

# Water Supply Reliability

Delta Independent Science Board

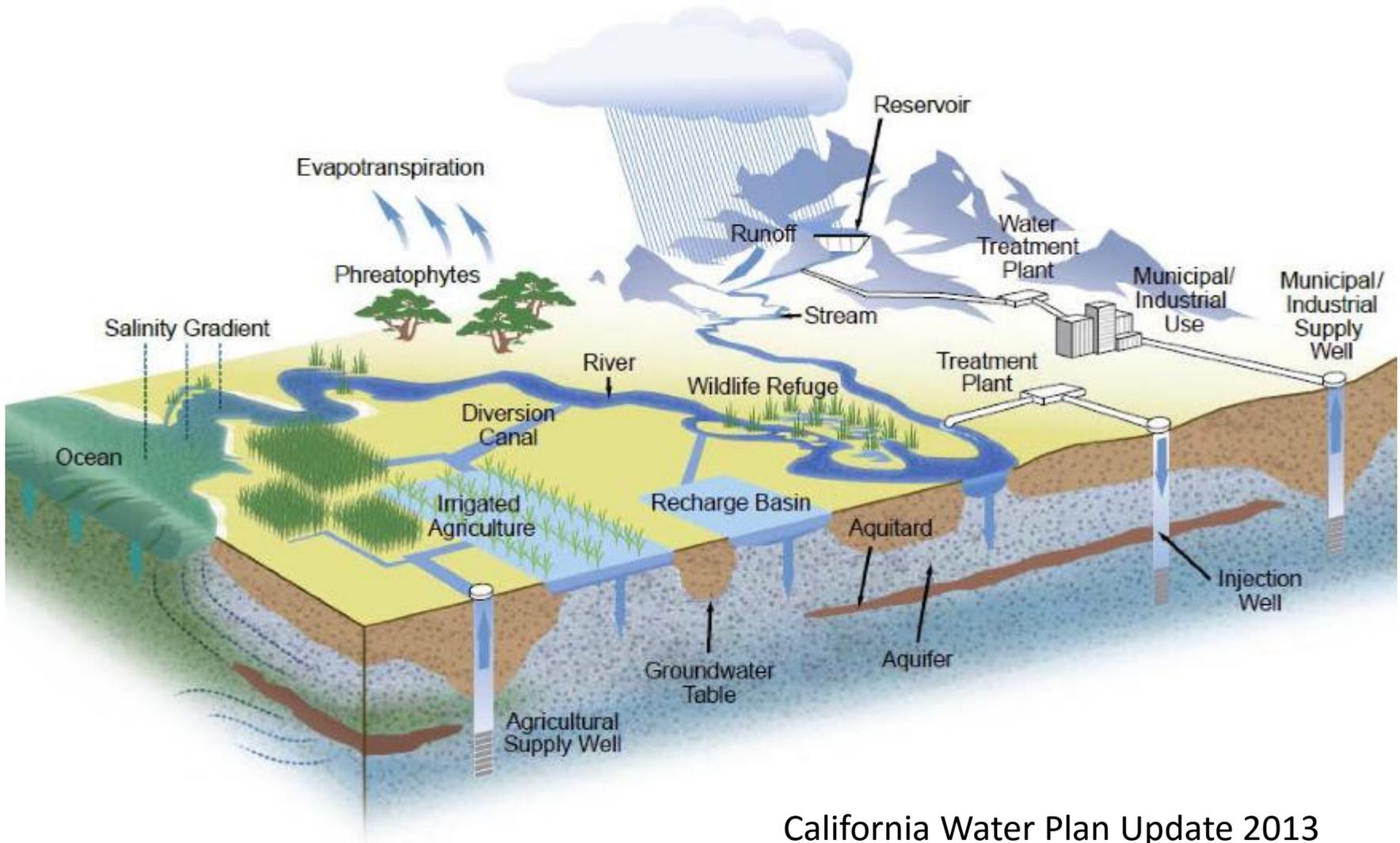
February 12, 2016

- Ron Milligan
- John Leahigh
- Erik Reyes
- Armin Munevar
- Walter Bourez

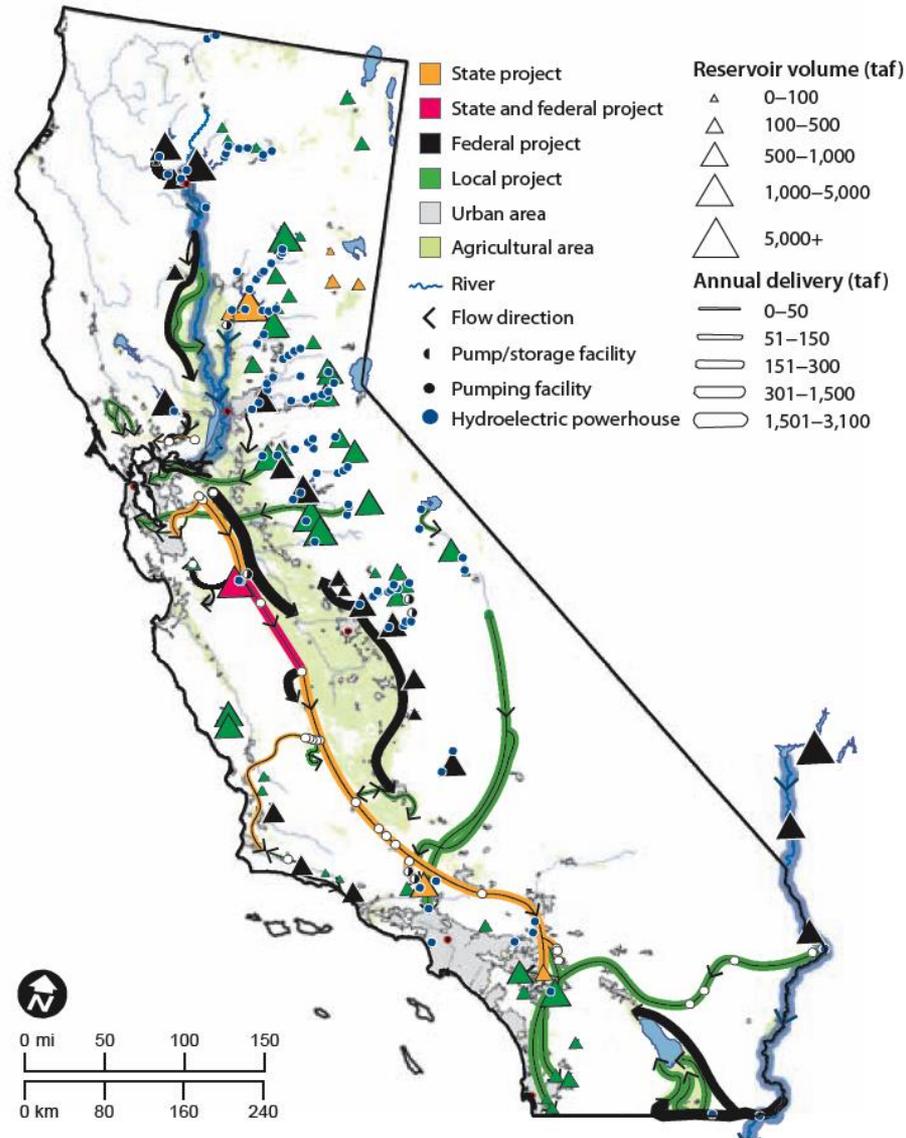
# Water Supply Reliability - Definition

- “The ability to meet water demands consistently”
  - CUWA Water Supply Reliability Report—August 15, 2012
- CALFED August 2003. “Perceptions of reliability are common to other types of demand / supply contexts and engineers have formalized this perception as follows:”
  - “Reliability is the probability that a system does not fail, or conversely, it is the probability of system failure subtracted from one.
  - In the utilities fields, this is more generally stated as a measure of a utility’s ability to deliver uninterrupted service.”
- "The likelihood that I can't get all the water I want cheaply."

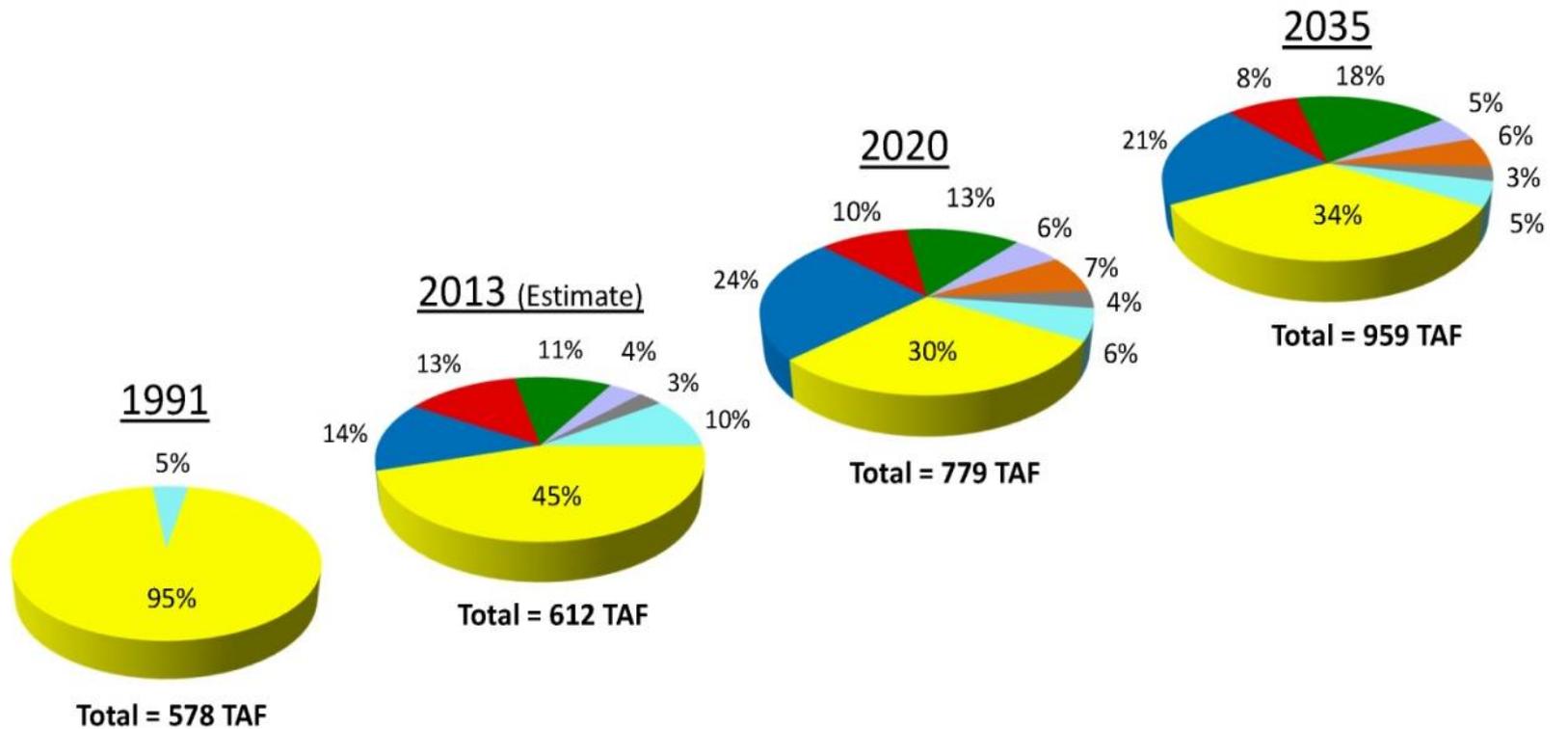
# Water supply is part of an intensely integrated hydrologic system



