed as a validation of a water right claim or an authorization to divert.

WR ID	Primary Owner	Claimed Priority Year	
A000018	GLENN-COLUSA IRRIGATION DISTRICT	1915	Not Curtailed
A000023	U.S. BUREAU OF RECLAMATION	Project	Not Curtailed
A000026	JAMES S PHELPS, TRUSTEE	1915	Not Curtailed
A000027	RECLAMATION DISTRICT #1004	1915	Not Curtailed
A000065	FRANK KIMP	1915	Not Curtailed
A000077A	Northern California Power Agency	1915	Not Curtailed
A000135	RICHARD L JENNINGS	1915	Not Curtailed
A000138	CARMICHAEL WATER DISTRICT	1915	Not Curtailed
A000186	CACHIL DEHE BAND OF WINTUN INDIANS OF	1915	Not Curtailed
A000230A	W.A. YERXA FAMILY REV TRUST	1916	Not Curtailed
A000230B	CHARLES W SEAVER	1916	Not Curtailed

*\*Indicates a statement of diversion and use that asserts a pre-1914 appropriative claim of right with a year of first use after 1914. For purposes of curtailment, and in the absence of reliable information supporting an earlier priority date, these claims are treated as having a priority date of January 1, 1914.*

# Delta Water Unavailability Visualization Tool - Tableau



# Delta Compliance & Responses Tracker - PowerBI

## Curtailment Compliance and Responses

This page contains an interactive tracker and tables that summarize compliance and responses regarding curtailment and reporting orders in the Sacramento-San Joaquin Delta watershed. The interactive tracker will be updated frequently to display the most current compliance information.

### % of Compliance Certification Filed by Subwatershed

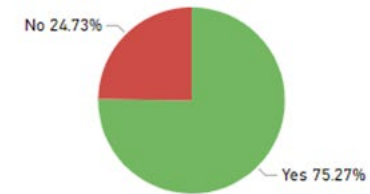
Green regions indicate higher compliance certification rates  
Red regions indicate lower compliance certification rates



### Compliance Certification Filed

**12.6K**

out of 16.7k required



Water Rights/Claims Filed  
Health and Safety Exceptions

**795**

Water Rights/Claims Filed  
Non-Consumptive Use Exceptions

**805**

In Legal Delta?

- No  
 Yes

Filter by Water Right Type

All

Filter by Subwatershed

All

Health and Safety Exception Filed?

- No  
 Yes, petition >55 gpcd  
 Yes, up to 55 gpcd

Non-Consumptive Exception Filed?

- No  
 Yes

[See Details on Certifications](#)

Updated 3/4/2022

# Mill & Deer Creeks

- Curtailment drought minimum flow requirements will remain in effect October 15-June 30, pending drought continuance and fish presence
- 50 cfs to the confluence with the Sacramento River has been consistently maintained on both Mill Creek and Deer Creek since October 15
- Pulse flow requests by Department of Fish and Wildlife or National Marine Fisheries Service may be submitted to the Board as early as April 1, 2022
- Voluntary action discussions are ongoing with stakeholders from each creek following meetings in February 2022

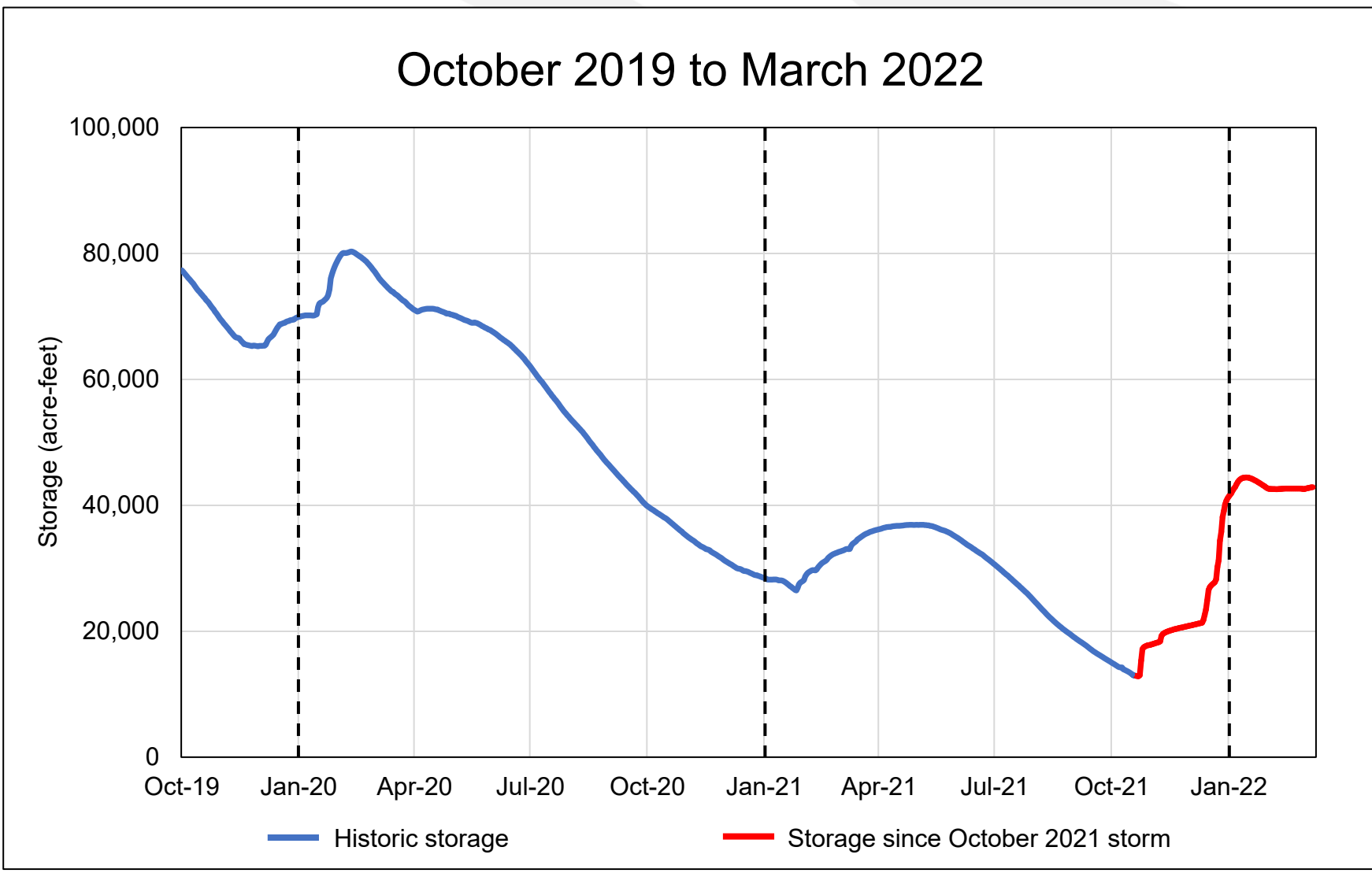


# Russian River

- **Curtailment Status:** curtailments suspended through April 1, 2022
- **Interactive Compliance Response Tracker:** [Power BI Dashboard](#) accessible on Russian River Drought webpage

[https://www.waterboards.ca.gov/drought/russian\\_river/](https://www.waterboards.ca.gov/drought/russian_river/)

# Lake Mendocino Storage



Updates as of 3/9/2022

*Calpella Current Flow*  
56 cfs

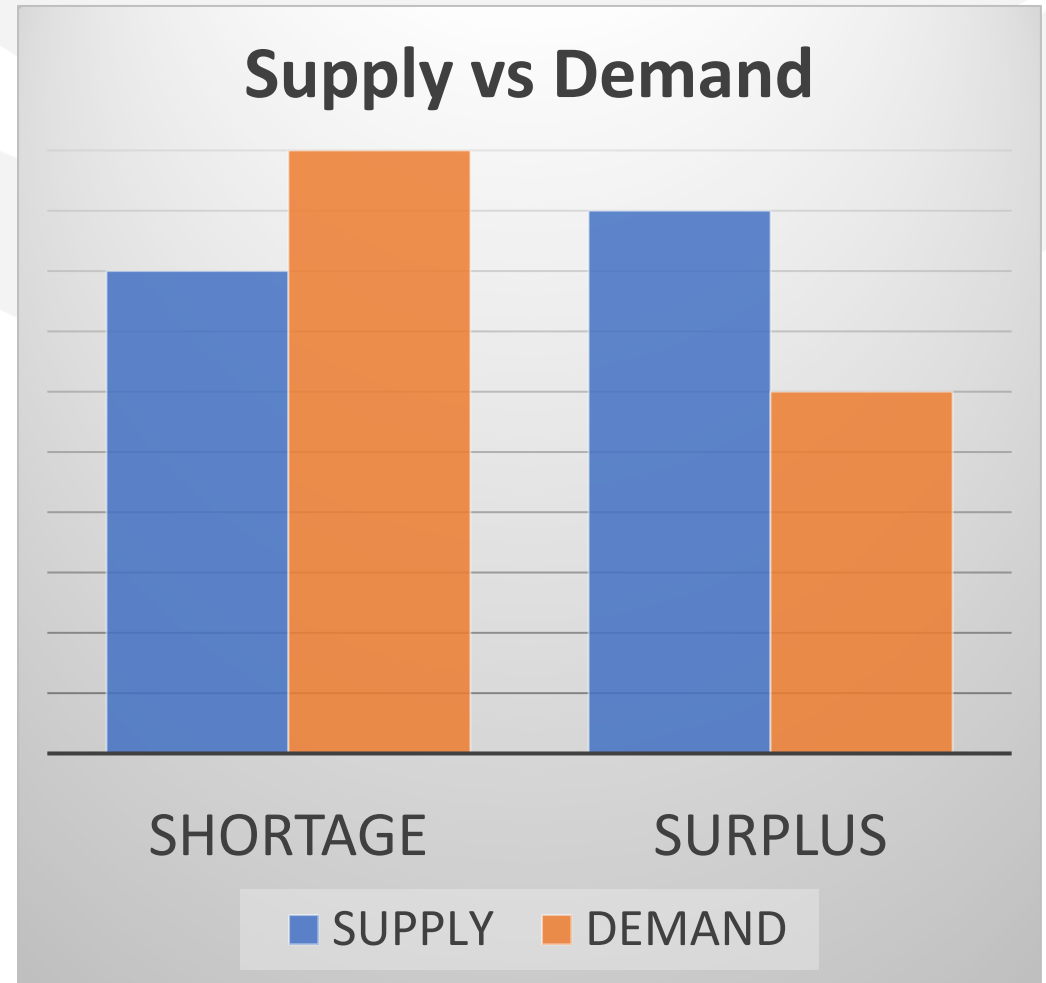
*Lake Mendocino Outflow*  
31 cfs

*Healdsburg Current Flow*  
108 cfs

*Lake Mendocino Storage*  
42,891 acre-feet

# Elements of Water Availability Analysis

- **How much** water is available?
- **When** is the water available?
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- **How many** water right diversions are there?
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# What is DWRAT?

A set of mathematical equations representing constraints and objective functions (rules and goals), optimized using a solver.

**Goals:** Maximize allocation of water for beneficial uses while minimizing shortage

**Rules:** 1) Geography 2) Physics 3) Legal Priority

<https://github.com/CAWaterBoardDataCenter/DWRAT>

See reference material for full list of constraints and detailed objective functions.

$$A_i = P_k u_i, \quad \forall i, i \in k \quad (1)$$

$$0 \leq P_k \leq 1, \quad \forall k \quad (2)$$

$$\sum_{i \in k} A_i \leq v_k - e_k - b_k, \quad \forall k \quad (3)$$

$$\text{Minimize } z = \alpha \sum_k w_k P_k - \sum_i A_i \quad (4)$$

$$P_j \leq P_k, \quad \forall k, j \in k \quad (5)$$

$$w_k = \frac{n_k}{n_{k, \text{system outlet}}} \quad (6)$$

$$\alpha < \text{Min} \left( \frac{w_k}{u_k} \right) \quad \forall k \quad (7)$$

$$0 \leq A_i \leq u_i, \quad \forall i \quad (8)$$

$$\sum_{i \in k} A_i \leq v_k - e_k - b_k - \sum_{i \in k} A_{\text{upstream riparian users } i}, \quad \forall k \quad (9)$$

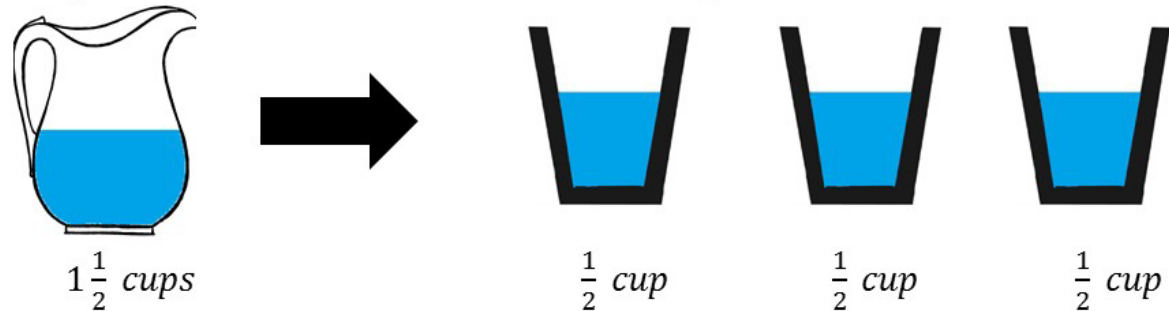
$$\text{Minimize } z = \sum_i p_i (u_i - A_i) \quad (10)$$

# Drought Water Right Allocation Tool (DWRAT)

## Water Availability in the Russian River Watershed

Three guys walk into a bar...