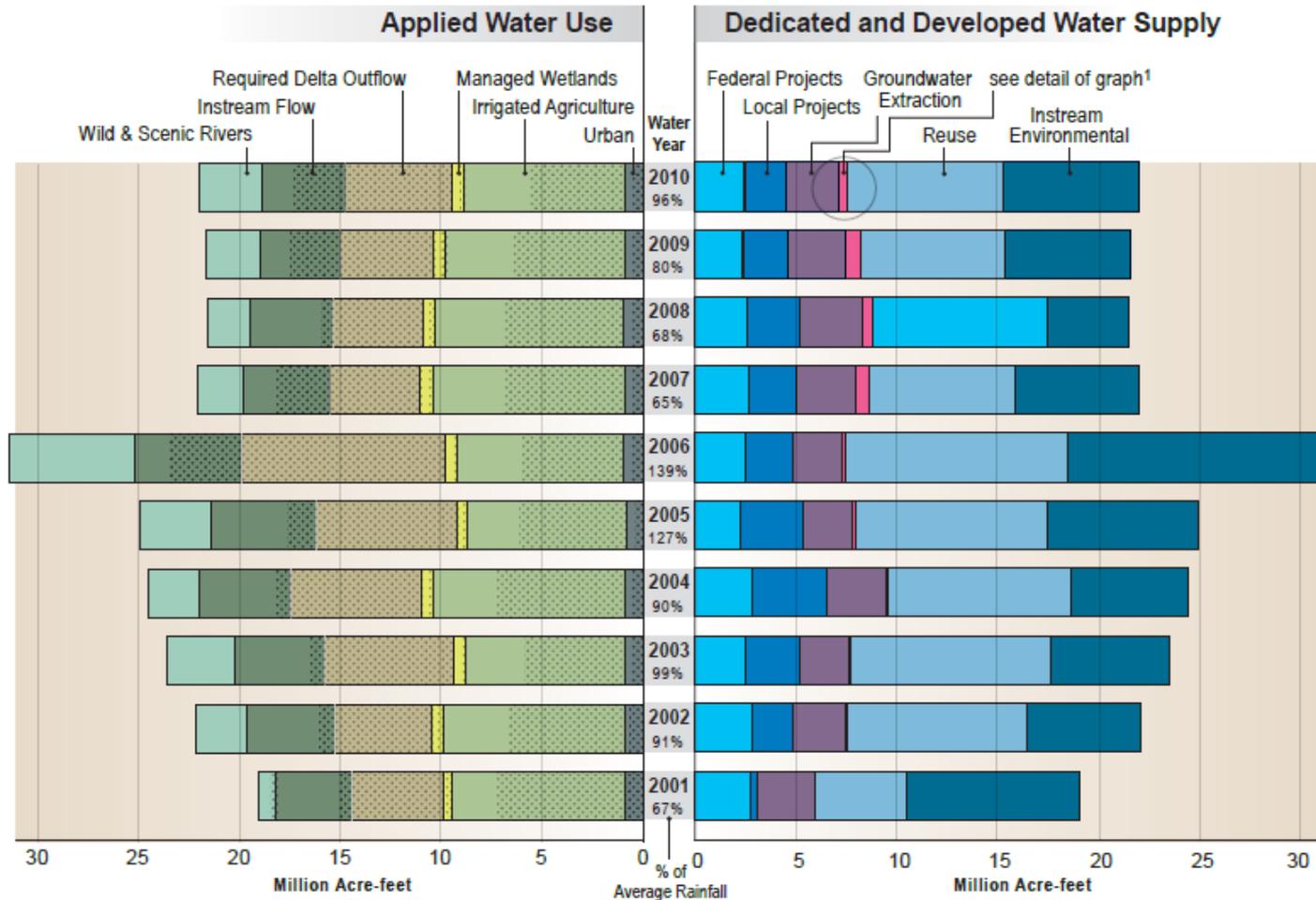
# ... and an intertied water system



# In some regions water supply reliability is based on a diverse portfolio



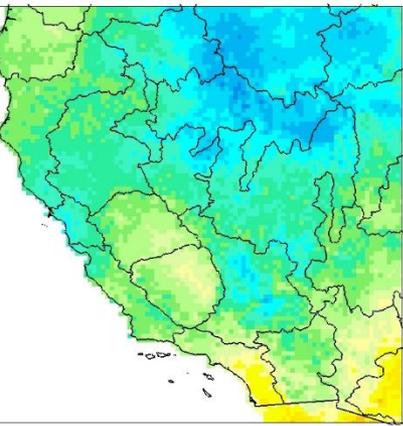
# ... and other regions have less diversity of supply sources



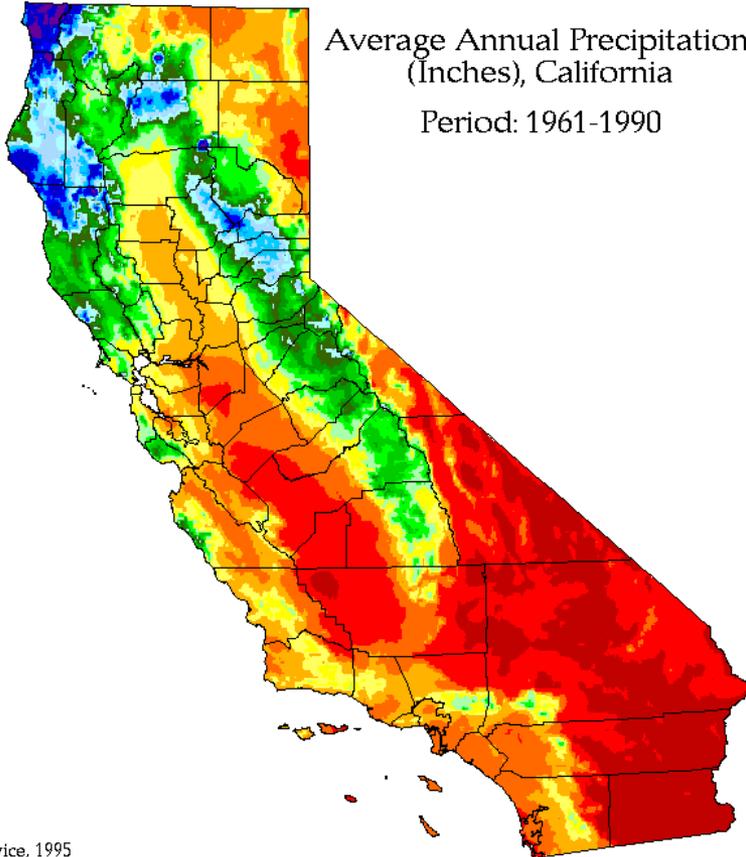
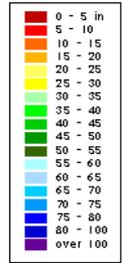
# Factors Affecting Reliability

- Climate
- Hydrology
- Geographic location
- Operational strategies
- Alternative supply
- Institutional constraints

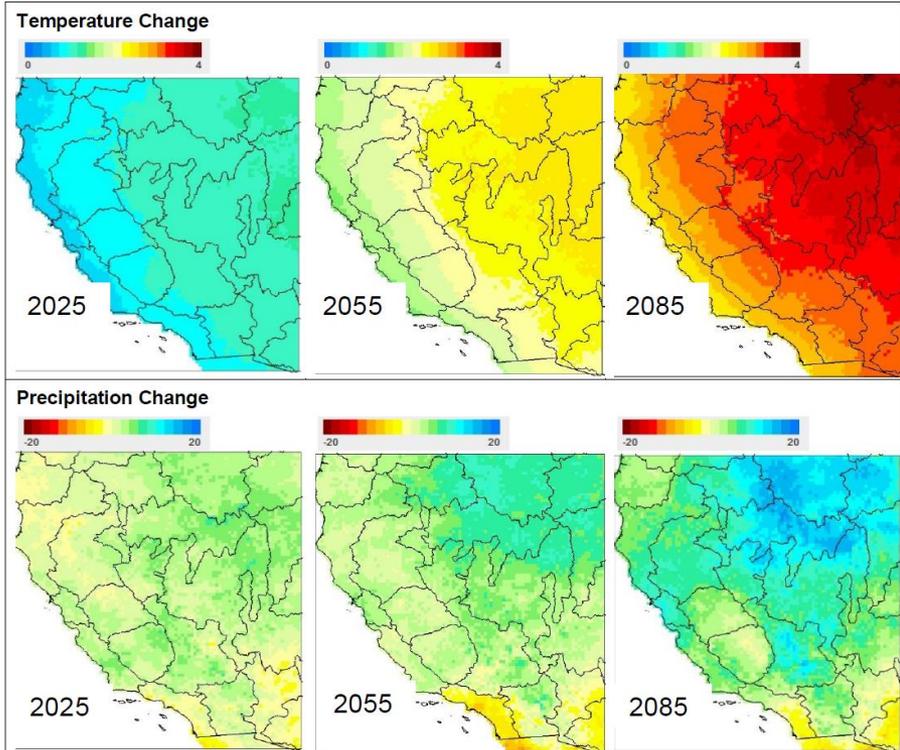
# Climate Variability and Change



Average Annual Precipitation  
(Inches), California  
Period: 1961-1990

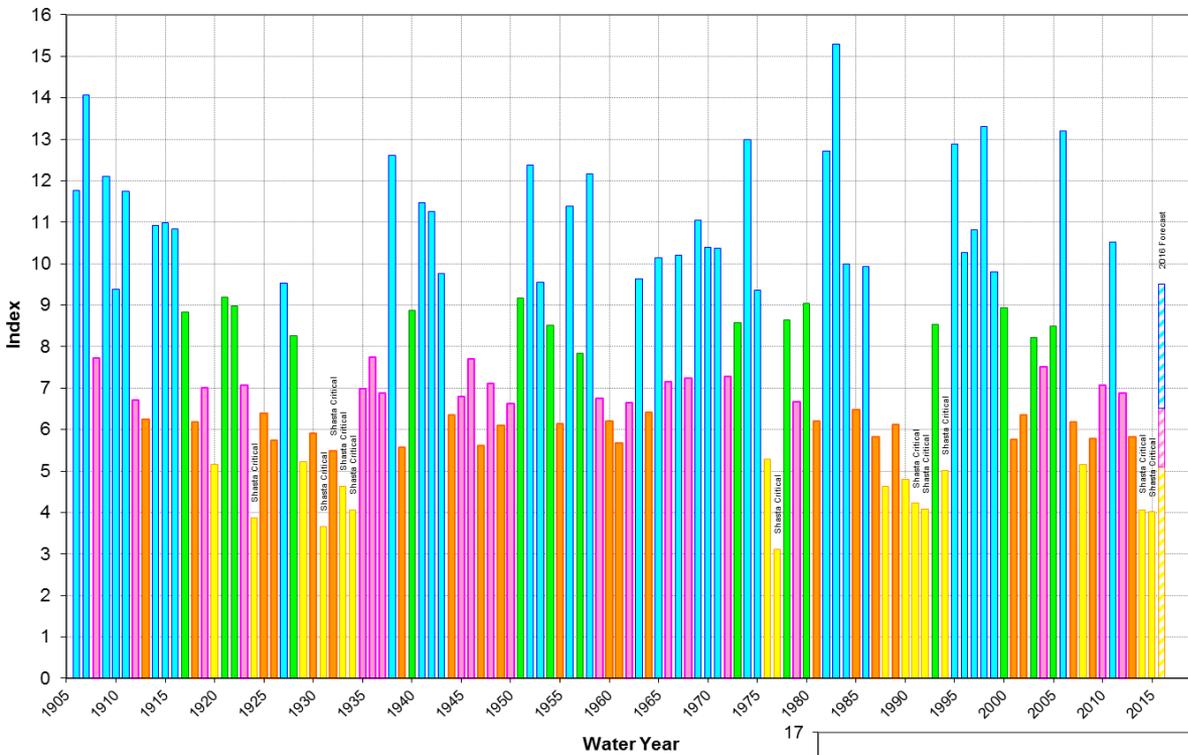


Projected Median Changes in Annual Temperature  
(C) and Precipitation (%) based on CMIP5 models