- Riparian allocation of shortage:

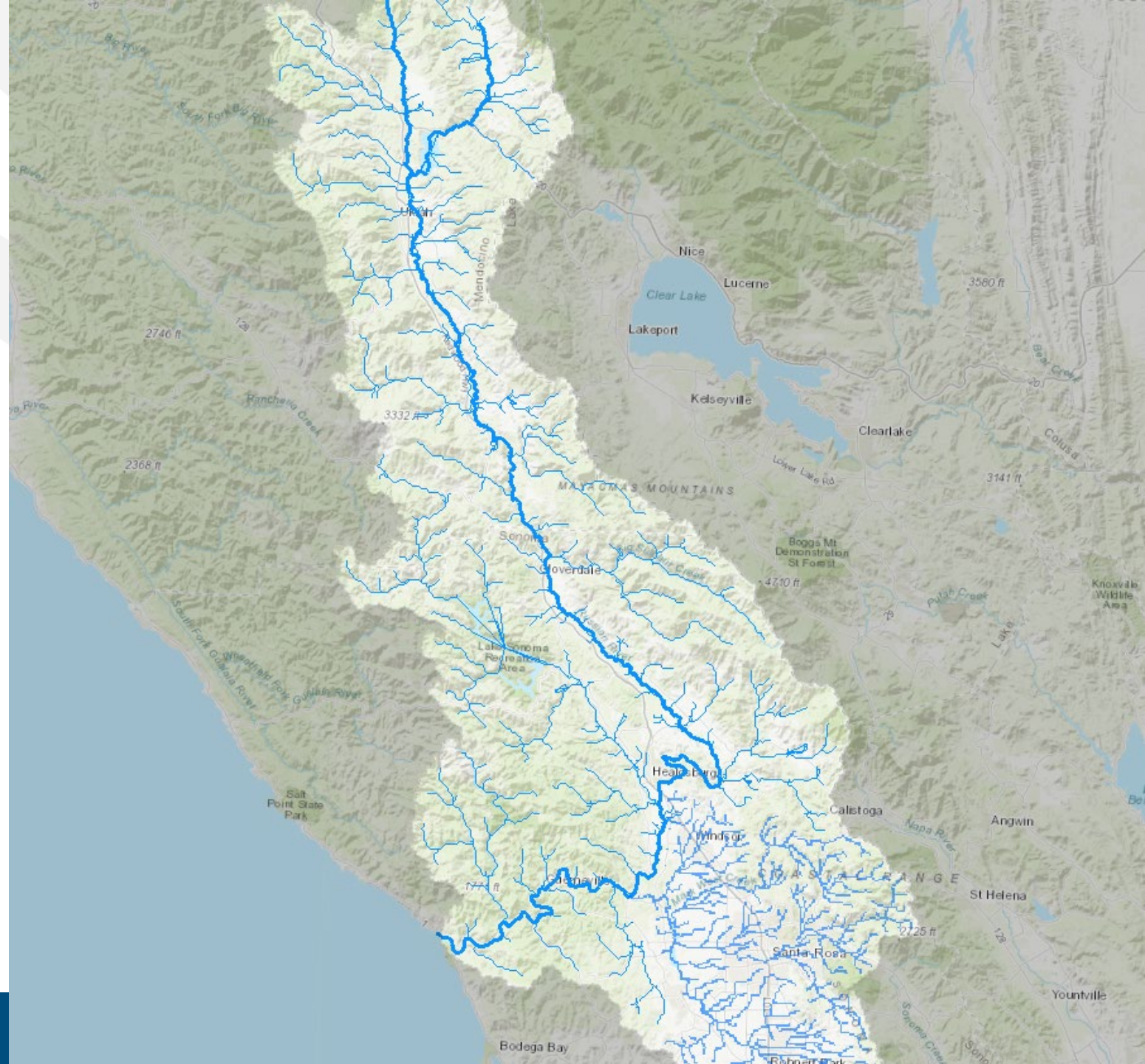


- Appropriative allocation of shortage:



# Example Data Driven Water Availability Analysis

## 1. Supply Flow Data



# Supply Flow Data Sources

- Russian River – uses a Surface Water Runoff Hydrologic Model
- PRMS
- Other options:
  - Direct Gage Data
  - Disaggregated Gage Data
  - Statistical Regression Models
  - Machine Learning Models
  - Remote Sensing Technology (potential future application)

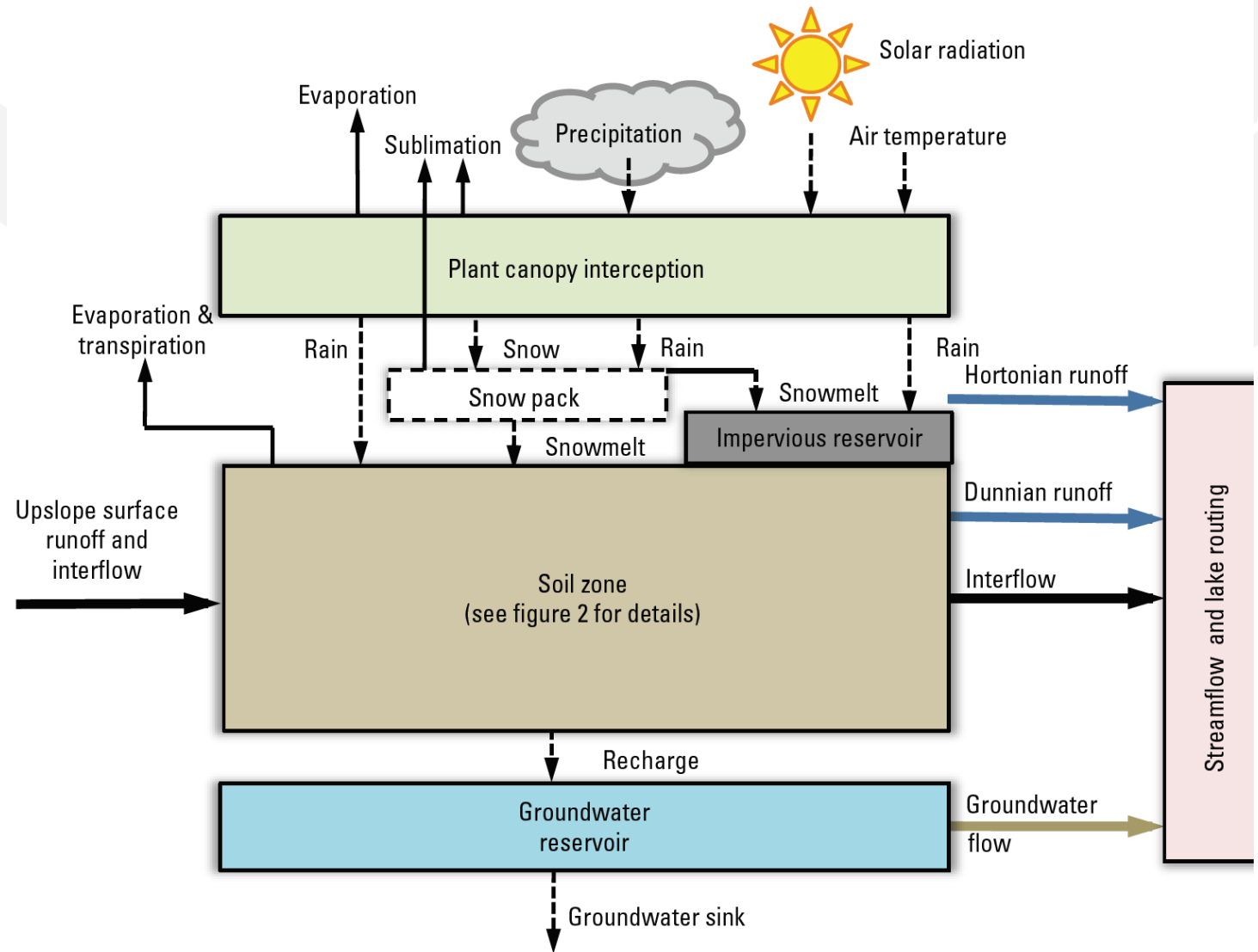
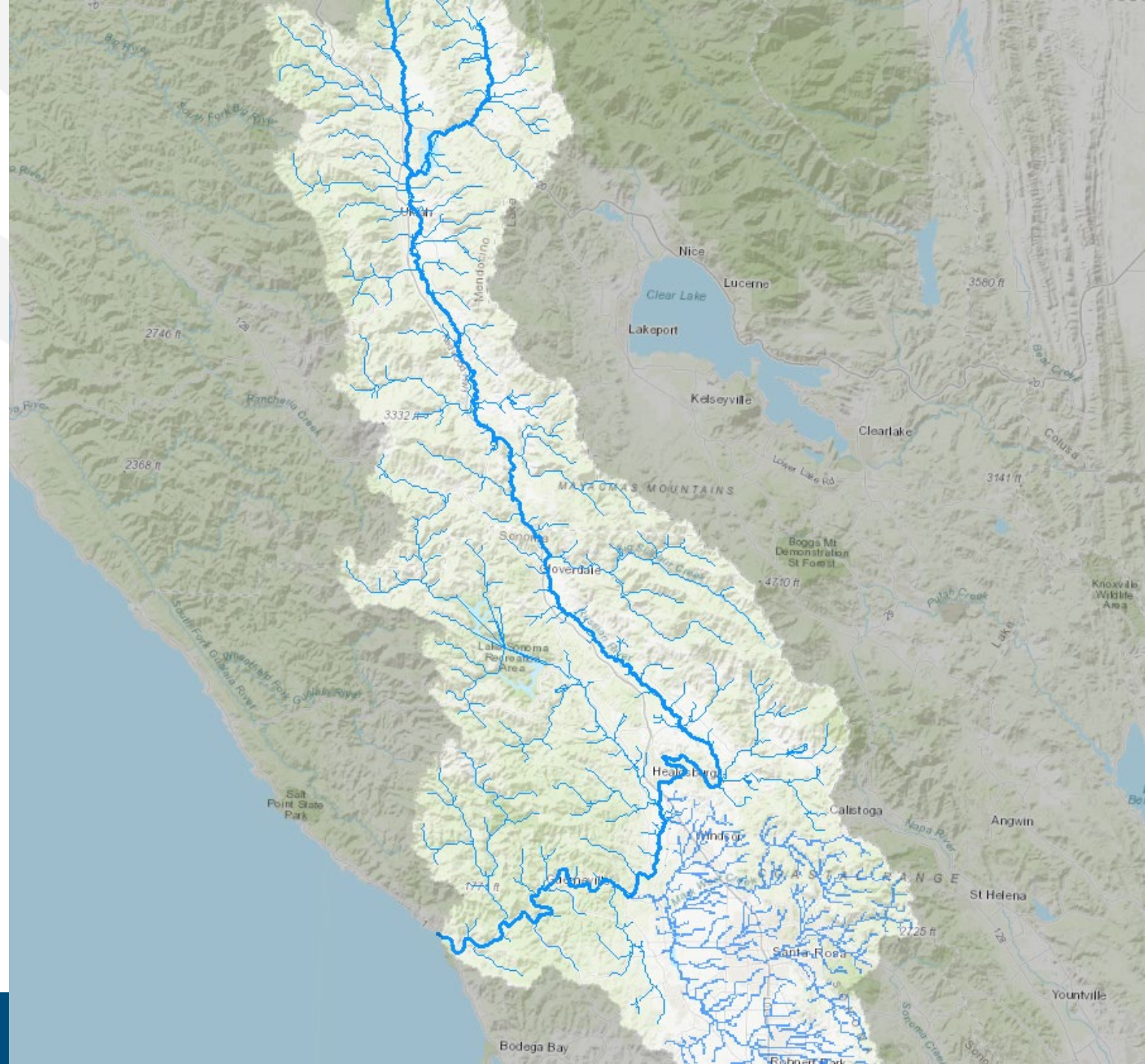