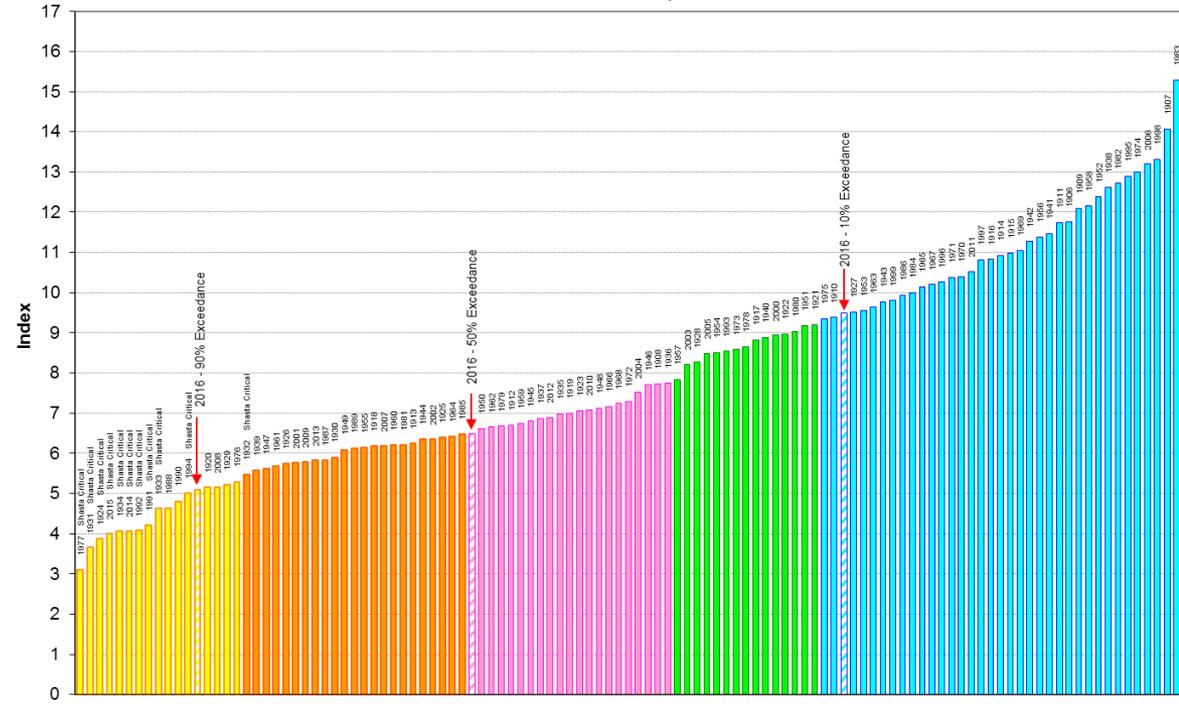


# Hydrology

## Sacramento Valley Water Year Index (40-30-30)

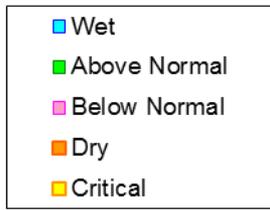
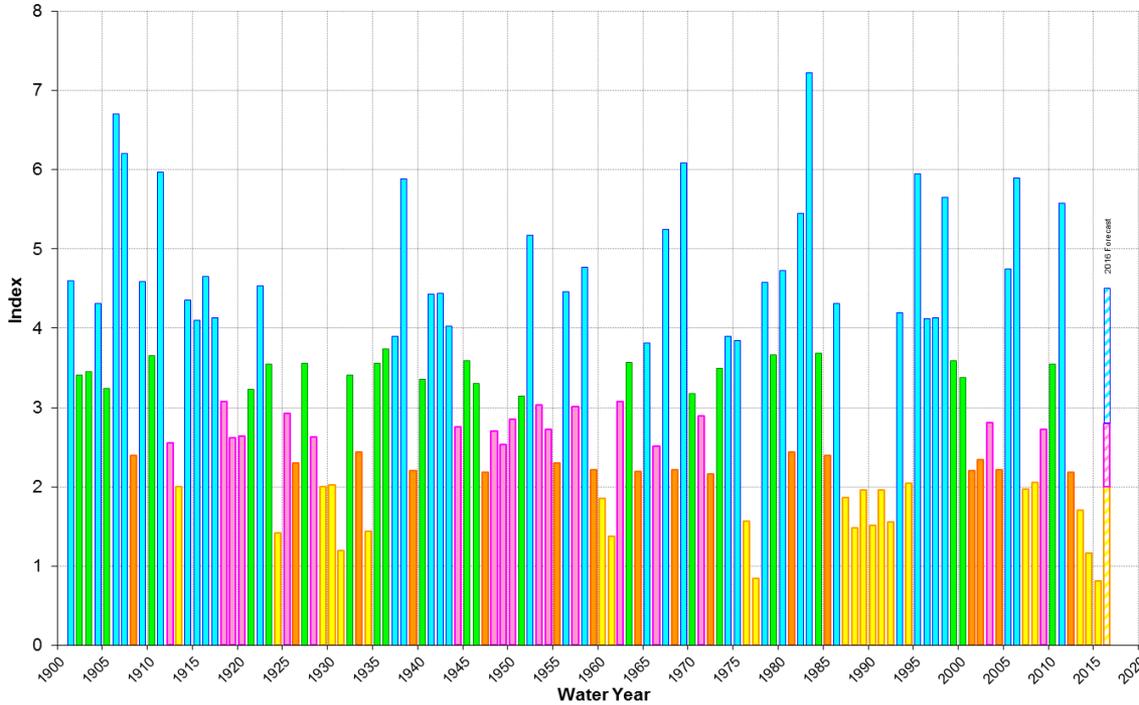


The 2016 Sacramento Valley Water Year Type Index is based on DWR February Forecast data:  
 90% = 5.1  
 50% = 6.5  
 10% = 9.5

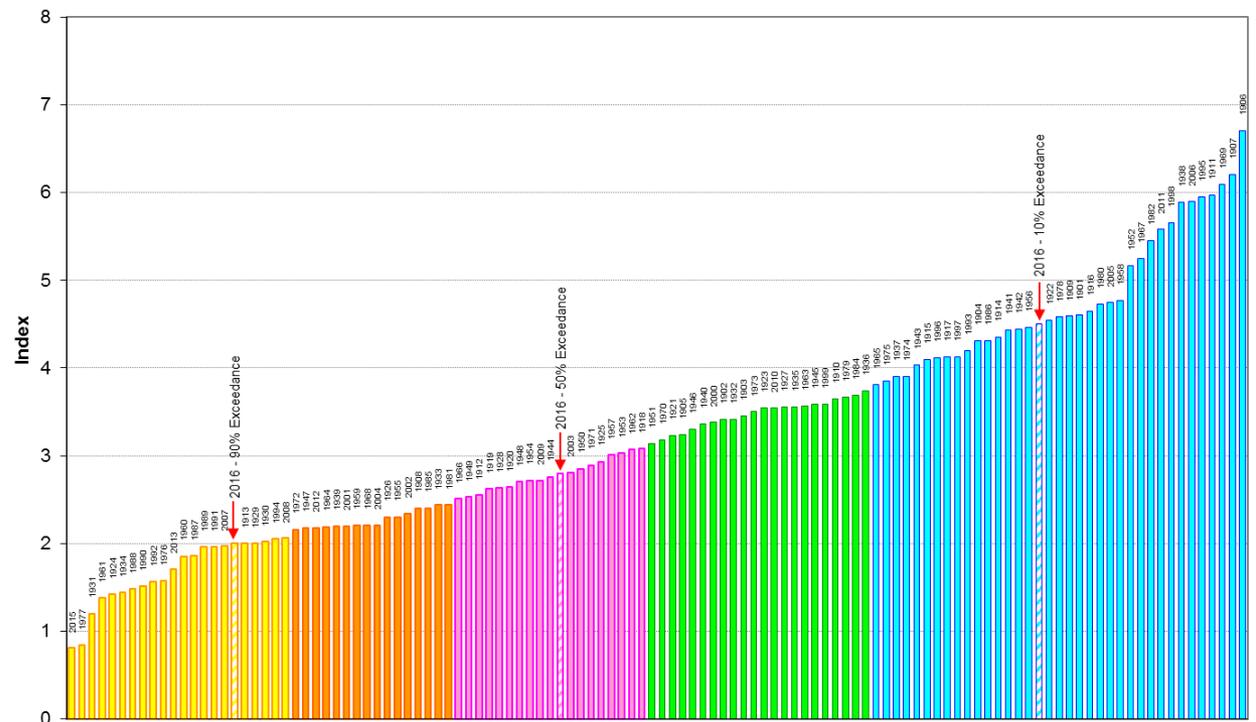


# Hydrology

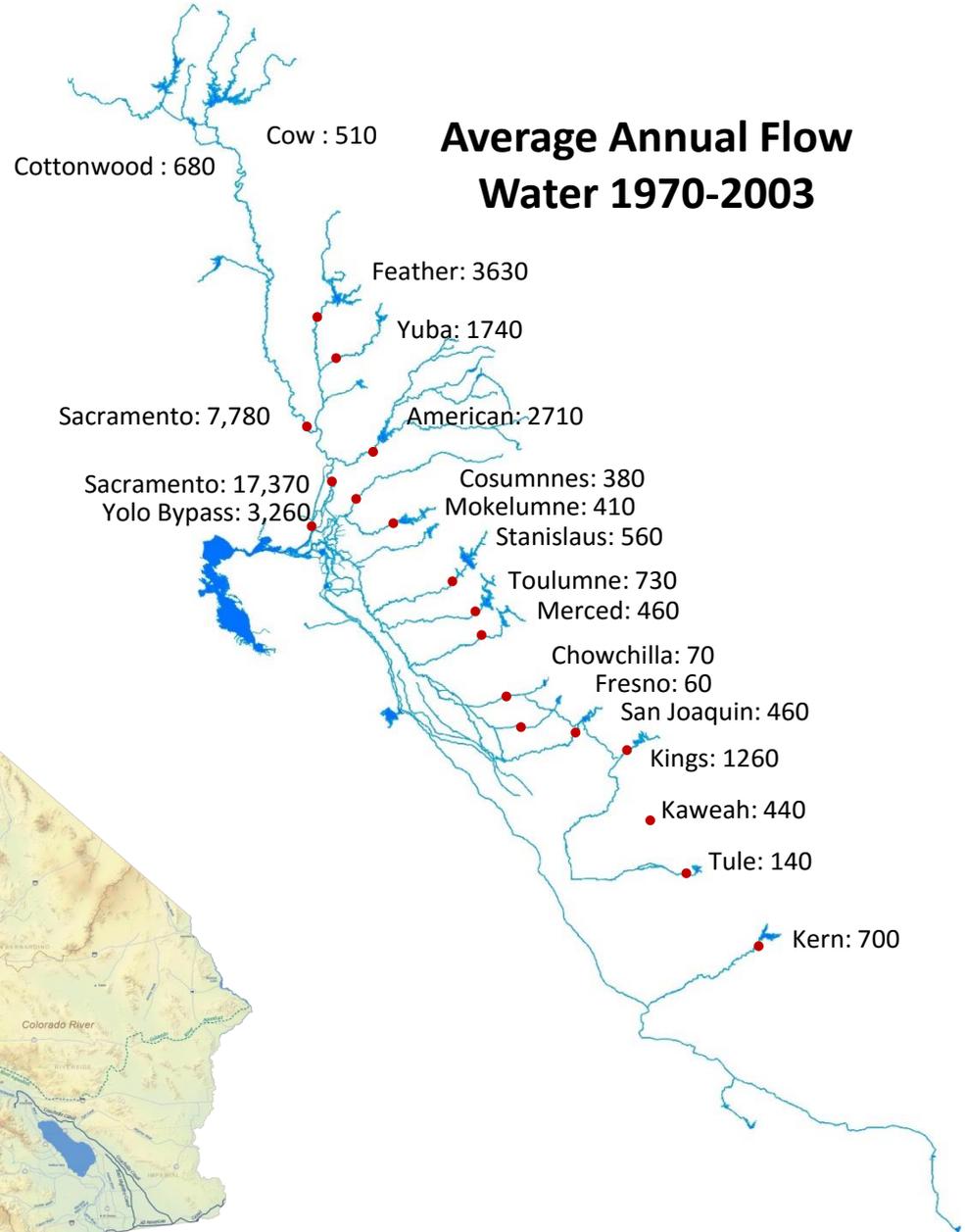
## San Joaquin Valley Water Year Index (60-20-20)



The 2016 San Joaquin Valley Water Year Type Index is based on DWR February Forecast data:  
 90% = 2.0  
 50% = 2.8  
 10% = 4.5