Figure 1. PRMS Hydrologic Processes. Adapted from "Precipitation Runoff Modeling System" by Markstrom and Others, 2020, retrieved from <https://www.usgs.gov/software/precipitation-runoff-modeling-system-prms>

# Example Data Driven Water Availability Analysis

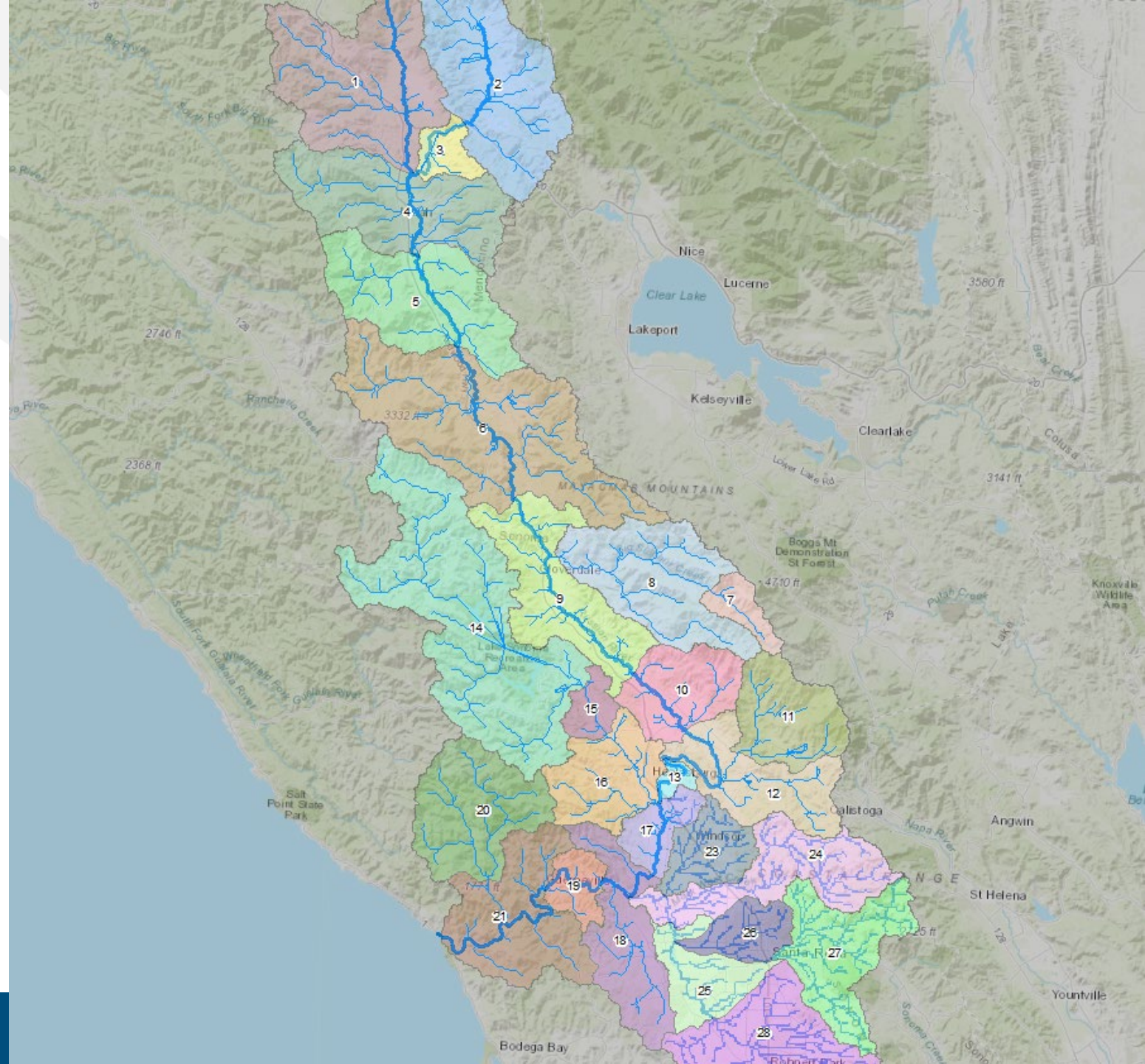
## 1. Supply Flow Data





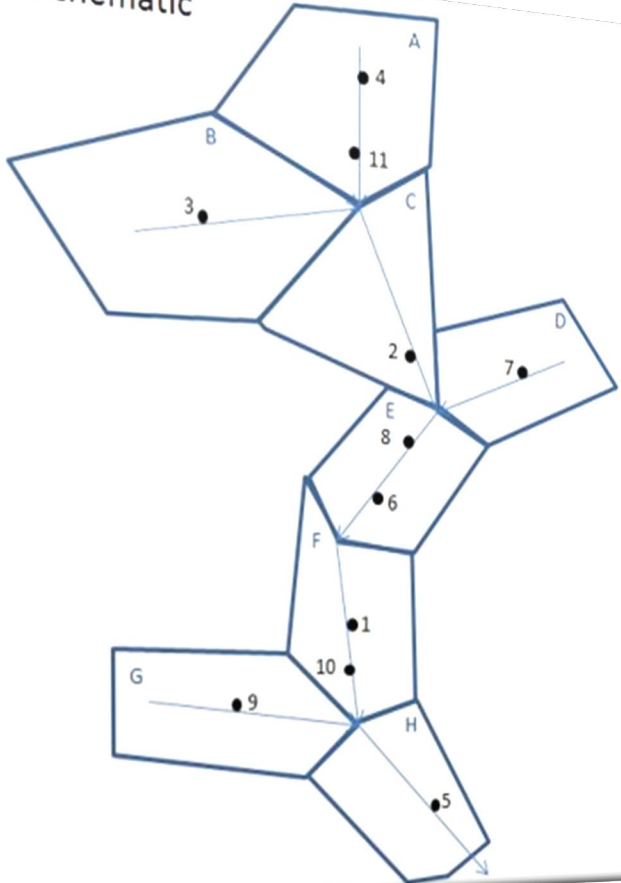
# Example Data Driven Water Availability Analysis

1. Supply Flow Data
2. Basin Delineation



# Rules of Physics and Geography

Basin Schematic



```

13 #!!!!!!!!!!!!!!!!!!!!!! YOU NEED TO SPECIFY THE OUTLET HERE !!!!!!!!!!!!!!!
14
15 outlet = "L_21_MSRR"
16
17 #!!!!!!!!!!!!!!!!!!!!!! YOU NEED TO SPECIFY THE OUTLET ABOVE !!!!!!!!!!!!!!!
18
19 flow_table_df = pd.read_csv('input/flows.csv', index_col= "BASIN")
20 flow_table_df.sort_index(axis = "index", inplace = True)
21 basins = flow_table_df.index.values
22 flows_to = flow_table_df["FLOWS_TO"].to_numpy()
23
24 # DICTIONARIES
25 flows_to_dictionary = {basins[k] : flows_to[k] for k, basin in enumerate(basins)}
26 index_dictionary = {basins[k] : [k] for k, basin in enumerate(basins)}
27
28 # Initialize empty basin x basin identity matrix
29 connectivity_matrix = numpy.identity(numpy.size(basins))
30
31 for k, basin in enumerate(basins):
32     while basin != outlet:
33         connectivity_matrix[k][index_dictionary[flows_to_dictionary[basin]]] = 1
34         basin = flows_to_dictionary[basin]
35
36 cm_df = pd.DataFrame(connectivity_matrix, index=basins, columns=basins)
37 cm_df.index.name = "BASIN"
38 cm_df.to_csv("input/basin_connectivity_matrix.csv")

```

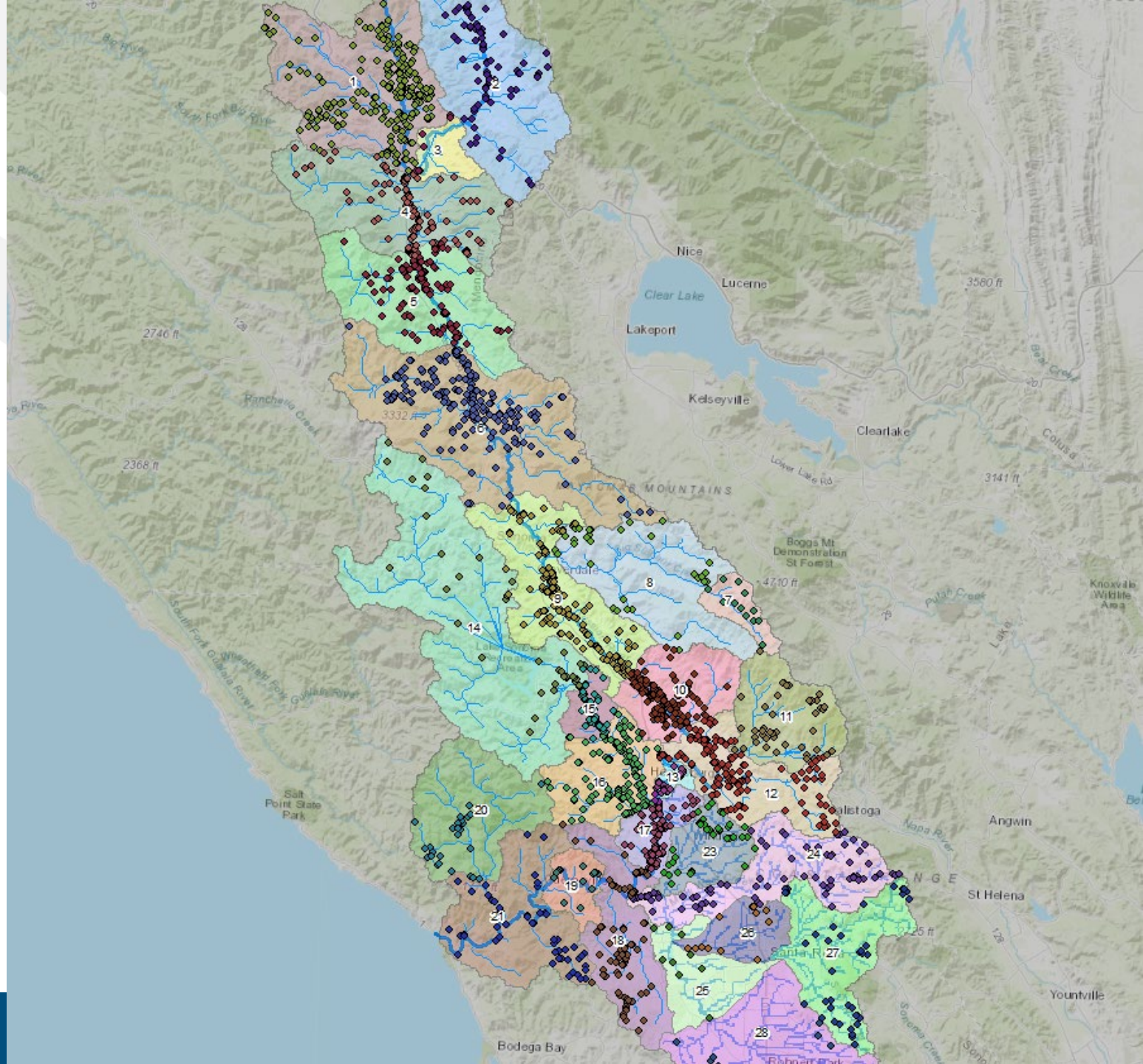
BASIN	L_14	L_14_MSDC	L_15	L_15_MSDC	L_16	L_16_MSDC	L_17	L_17_MSRR
L_14	1	1	0	1	0	1	0	1
L_14_MSDC	0	1	0	1	0	1	0	1
L_15	0	0	1	1	0	1	0	1
L_15_MSDC	0	0	0	1	0	1	0	1
L_16	0	0	0	0	1	1	0	1
L_16_MSDC	0	0	0	0	0	1	0	1
L_17	0	0	0	0	0	0	1	1
L_17_MSRR	0	0	0	0	0	0	0	1
L_18	0	0	0	0	0	0	0	0
L_18_MSRR	0	0	0	0	0	0	0	0
L_19	0	0	0	0	0	0	0	0
L_19_MSRR	0	0	0	0	0	0	0	0
L_20	0	0	0	0	0	0	0	0
L_21	0	0	0	0	0	0	0	0
L_21_MSRR	0	0	0	0	0	0	0	0
L_22	0	0	0	0	0	0	0	0

# Example Data Driven Water Availability Analysis

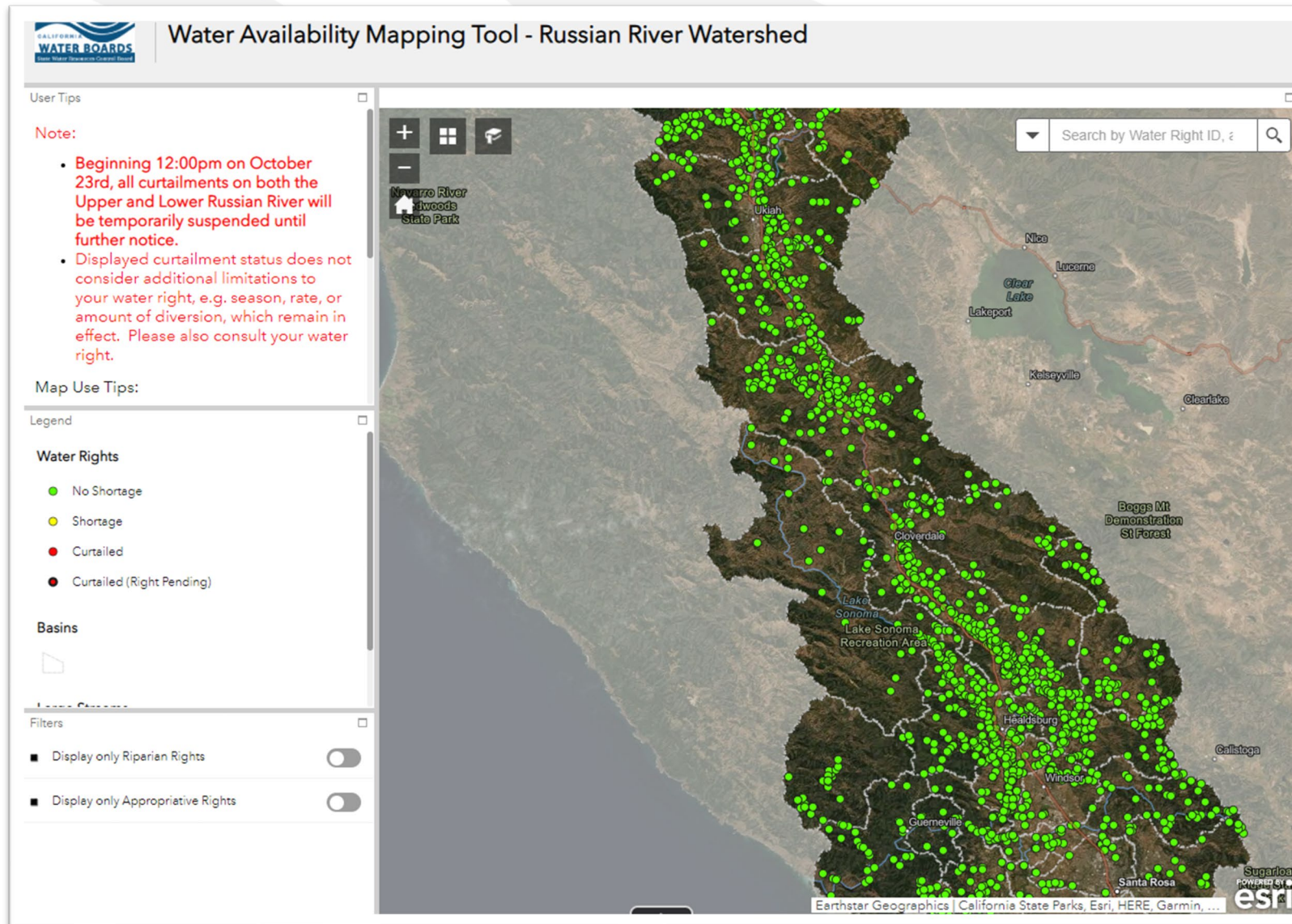
1. Supply Flow Data
2. Basin Delineation
3. Then add in Demand Data



[https://www.waterboards.ca.gov/drought/drought\\_tools\\_methods/demandanalysis.html](https://www.waterboards.ca.gov/drought/drought_tools_methods/demandanalysis.html)



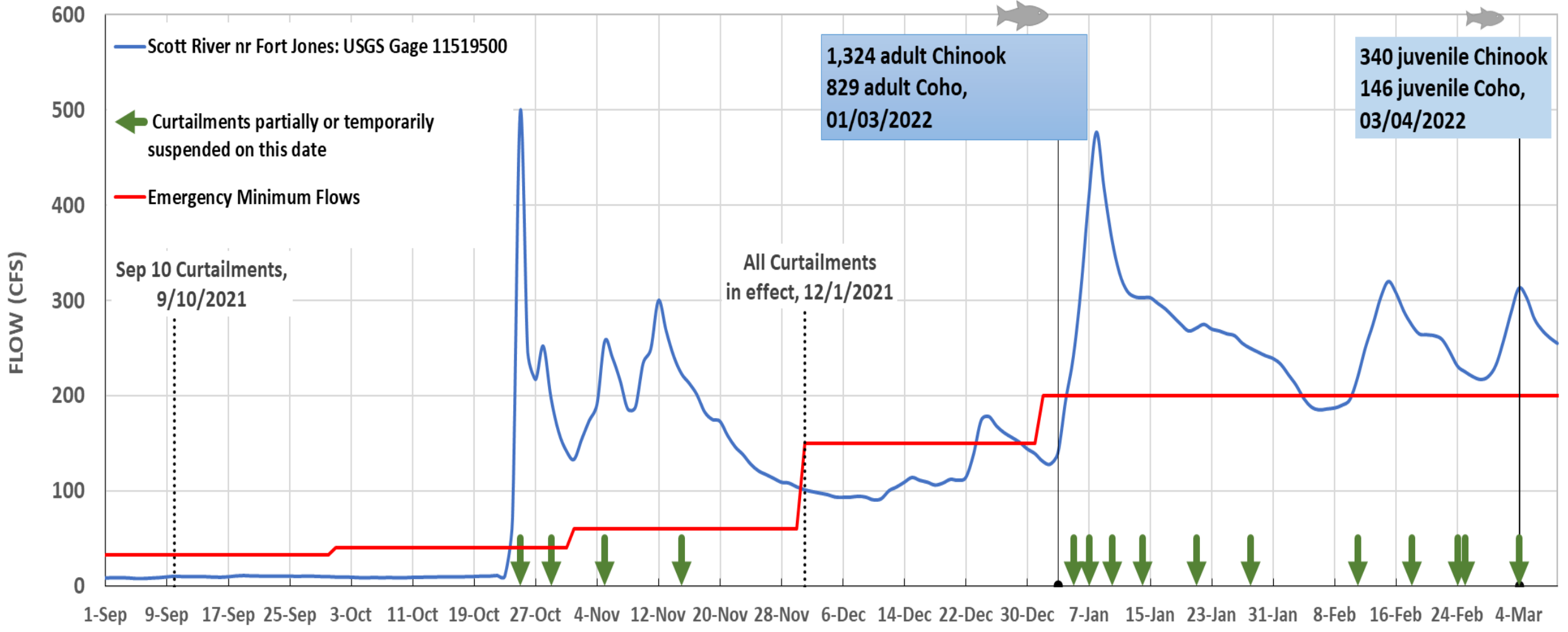
# Implementation and Support for Regulatory Action



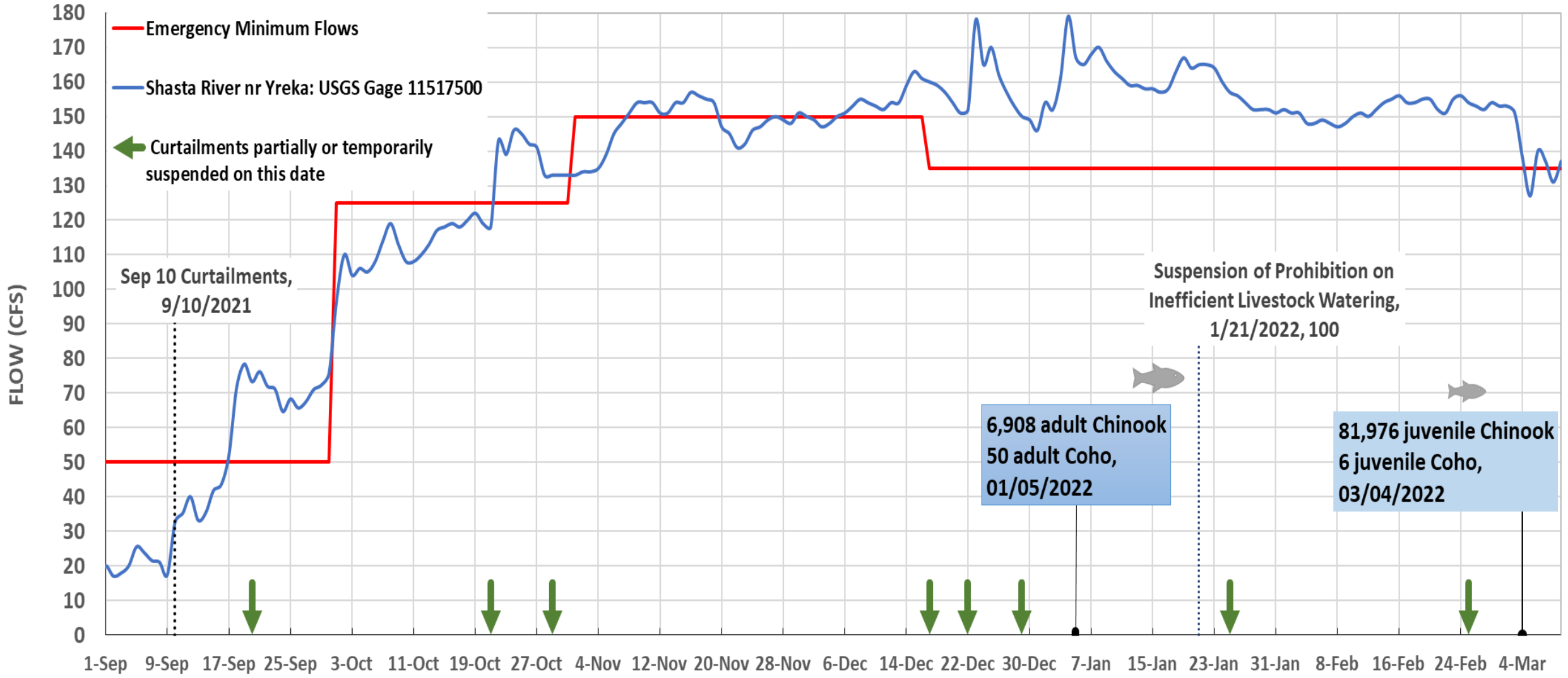
# Scott & Shasta Rivers

- Curtailment Status:
  - Scott: All curtailments suspended through March 18<sup>th</sup> (March flow requirement: 200 cfs flow requirement)
  - Shasta: All curtailments suspended through March 31st so long as flows maintained at or above 135 cfs flow requirement and coordination with Watermaster
- Local Cooperative Solutions:
  - New [webpage](#) and guidance posted
  - First proposal received and under review

# Scott River



# Shasta River



# Power BI Dashboard: Shasta River Curtailment Status

## Shasta River Watershed Curtailment Status Dashboard

Last Date Updated: February 25, 2022

(only shows curtailed water rights and water rights with suspended curtailments)

Curtailment Status Table

Application Number	Primary Owner	Curtailment Status
A000448	GRENADA IRRIGATION DISTRICT	Curtailment Suspended
A003544	MONTAGUE WATER CONSERVATION DISTRICT	Curtailment Suspended
A003555	MONTAGUE WATER CONSERVATION DISTRICT	Curtailment Suspended
A003952	WILLIAM B DUNCAN	Curtailment Suspended
A004831	RAYMOND D EKSTROM	Curtailment Suspended
A004909	MONTAGUE WATER CONSERVATION DISTRICT	Curtailment Suspended
A008809	EMMERSON INVESTMENT, INC	Curtailment Suspended
A010930	FREDERICK SCHNACK	Curtailment Suspended
A010949A	CALIFORNIA DEPARTMENT	Curtailment Suspended