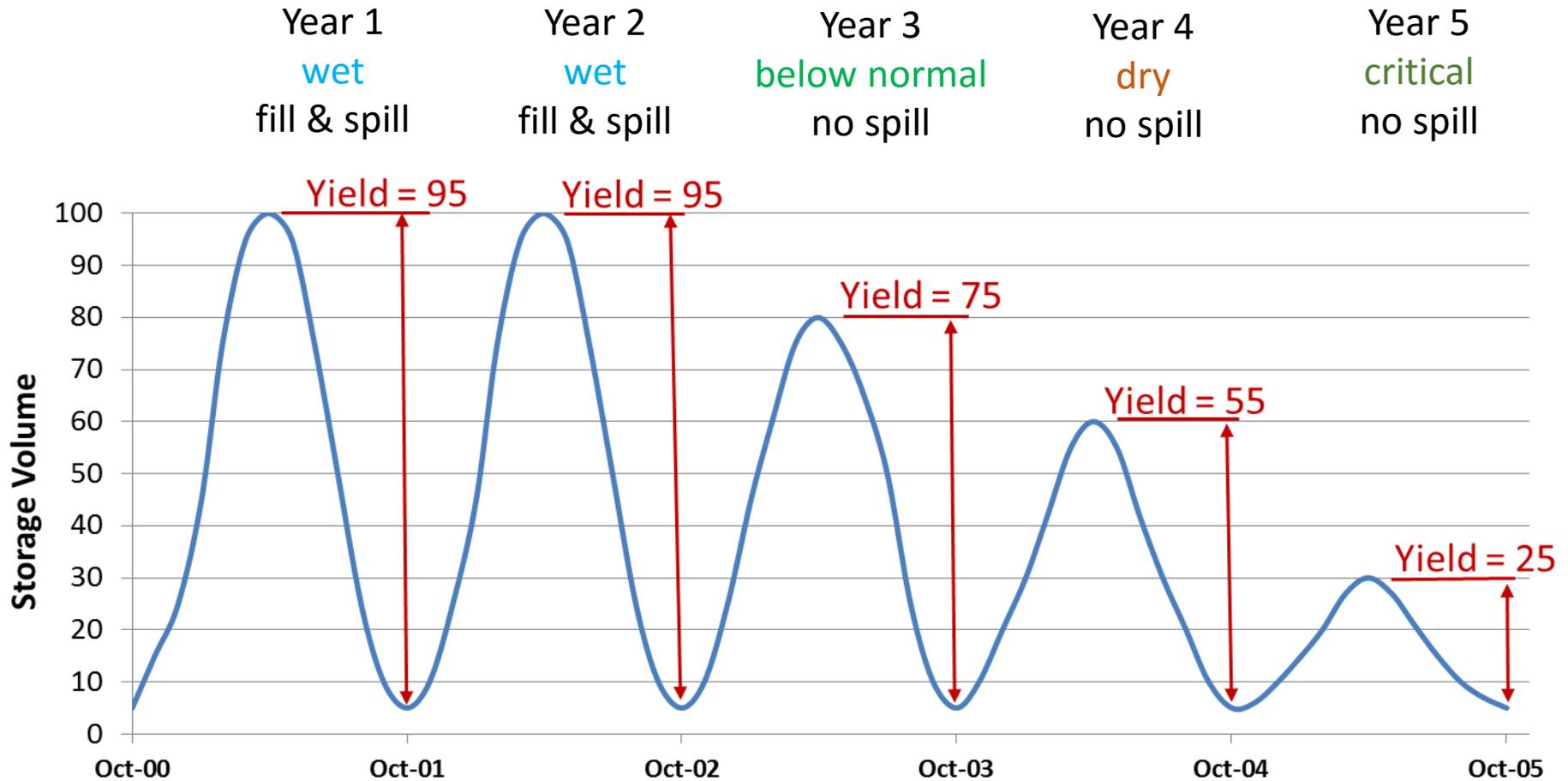
# Reliability – Location, Location, Location



# Operational strategy

- Average annual delivery versus dry year minimum delivery
- SWP
  - Article 56 is a provision to allow SWP contractors the flexibility to manage their preference of annual average delivery or dry year minimum delivery
- CVP
  - Rescheduled water

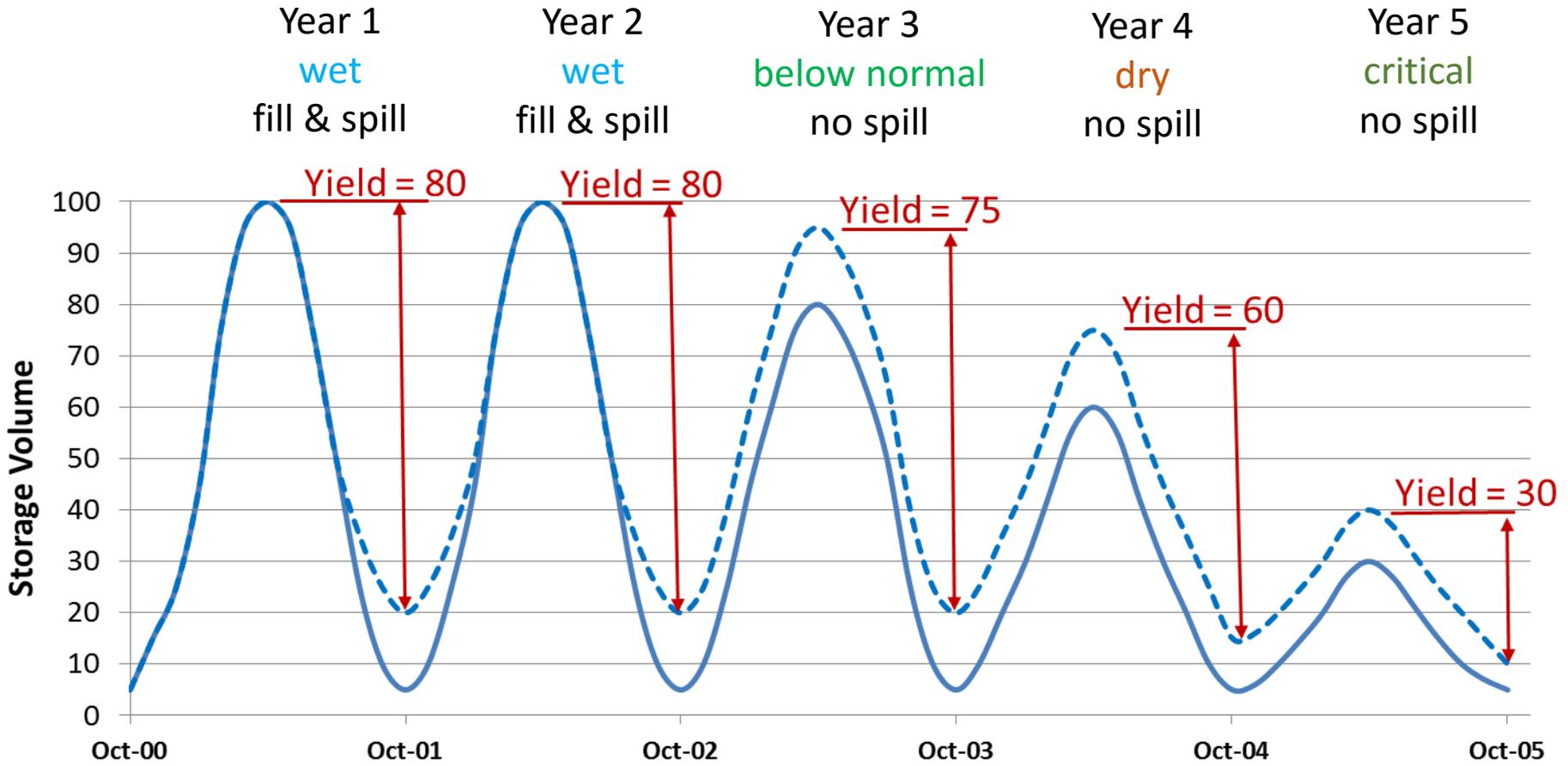
# Conceptual 5 Year Reservoir Operation



**Yield = water supply delivery or environmental release**

**Maximum Annual Drawdown = Maximum Average Yield**

# Conceptual 5 Year Reservoir Operation



Yield = water supply delivery or environmental release

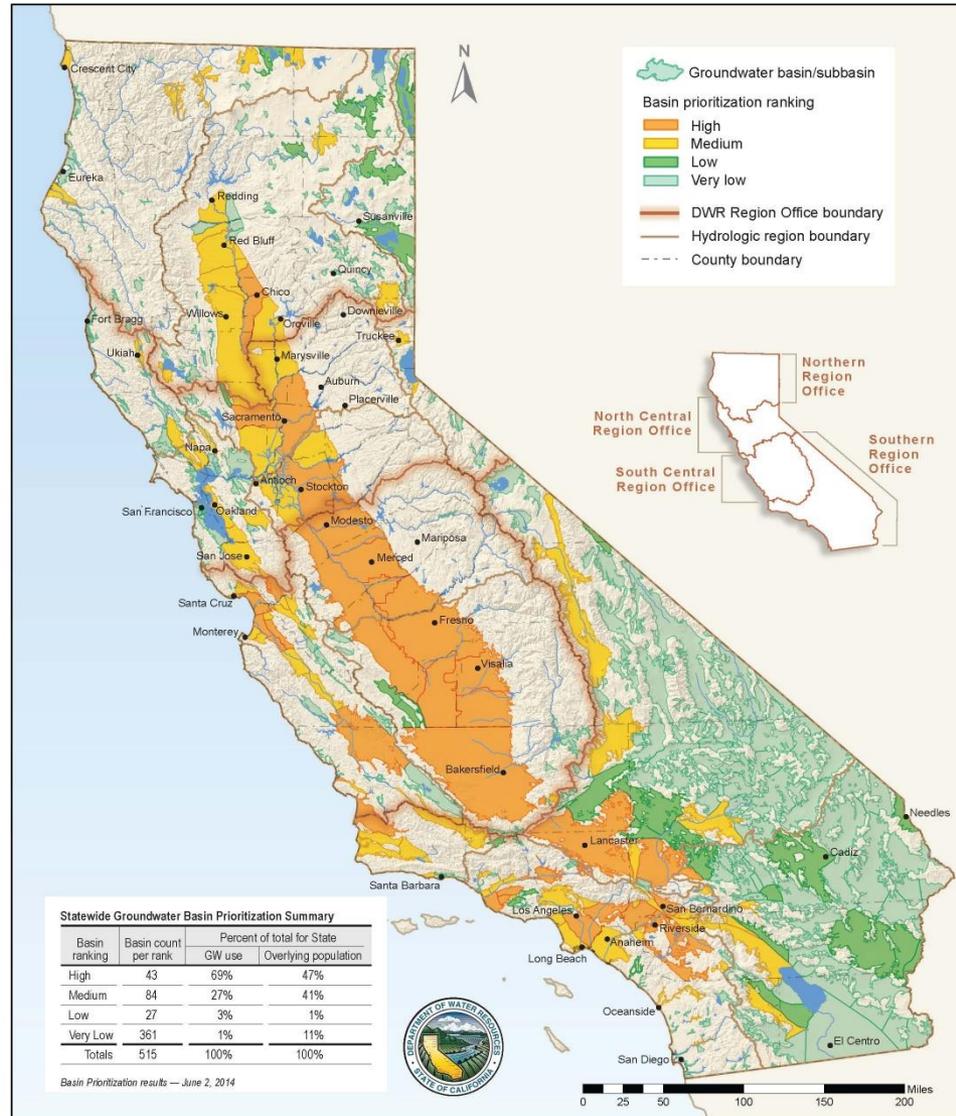
**Increased carryover target reduces average yield  
and increases dry year reliability**

# Alternative Water Supply

- Options
- Conjunctive management
  - Conjunctive management is key for water supply reliability for much of the state
- Groundwater Overdraft
  - Overdrafted areas do not have sustainable conditions or long-term reliability