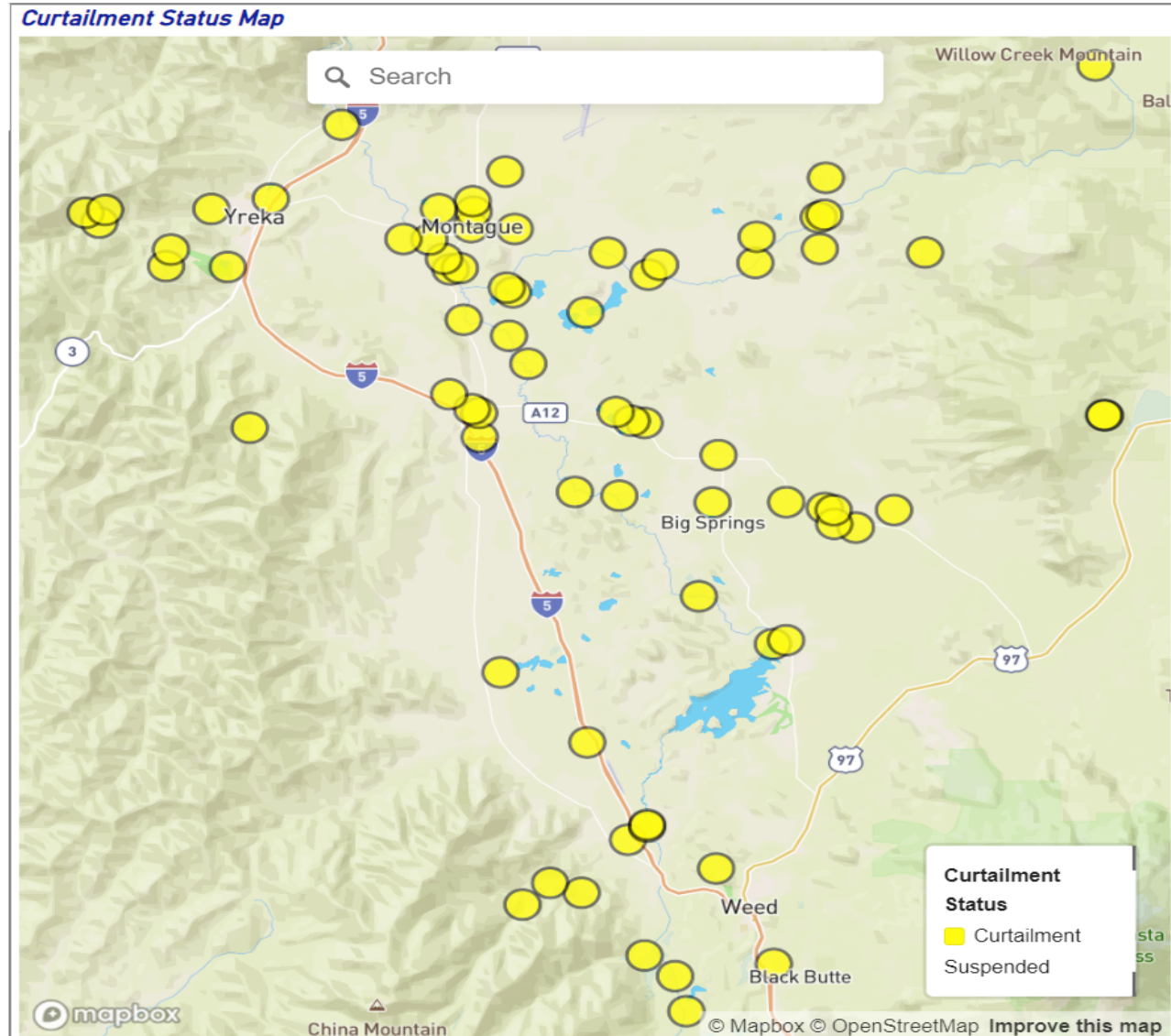
### Application Number

### Primary Owner

### Filter Water Rights

- Select all
- Appropriative Groundwater Right
- Surface Water Right

Note: Appropriative Groundwater Right locations are approximate





# Water Right Enforcement Updates

## **Scott and Shasta Rivers**

- Preparing to Issue Administrative Civil Liability Orders on March 21
- 30 pending complaint investigations

## **Sacramento and San Joaquin Watersheds**

- Investigated and closed 25 complaints this winter while curtailments were suspended
- Term 91 curtailments anticipated to be the first curtailment inspections in 2022

## **Russian River Watershed**

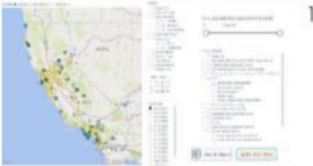
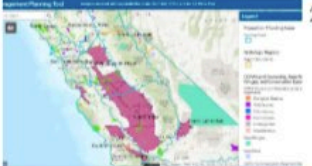


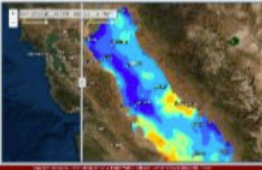



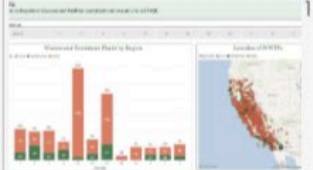

- Issued 60 Final Administrative Civil Liability Orders
- 15 pending complaint investigations

Statewide, year-round presence in investigating water right complaints, regardless of curtailment status

# More on Water Data Month

- A new data visualization every day in March
- [www.waterboards.ca.gov/resources/oima/cowi/water\\_data\\_month.html](http://www.waterboards.ca.gov/resources/oima/cowi/water_data_month.html)

# #Marchiswaterdatamonth 2022

Monday	Tuesday	Wednesday	Thursday	Friday
	 1	 2	 3	 4
 7	 8	 9	 10	 11
 14	15	16	17	18
21	22	23	24	25
28	29	30	31	

# Additional Information & Updates

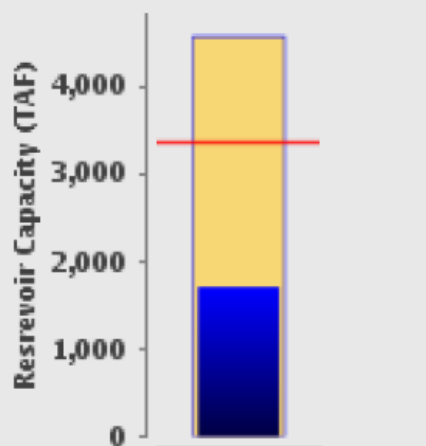
- Dry year warning letter to all water right holders or claimants (40,000+) will be mailed this week or early next week.
- Drought Webpage
  - [waterboards.ca.gov/drought](http://waterboards.ca.gov/drought)
- Email Subscription Lists
  - [waterboards.ca.gov/resources/email\\_subscriptions](http://waterboards.ca.gov/resources/email_subscriptions)
    - Under “State Water Resources Control Board”, then “Water Rights”
  - Bay-Delta: “Delta Drought”
  - Mill & Deer Creeks: “Mill Deer Drought”
  - Russian River: “Russian River Drought”
  - Scott & Shasta Rivers: “Scott-Shasta Drought”

# Hydro Update - Extra Slides



## Lake Shasta Conditions

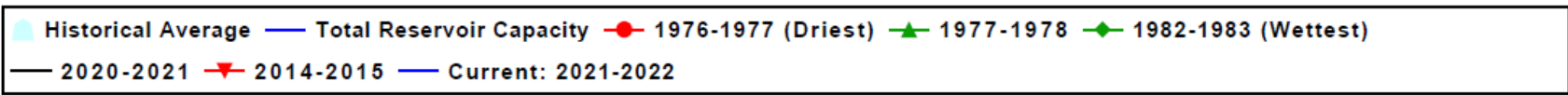
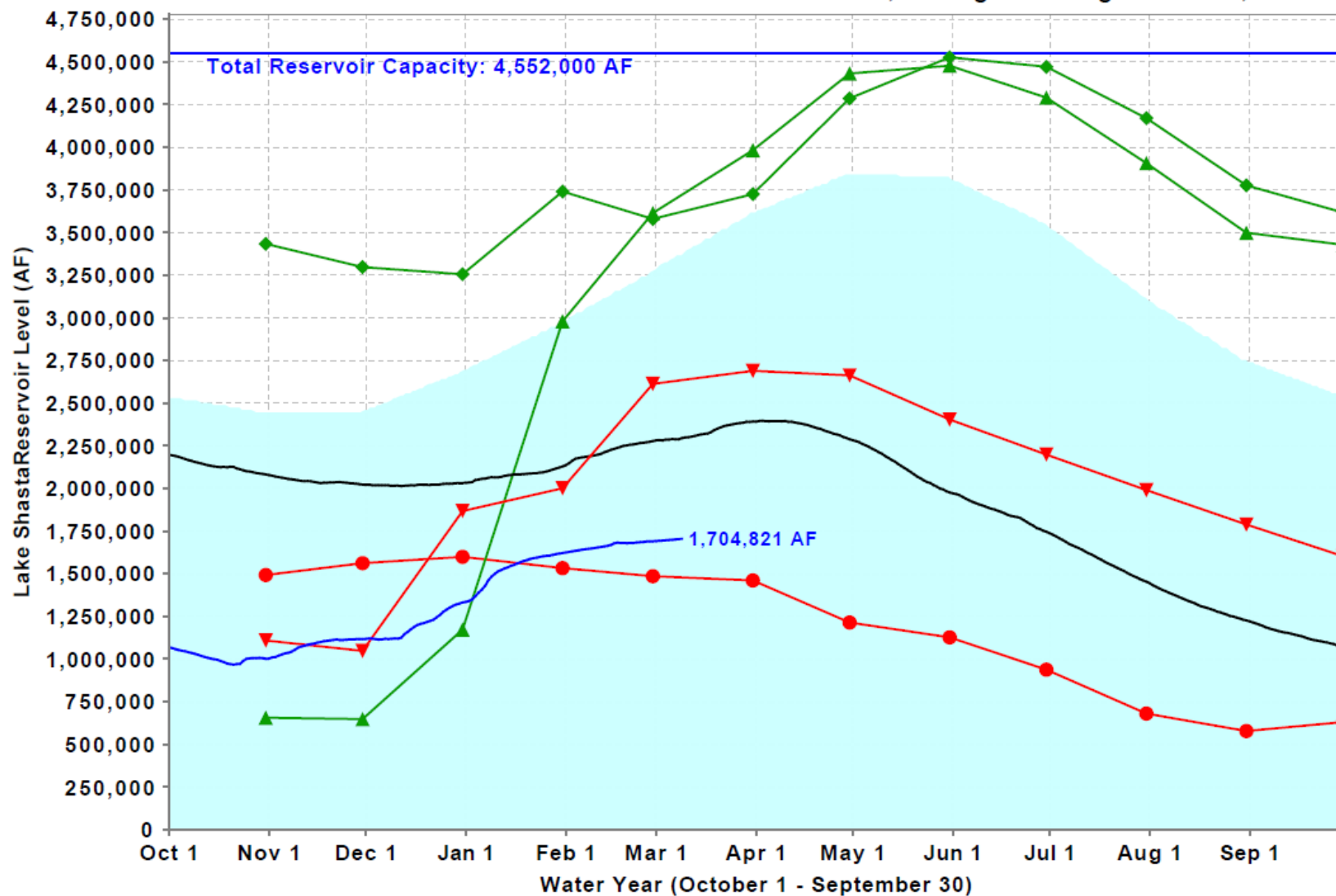
(as of Midnight - March 9, 2022)



Current Level: 1,704,821 AF

37% (Total Capacity) | 51% (Historical Avg.)

Lake Shasta Levels: Various Past Water Years and Current Water Year, Ending At Midnight March 9, 2022