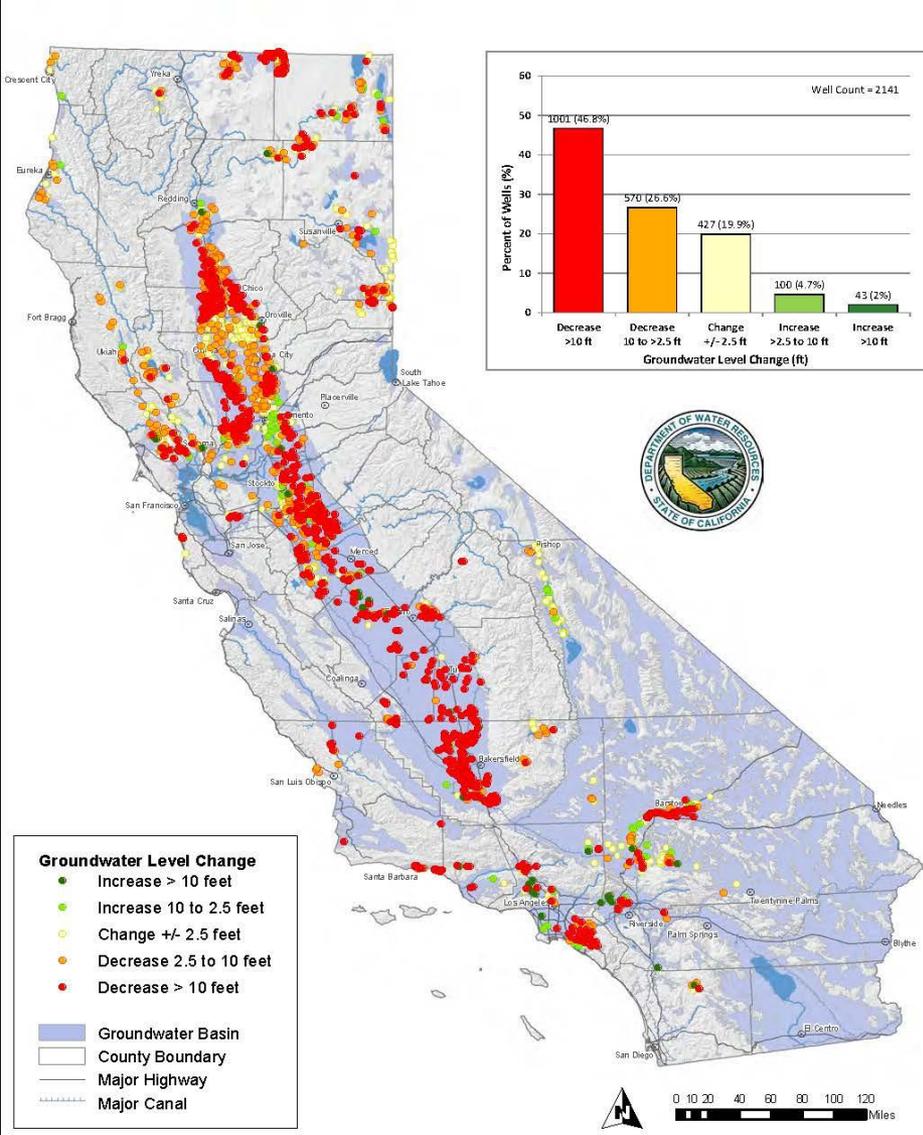
# Ground Water Conditions

## CASGEM Groundwater Basin Prioritization

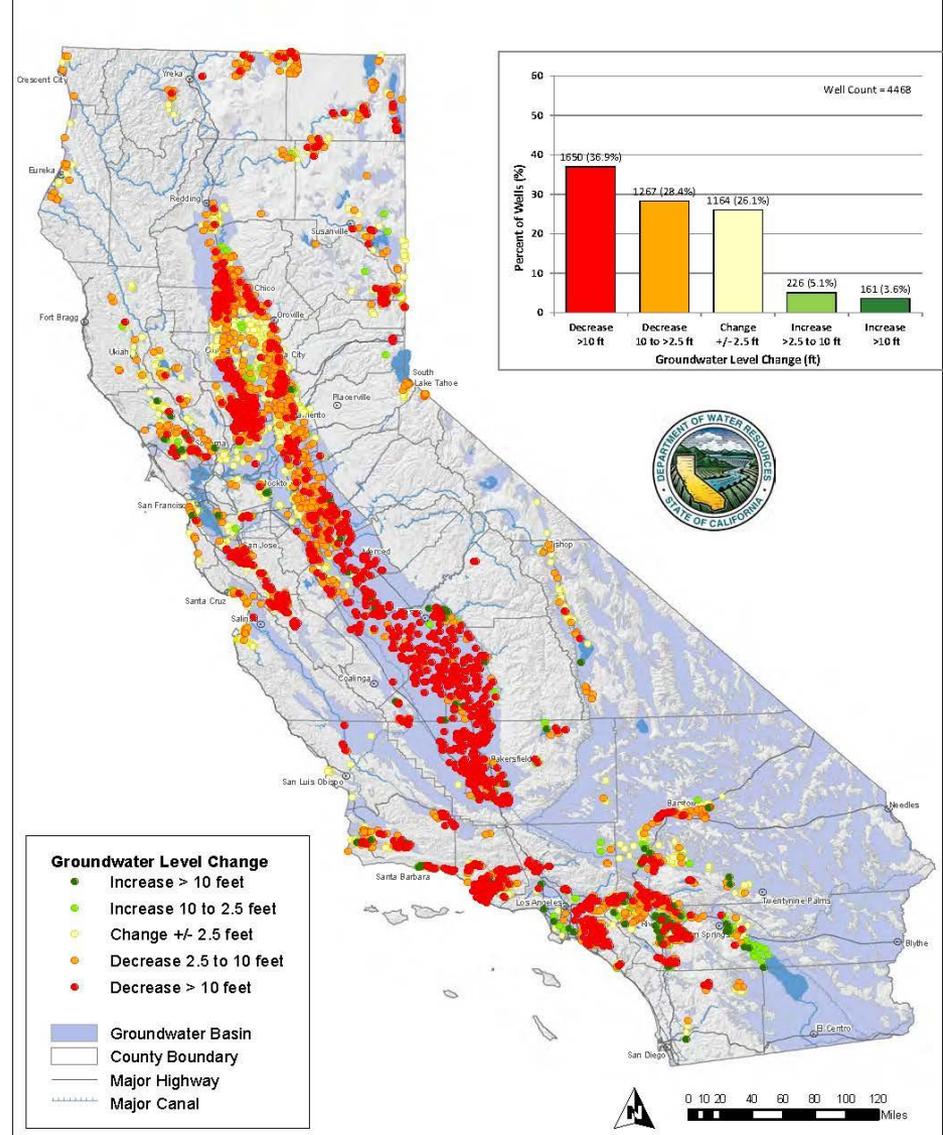


# Change in Groundwater Levels in Wells

## Groundwater Level Change\* - Spring 2005 to Spring 2015



## Groundwater Level Change\* - Spring 2012 to Spring 2015



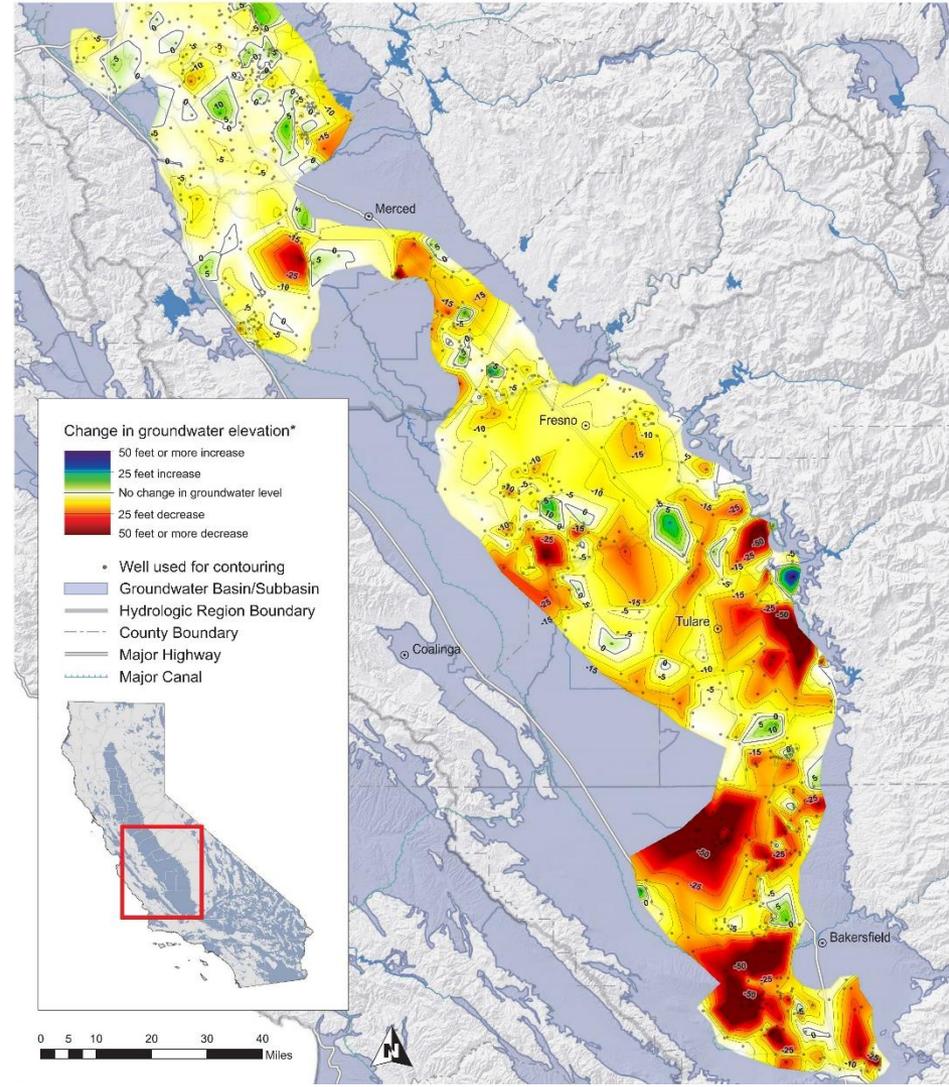
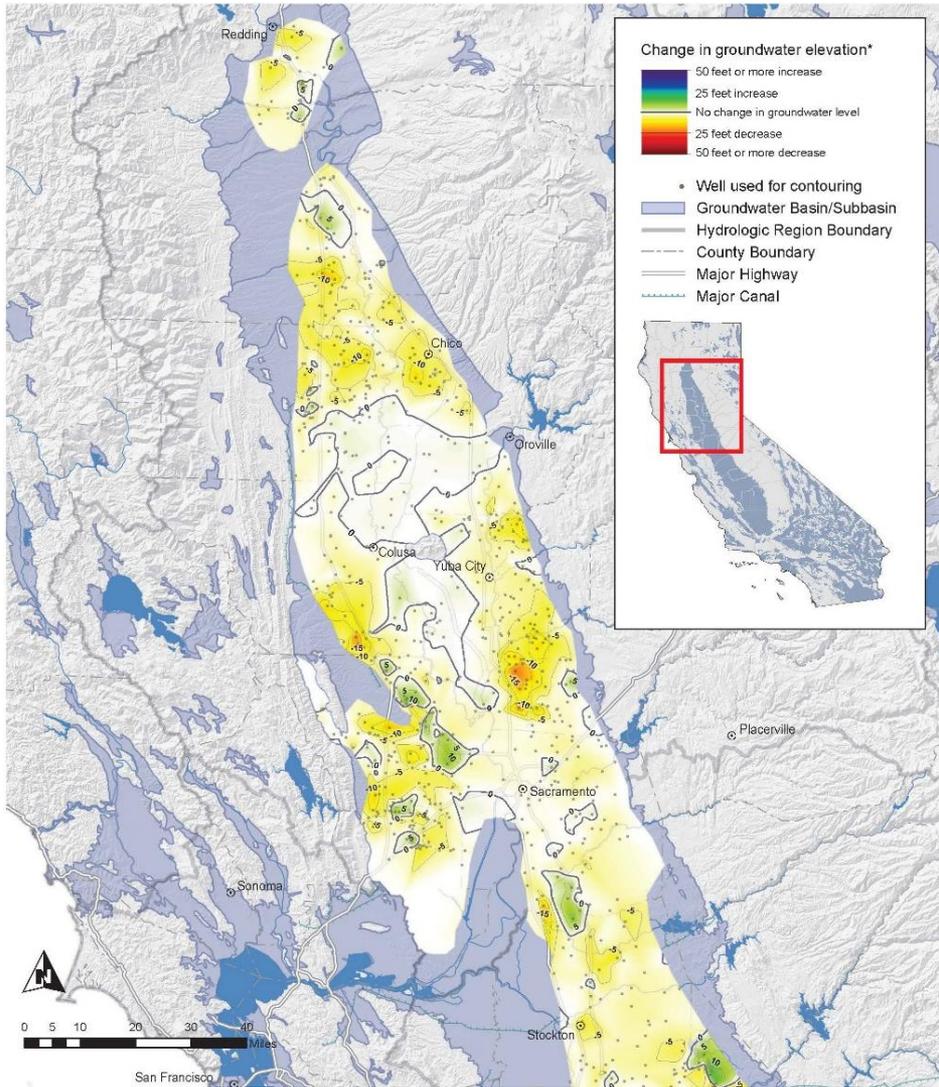
\*Groundwater level change determined from water level measurements in wells. Map and chart based on available data from the DWR Water Data Library as of 07/15/2015. Document Name: S2015\_S2005\_DM\_20150717 Updated: 07/17/2015 Data subject to change without notice.

\*Groundwater level change determined from water level measurements in wells. Map and chart based on available data from the DWR Water Data Library as of 07/15/2015. Document Name: S2015\_S2012\_DM\_20150717 Updated: 07/17/2015 Data subject to change without notice.

# Change in Groundwater Elevation Spring 2013 to Spring 2014

## Northern Central Valley

## Southern Central Valley



# Solutions

## Groundwater Levels near Delano, CA



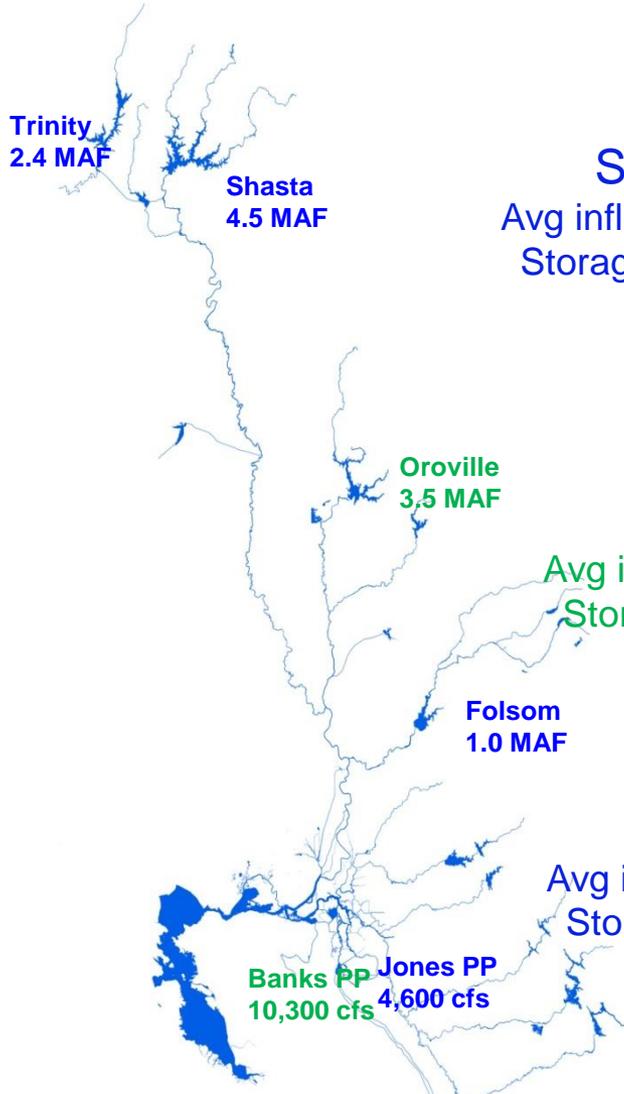
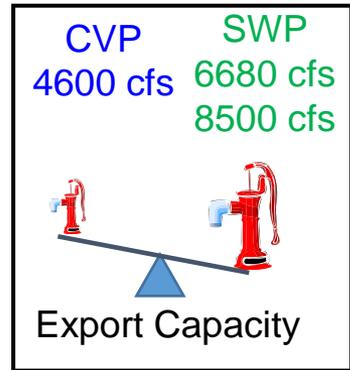
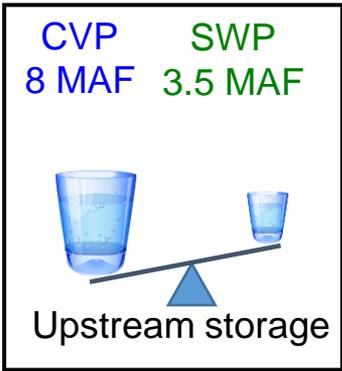
# Tradeoffs

## We Have Choices



Water Deliveries	Delta Outflow
Delta Flow Requirements	Upstream Environmental Benefit
CVP North of Delta Delivery	CVP South of Delta Delivery
Shasta Storage	Folsom Storage
Oroville Storage	SWP SOD Storage
Urban water supply	Agricultural water supply
North of Delta Storage	South of Delta Storage
Stream Temperature	Stream Habitat
Stream Temperature	Spring Flows
Power	Water Supply
Power	Spring time releases
Species A	Species B
Salmon Habitat	Delta Smelt Flow Criteria
American River fishery	Sacramento River fishery
Fall period flows	Spring time flows
Average annual water supply	Dry year water supply reliability

# Key Features of CVP/SWP

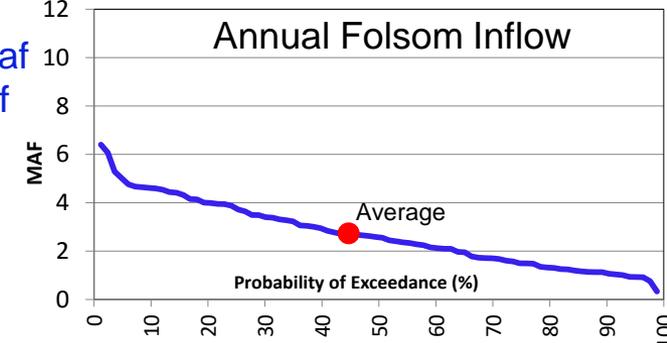
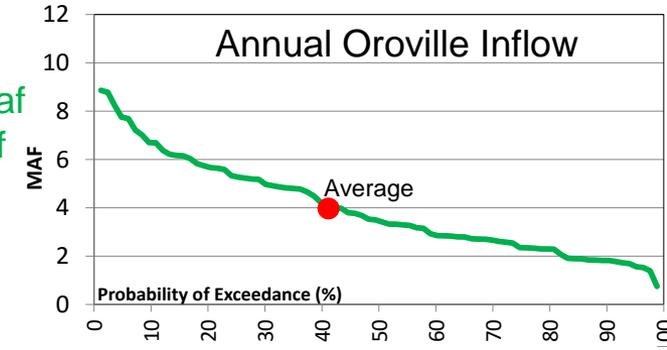
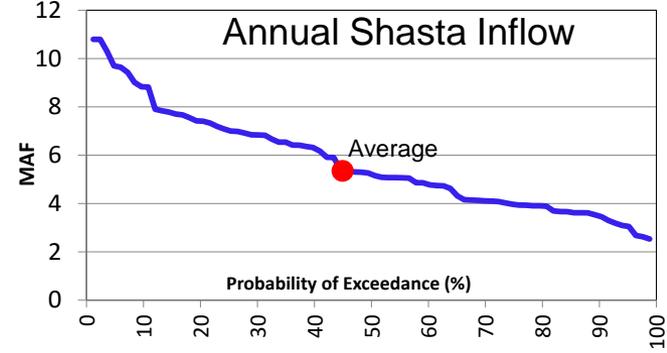
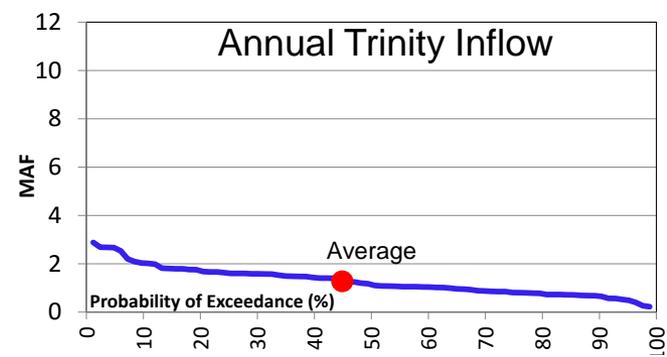


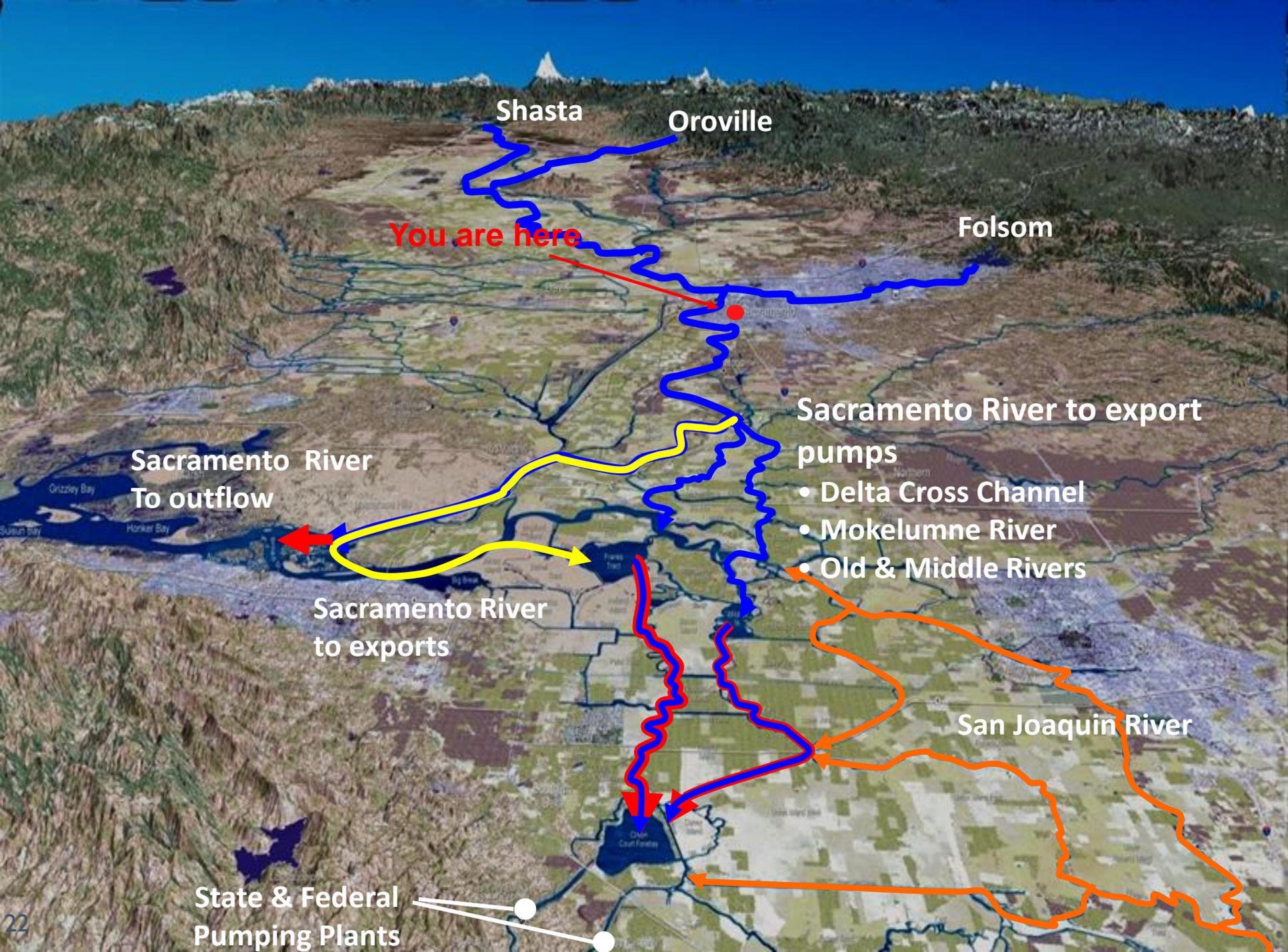
**Trinity**  
Avg inflow = 1.3 maf  
Storage = 2.4 maf

**Shasta**  
Avg inflow = 5.7 maf  
Storage = 4.5 maf

**Oroville**  
Avg inflow = 4.0 maf  
Storage = 3.5 maf

**Folsom**  
Avg inflow = 2.7 maf  
Storage = 1.0 maf





Shasta

Oroville

Folsom

You are here

Sacramento River  
To outflow

Sacramento River to export  
pumps

- Delta Cross Channel
- Mokelumne River
- Old & Middle Rivers

Sacramento River  
to exports

San Joaquin River

State & Federal  
Pumping Plants

# Changes in CVP/SWP Reliability

- Due to changes in regulatory criteria

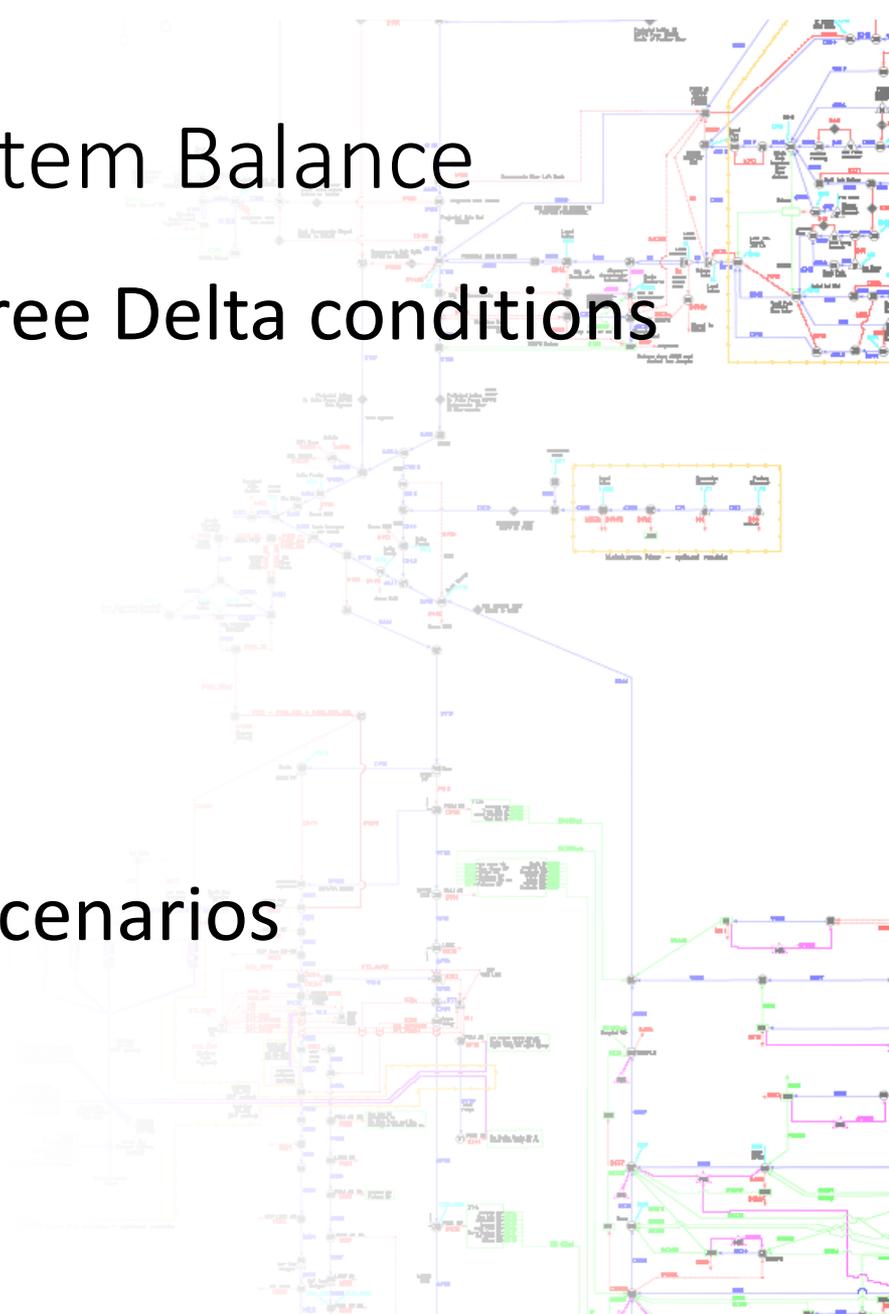
# Modeling To Explore Changes in System Balance