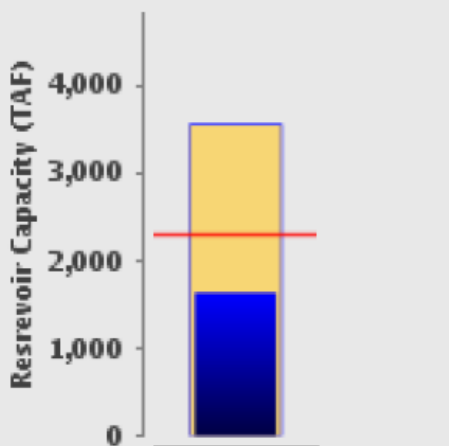
Data Updated 03/10/2022 10:18 AM



Lake Oroville

## Lake Oroville Conditions

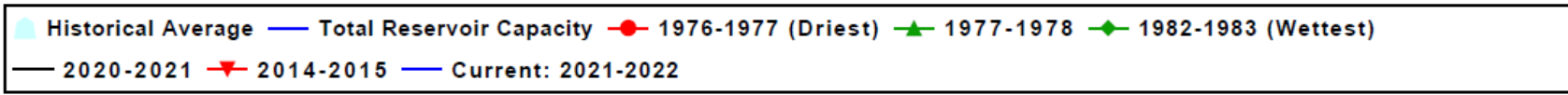
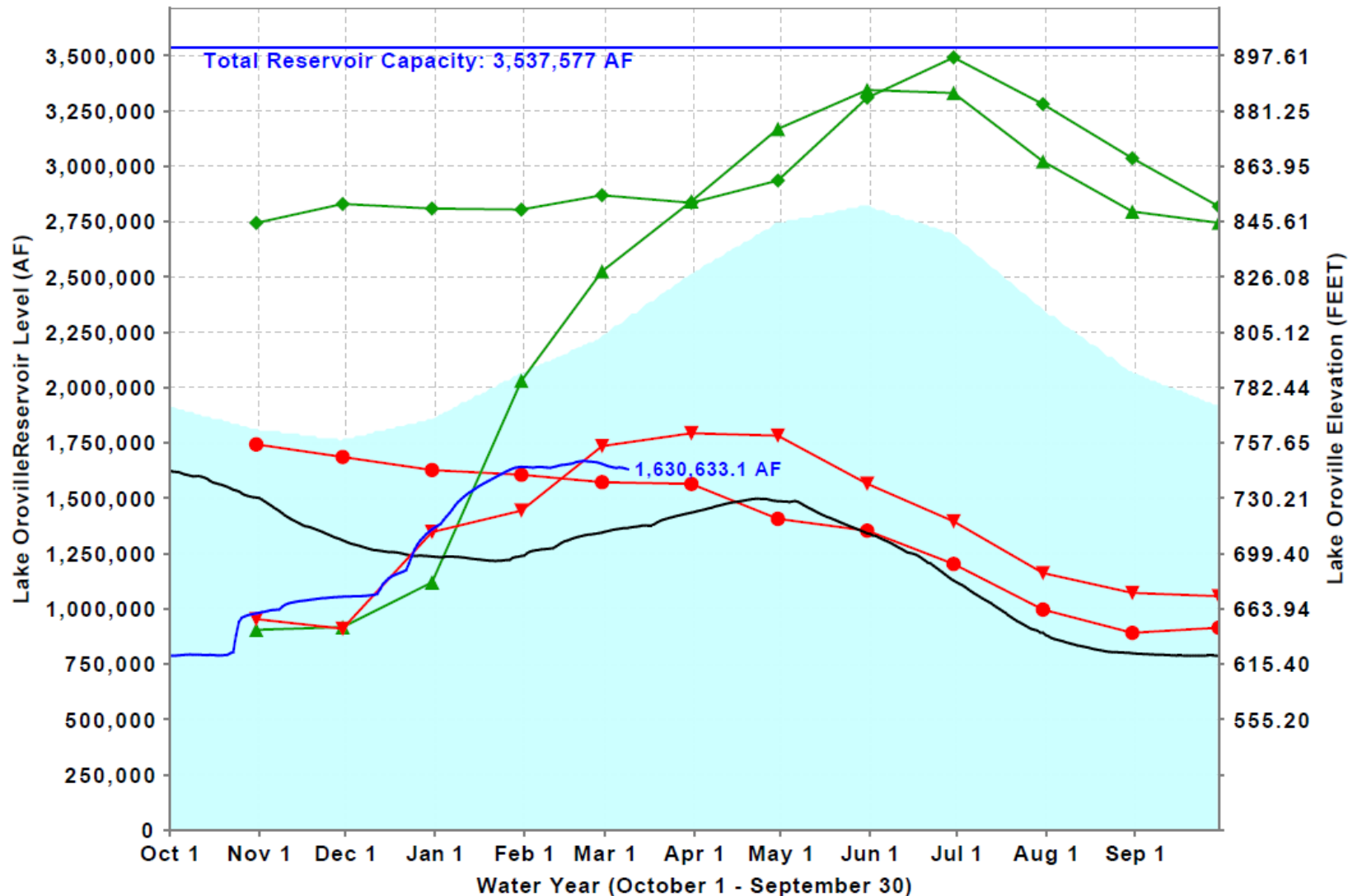
(as of Midnight - March 9, 2022)



Current Level: 1,630,633.1 AF

46% (Total Capacity) | 71% (Historical Avg.)

Lake Oroville Levels: Various Past Water Years and Current Water Year, Ending At Midnight March 9, 2022

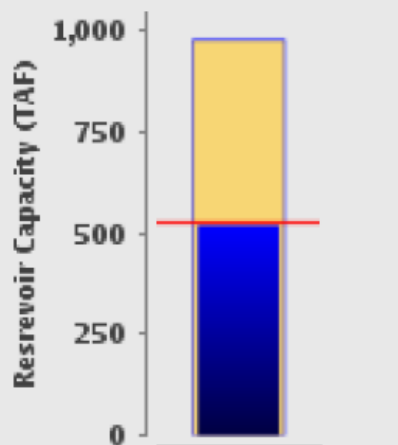


Data Updated 03/10/2022 10:18 AM



## Folsom Lake Conditions

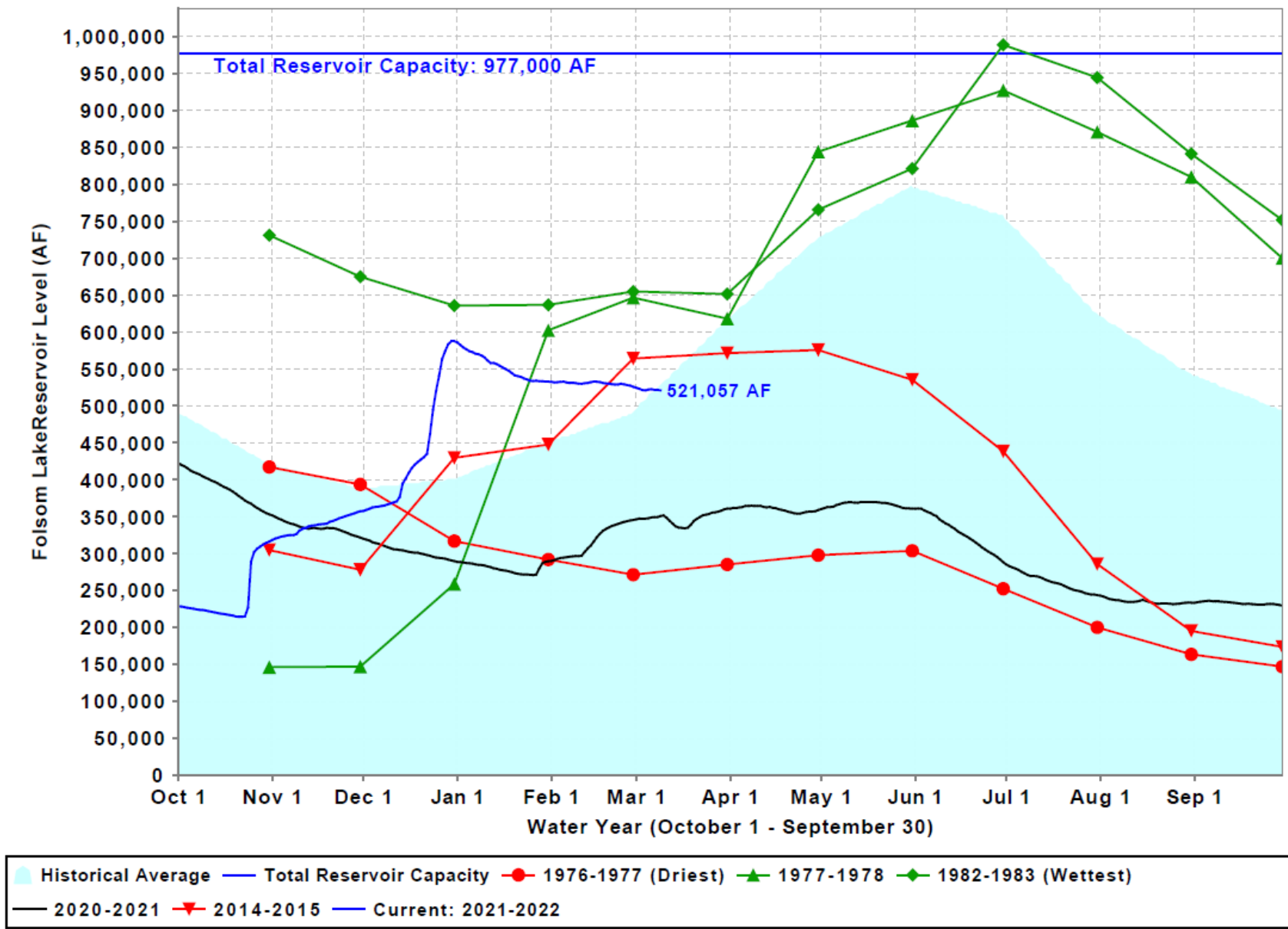
(as of Midnight - March 9, 2022)



Current Level: 521,057 AF

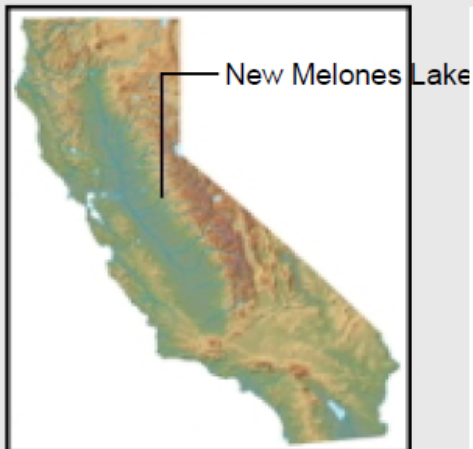
53% (Total Capacity) | 99% (Historical Avg.)

Folsom Lake Levels: Various Past Water Years and Current Water Year, Ending At Midnight March 9, 2022

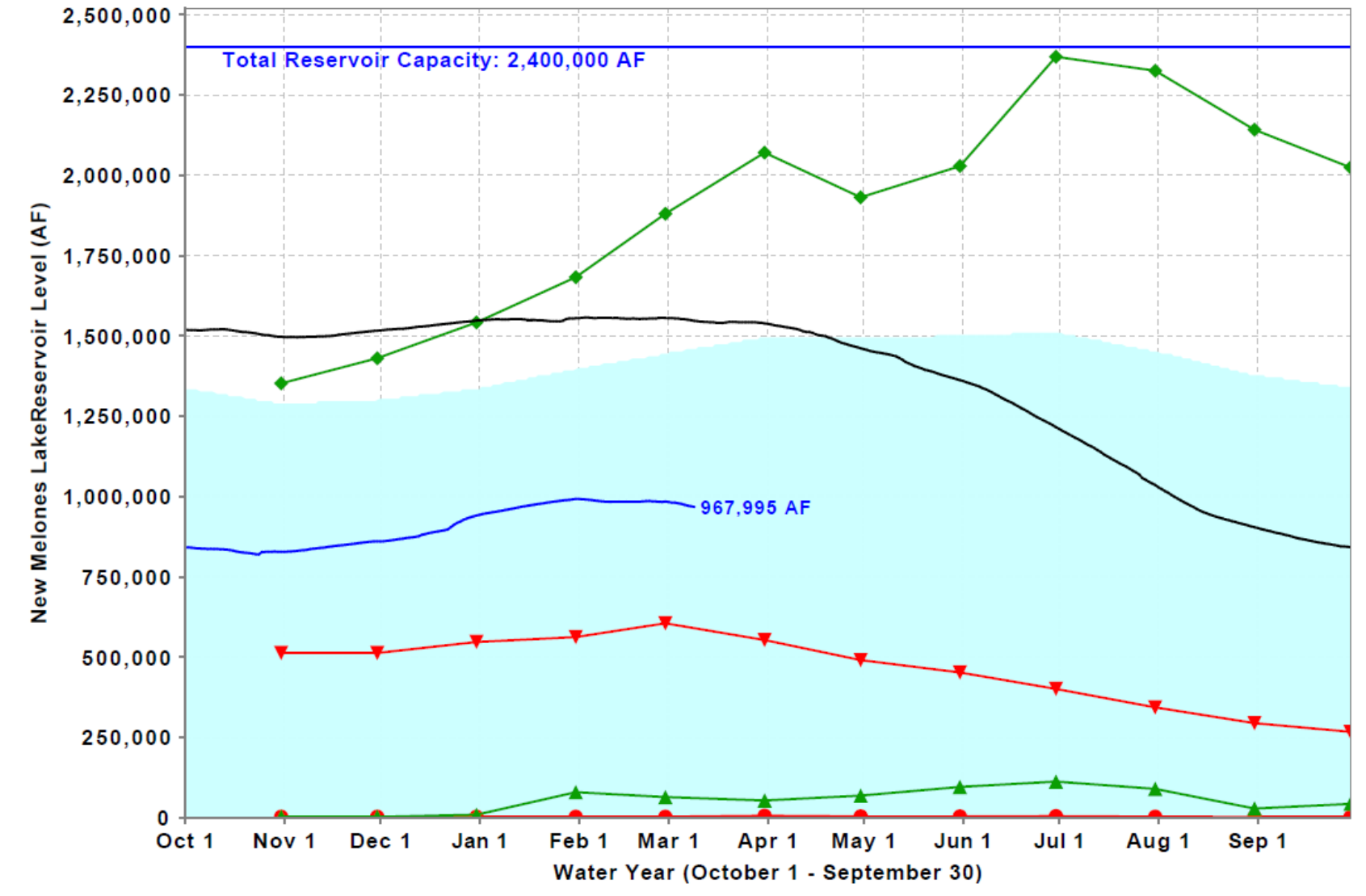


Data Updated 03/10/2022 10:18 AM



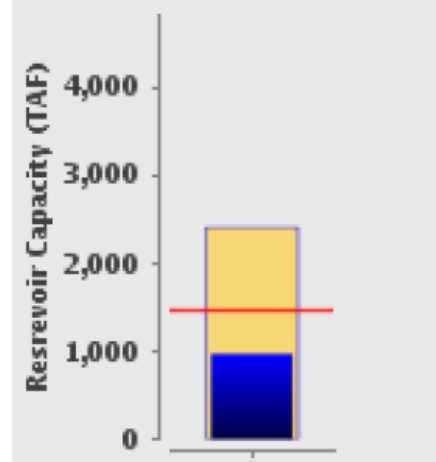


New Melones Lake Levels: Various Past Water Years and Current Water Year, Ending At Midnight March 9, 2022



### New Melones Lake Conditions

(as of Midnight - March 9, 2022)



Current Level: 967,995 AF

40% (Total Capacity) | 67% (Historical Avg.)