## Retrospective analysis with three Delta conditions

1. D-1485
  - Includes upstream CVPIA actions
    - American, Sacramento, Clear Creek
2. D-1641 (2006)
  - Spring X2, E/I
3. Existing (BiOps)
  - D-1641
  - CVPIA
  - Salmon BO
  - Smelt BO

## Consistent in all three model scenarios

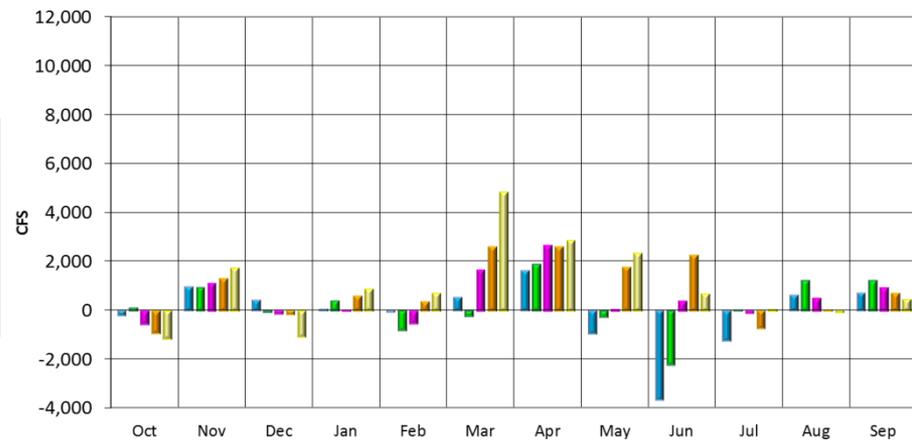
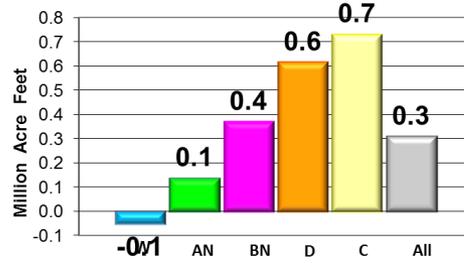
- Trinity River Decision
- Demands
  - Refuge
  - SWP SOD
- Facilities
- SJR BiOps RPAs
- Upstream CVPIA and BiOps



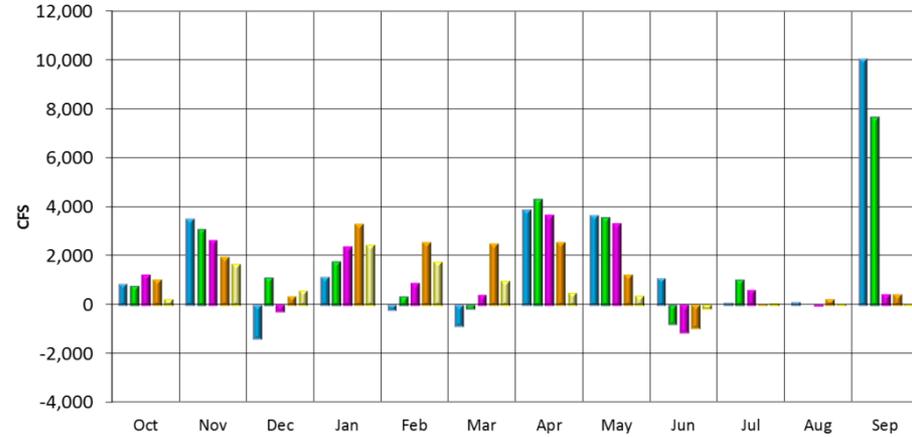
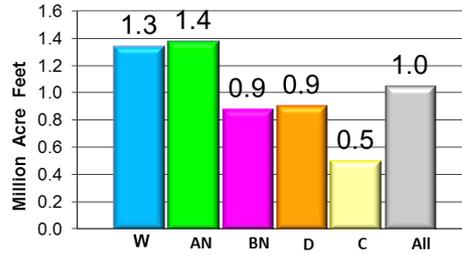
# Flow Changes

## Delta Outflow

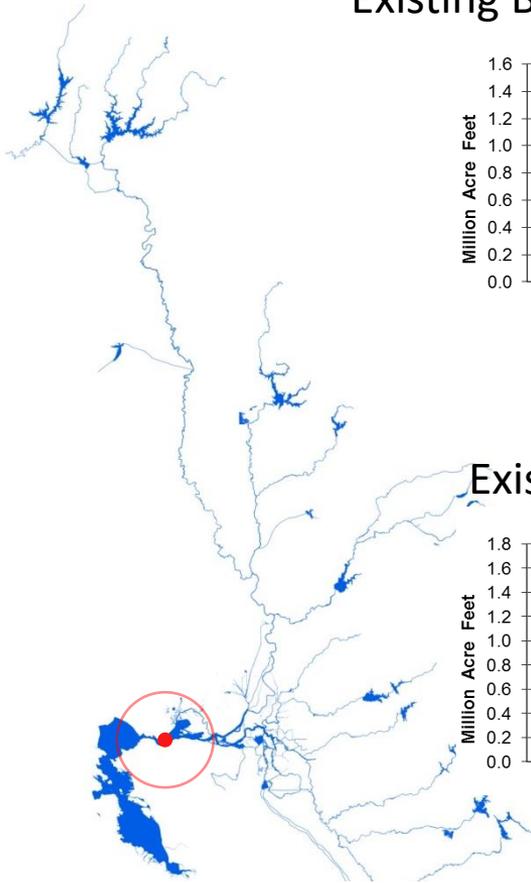
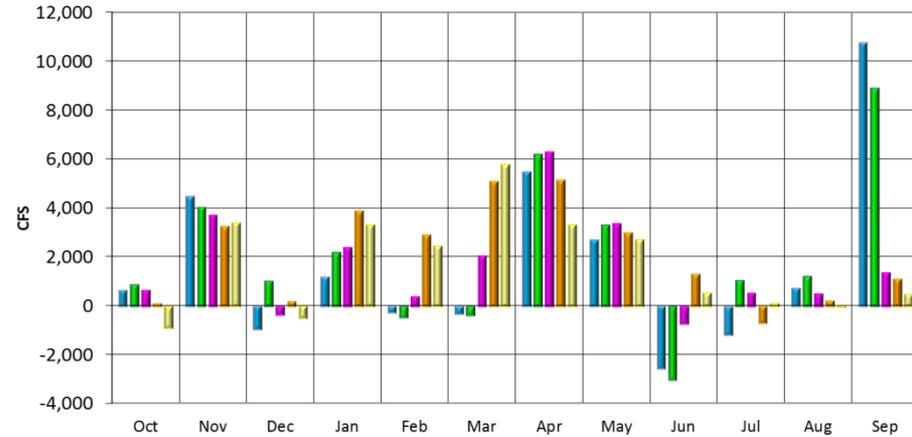
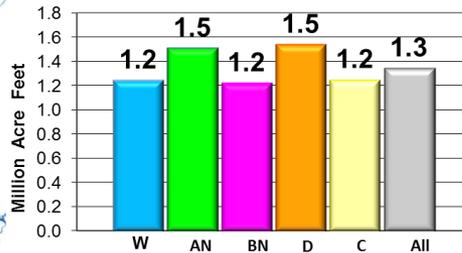
### D1641 minus D1485