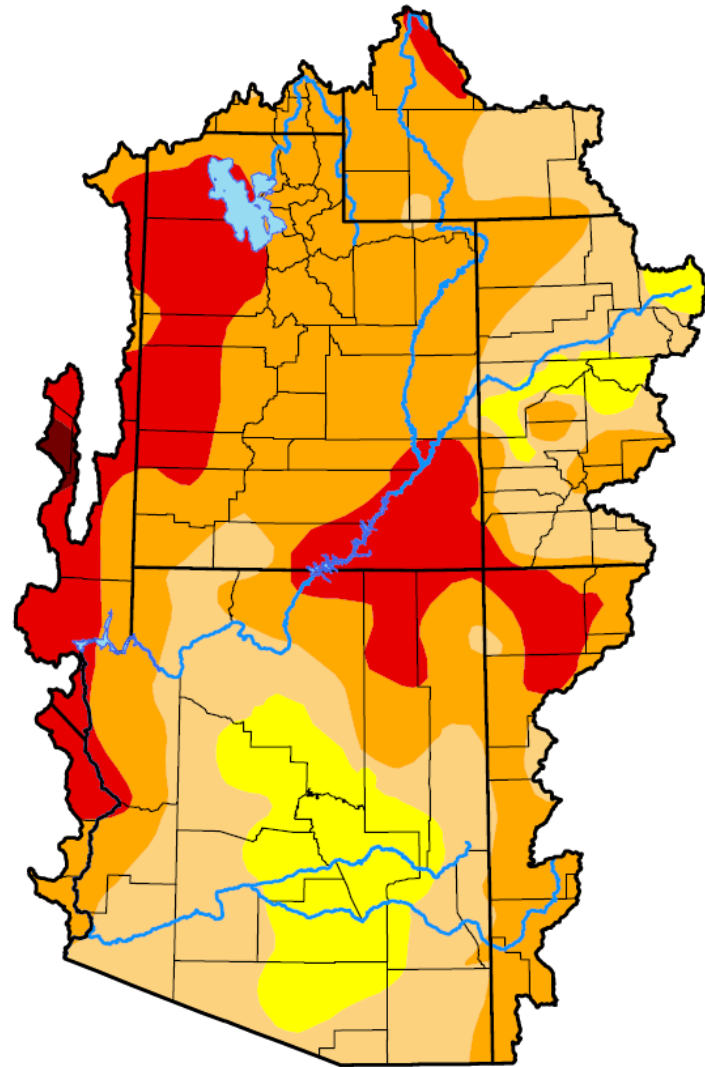
■ Historical Average 
 — Total Reservoir Capacity 
 ● 1976-1977 (Driest) 
 ▲ 1977-1978 
 ◆ 1982-1983 (Wettest) 
 — 2020-2021 
 ▼ 2014-2015 
 — Current: 2021-2022

Data Updated 03/10/2022 10:18 AM

# U.S. Drought Monitor

## Colorado Basin RFC

**March 8, 2022**  
 (Released Thursday, Mar. 10, 2022)  
 Valid 7 a.m. EST



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
<b>Current</b>	0.00	100.00	88.85	60.88	18.36	0.32
<b>Last Week</b> <i>03-01-2022</i>	0.00	100.00	88.85	60.88	19.36	0.32
<b>3 Months Ago</b> <i>12-07-2021</i>	0.00	100.00	91.35	68.02	33.67	4.12
<b>Start of Calendar Year</b> <i>01-04-2022</i>	0.00	100.00	81.98	58.30	16.07	0.32
<b>Start of Water Year</b> <i>09-28-2021</i>	0.00	100.00	91.13	71.92	46.19	8.34
<b>One Year Ago</b> <i>03-09-2021</i>	0.00	100.00	99.50	91.49	80.59	51.66

Intensity:



*The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>*

Author:

Brian Fuchs  
 National Drought Mitigation Center



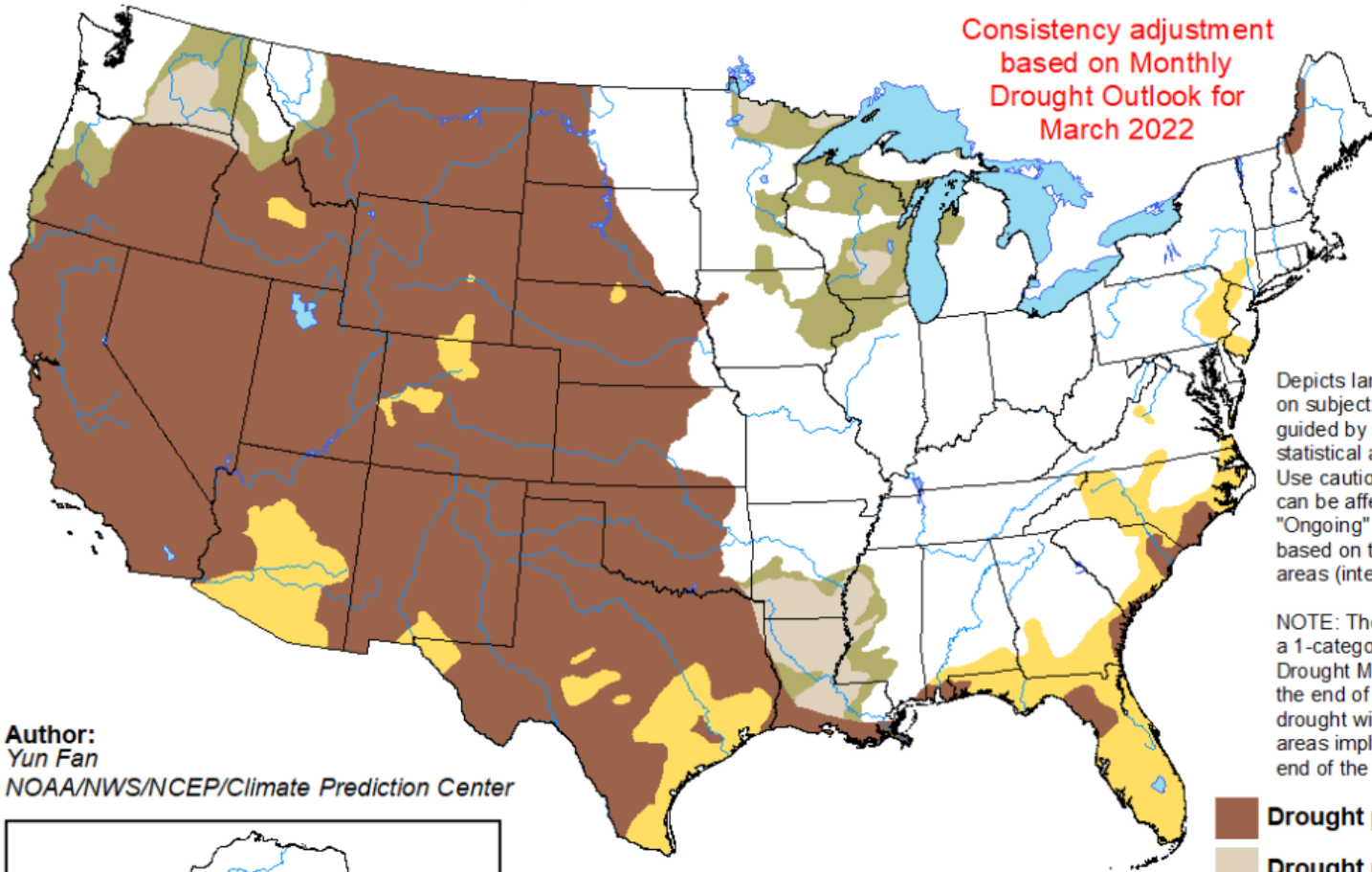
[droughtmonitor.unl.edu](https://droughtmonitor.unl.edu)

# U.S. Seasonal Drought Outlook

## Drought Tendency During the Valid Period

Valid for March 1 - May 31, 2022  
Released February 28, 2022

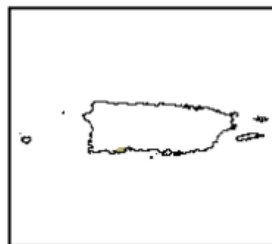
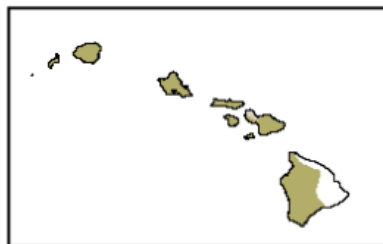
Consistency adjustment  
based on Monthly  
Drought Outlook for  
March 2022







Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Use caution for applications that can be affected by short lived events. "Ongoing" drought areas are based on the U.S. Drought Monitor areas (intensities of D1 to D4).

NOTE: The tan areas imply at least a 1-category improvement in the Drought Monitor intensity levels by the end of the period, although drought will remain. The green areas imply drought removal by the end of the period (D0 or none).

Author:  
Yun Fan  
NOAA/NWS/NCEP/Climate Prediction Center



-  Drought persists
-  Drought remains but improves
-  Drought removal likely
-  Drought development likely



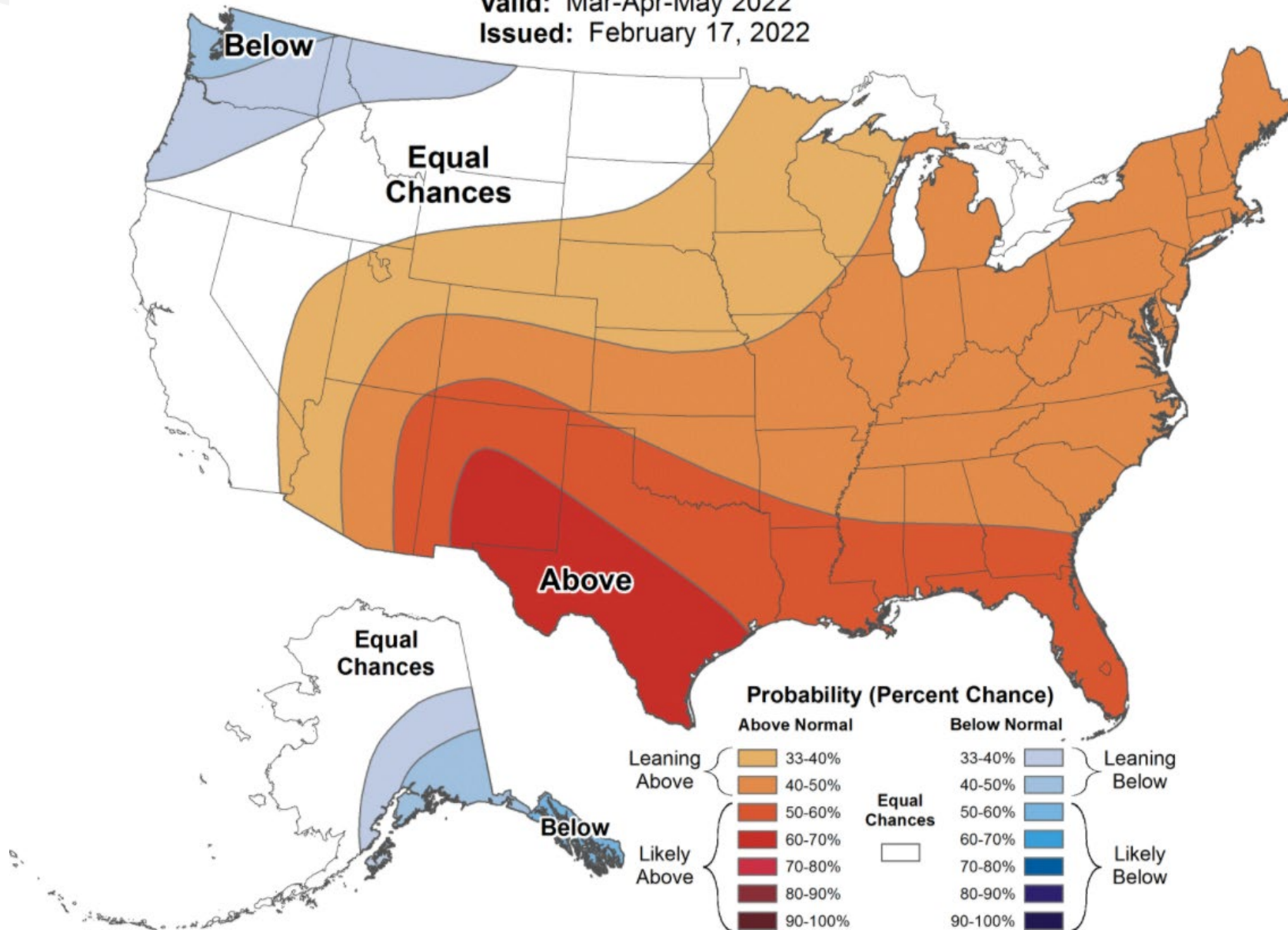
<http://go.usa.gov/3eZ73>



# Seasonal Temperature Outlook



Valid: Mar-Apr-May 2022  
Issued: February 17, 2022

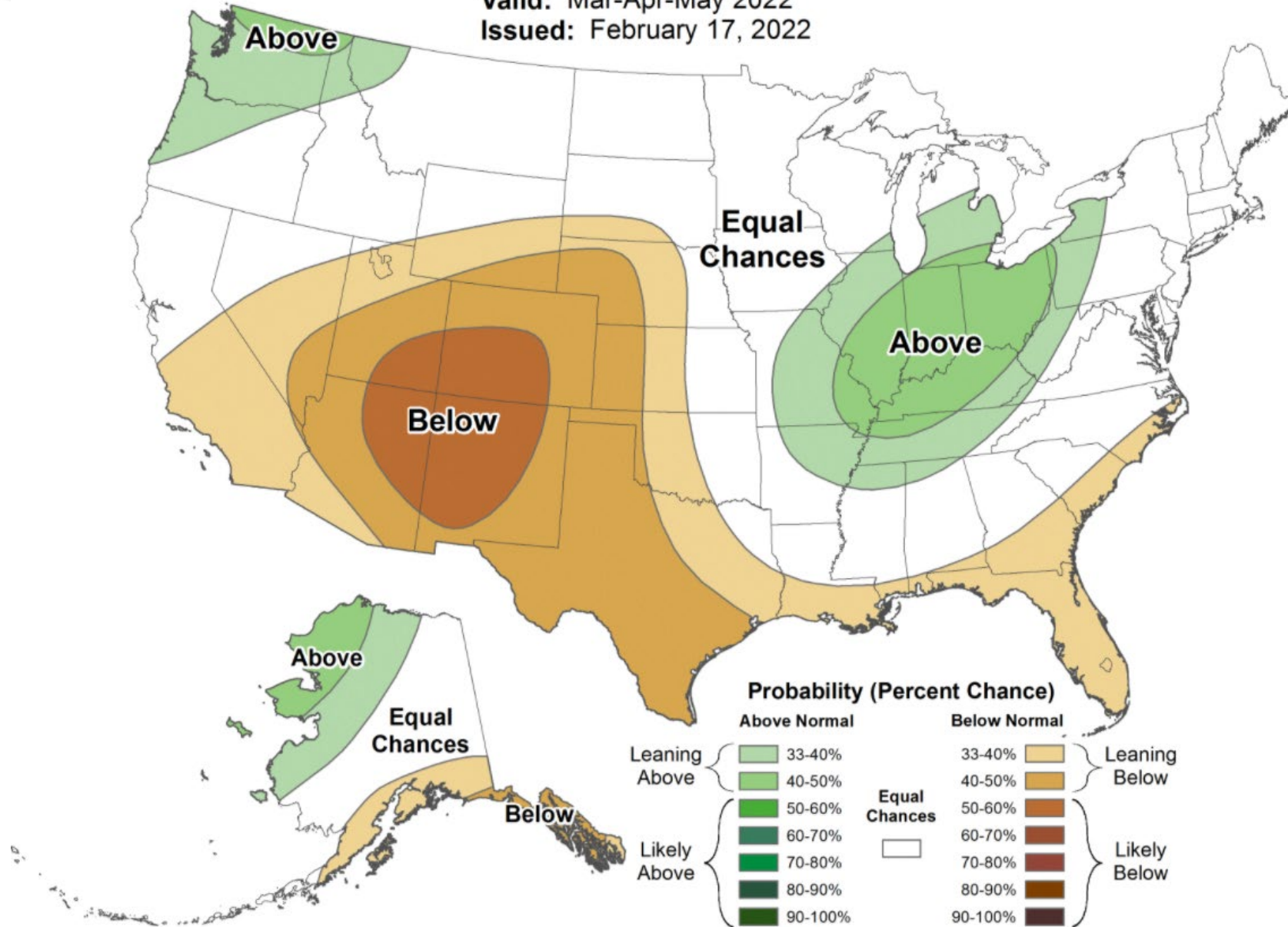




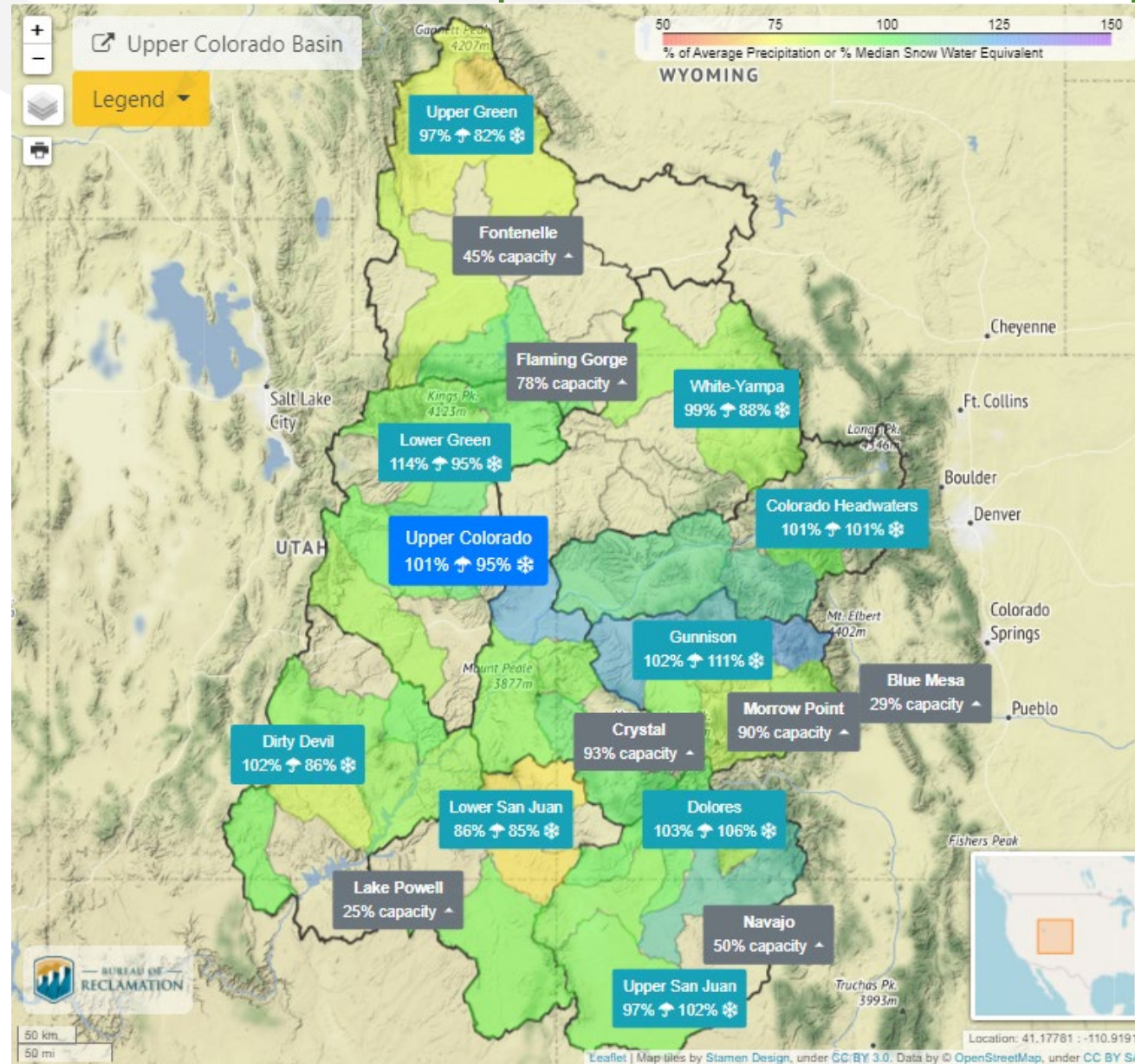
# Seasonal Precipitation Outlook



Valid: Mar-Apr-May 2022  
Issued: February 17, 2022



# Colorado River Basin Precipitation & Snow Water Equivalent



# El Niño/La Niña

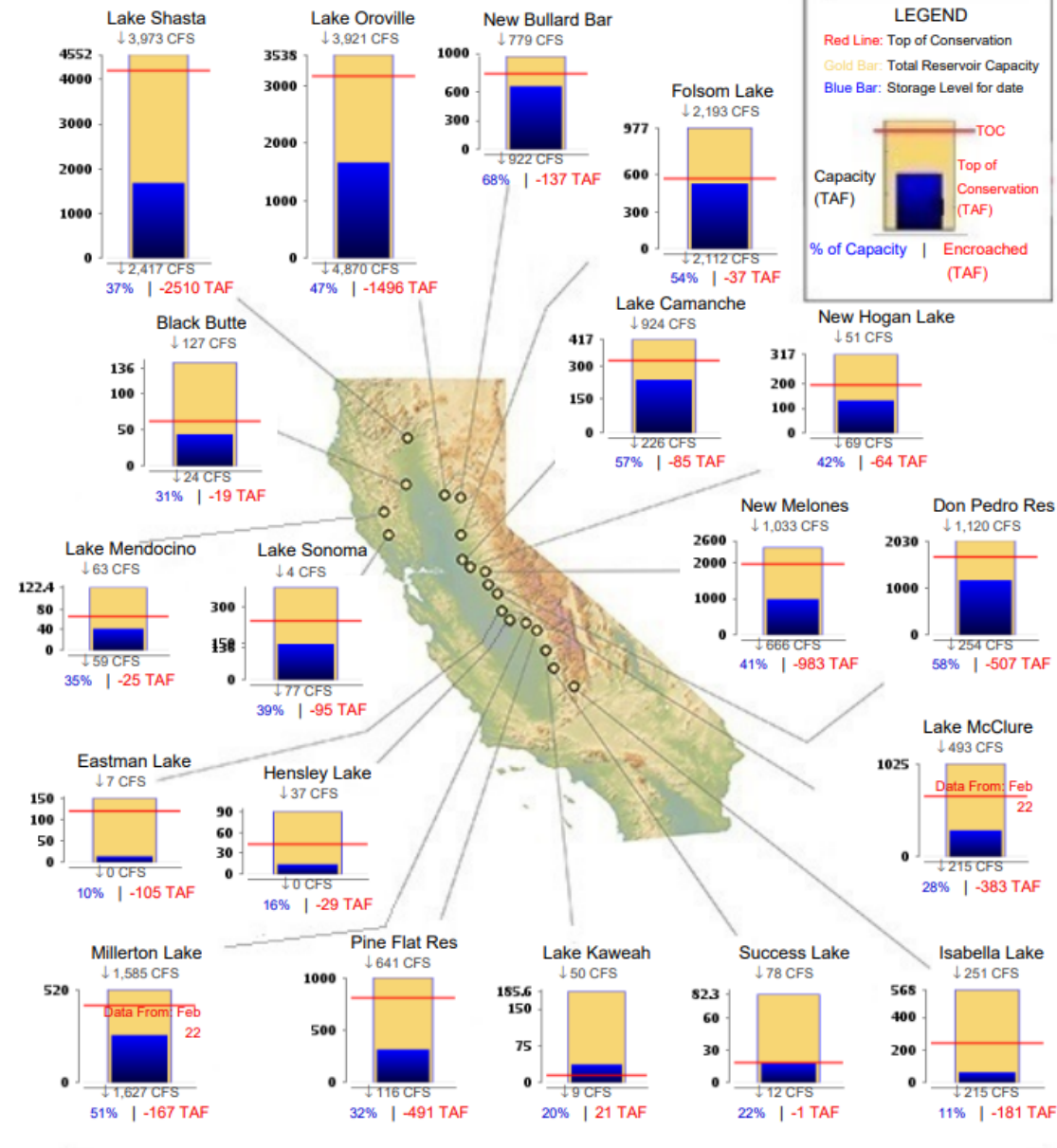
Last update 3/10/2022

La Niña is likely to continue into the Northern Hemisphere spring (53% chance during June-August 2022).

Afterwards, there is a 40-50% chance of La Niña or ENSO-neutral Conditions

# TOP OF CONSERVATION CONDITIONS (TOC) CENTRAL VALLEY RUSSIAN RIVER FLOOD CONTROL RESERVOIRS

Midnight - February 23, 2022



Updated 02/24/2022 09:15 AM