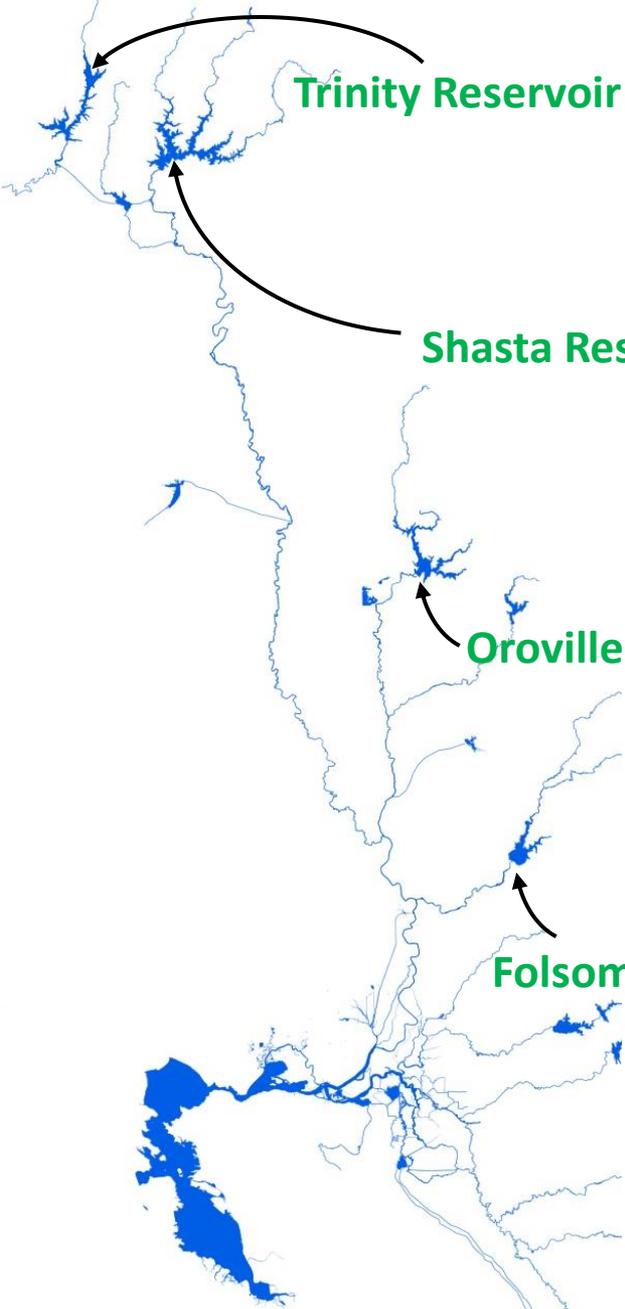
### Existing BiOps minus D1641



### Existing minus D1485



# Project Reservoir Summary



Trinity Reservoir

Shasta Reservoir

Oroville Reservoir

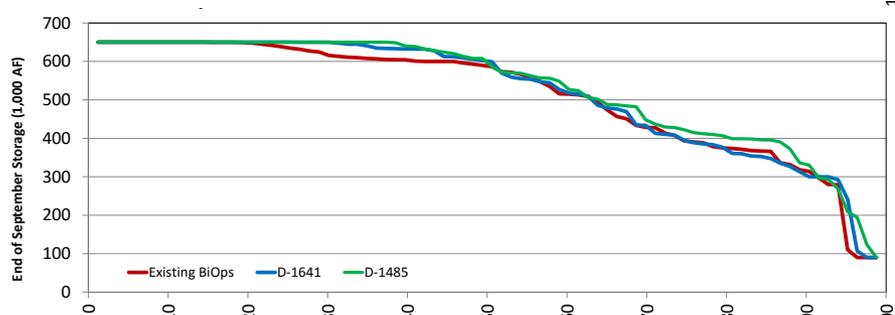
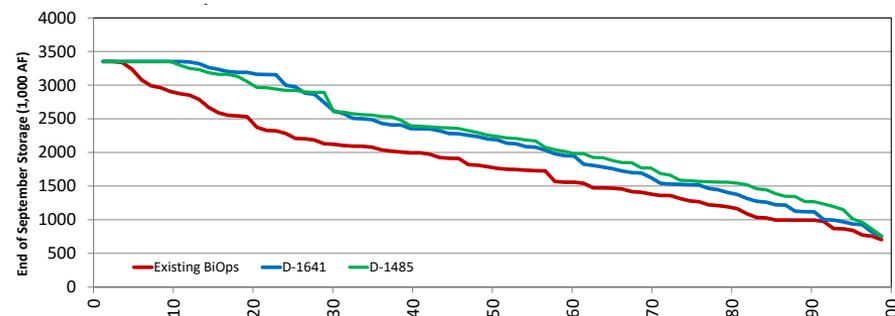
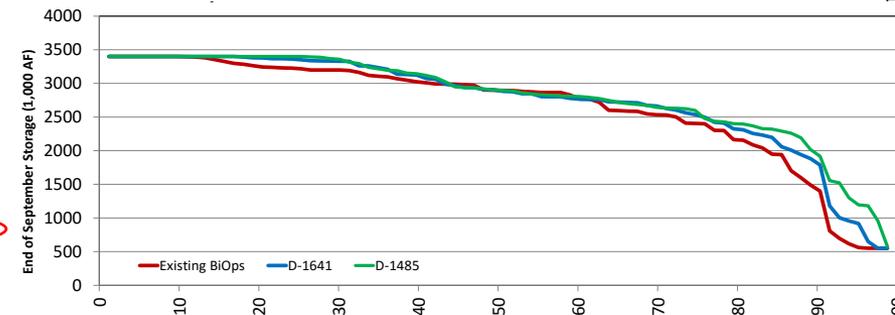
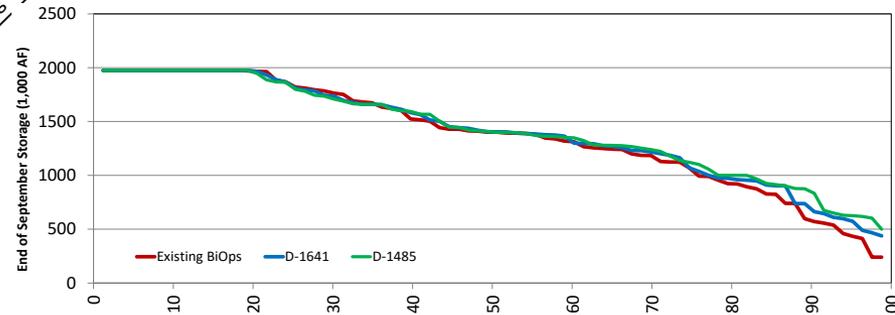
Folsom Reservoir

Trinity	Year Type	Existing minus D1485		
		D1641	Existing	minus D1641
W	7	0	7	
AN	-27	-18	-45	
BN	-39	-12	-51	
D	1	-42	-42	
C	-43	-104	-147	
All	-15	-29	-44	

Shasta	Year Type	Existing minus D1485		
		D1641	Existing	minus D1641
W	-3	-135	-138	
AN	-27	-42	-69	
BN	-43	42	0	
D	-42	-90	-132	
C	-257	-231	-488	
All	-59	-95	-154	

Oroville	Year Type	Existing minus D1485		
		D1641	Existing	minus D1641
W	46	-509	-463	
AN	-83	-394	-477	
BN	-99	-317	-416	
D	-96	-259	-355	
C	-140	-150	-291	
All	-56	-352	-408	

Folsom	Year Type	Existing minus D1485		
		D1641	Existing	minus D1641
W	-8	-32	-39	
AN	-10	-14	-24	
BN	-9	32	23	
D	-25	18	-7	
C	-2	-38	-40	
All	-11	-8	-20	



Probability of Exceedance (%)

# CVP/SWP Operational Changes



*Folsom - 1991*

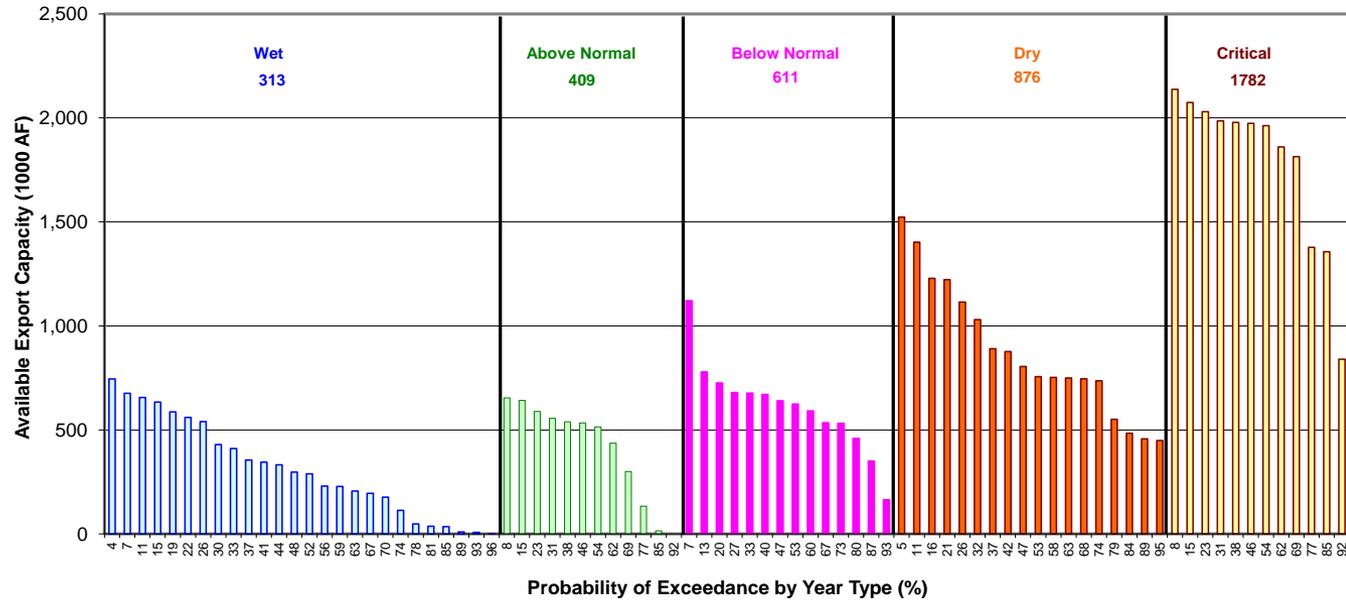


*Oroville - 1991*

- **D-1485:** CVP/SWP relied on exporting surplus flows and used storage for dry year reliability
- **With D-1641 and BiOps:** Ability to divert surplus is limited, therefore the CVP/SWP rely on storage releases to meet demands and flow requirements

**Increases in regulations have changed the system balance and lead to decreases in water supply reliability for many beneficial uses - we operate with more risk**

# Without BiOps: Delta Export Capacity Available June Through September

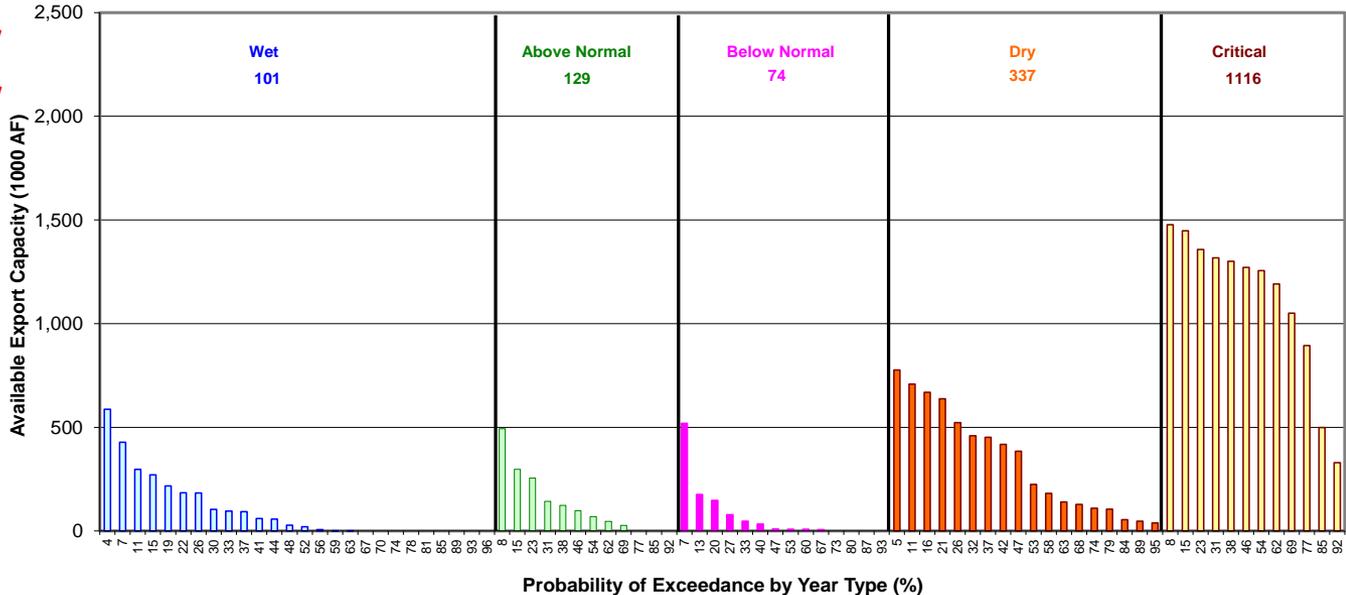


# Changes in Water Transfers with BiOps

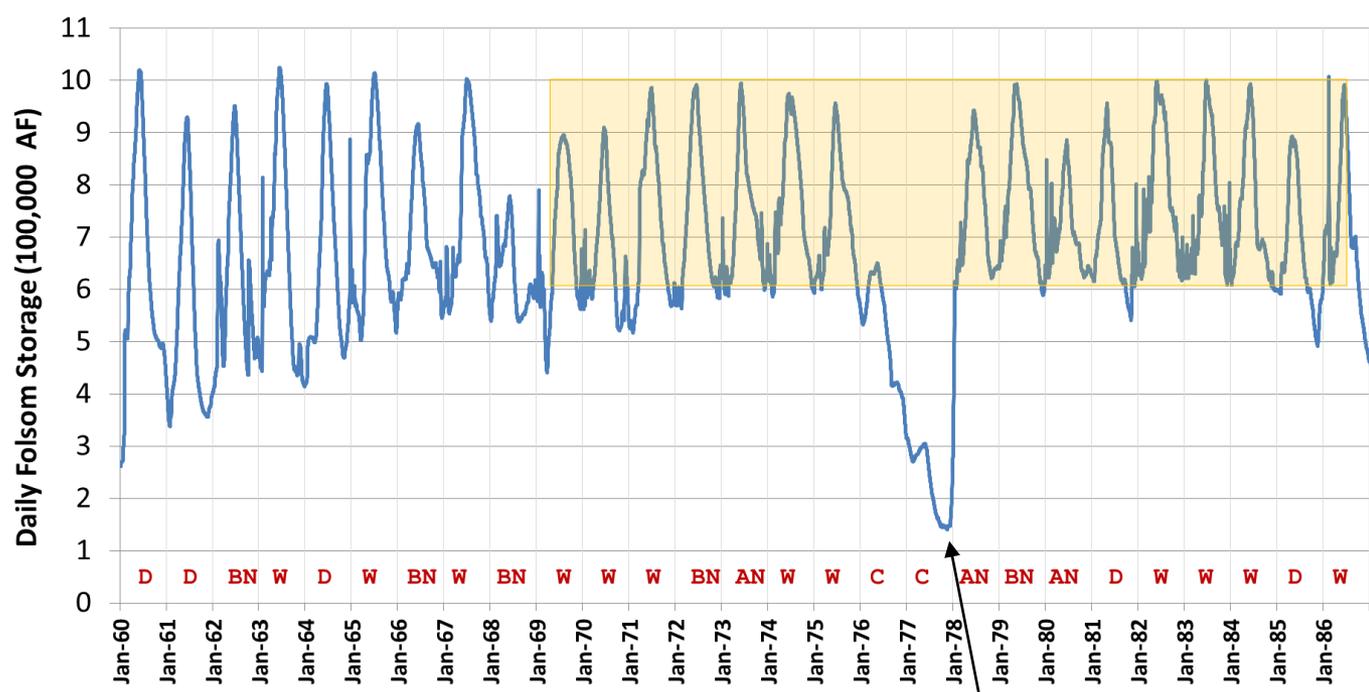
## With BiOps:

- No Delta export capacity for transfers prior to July
- Decrease in capacity in dry years
- Limited capacity in below normal years

# With BiOps: Delta Export Capacity Available June Through September

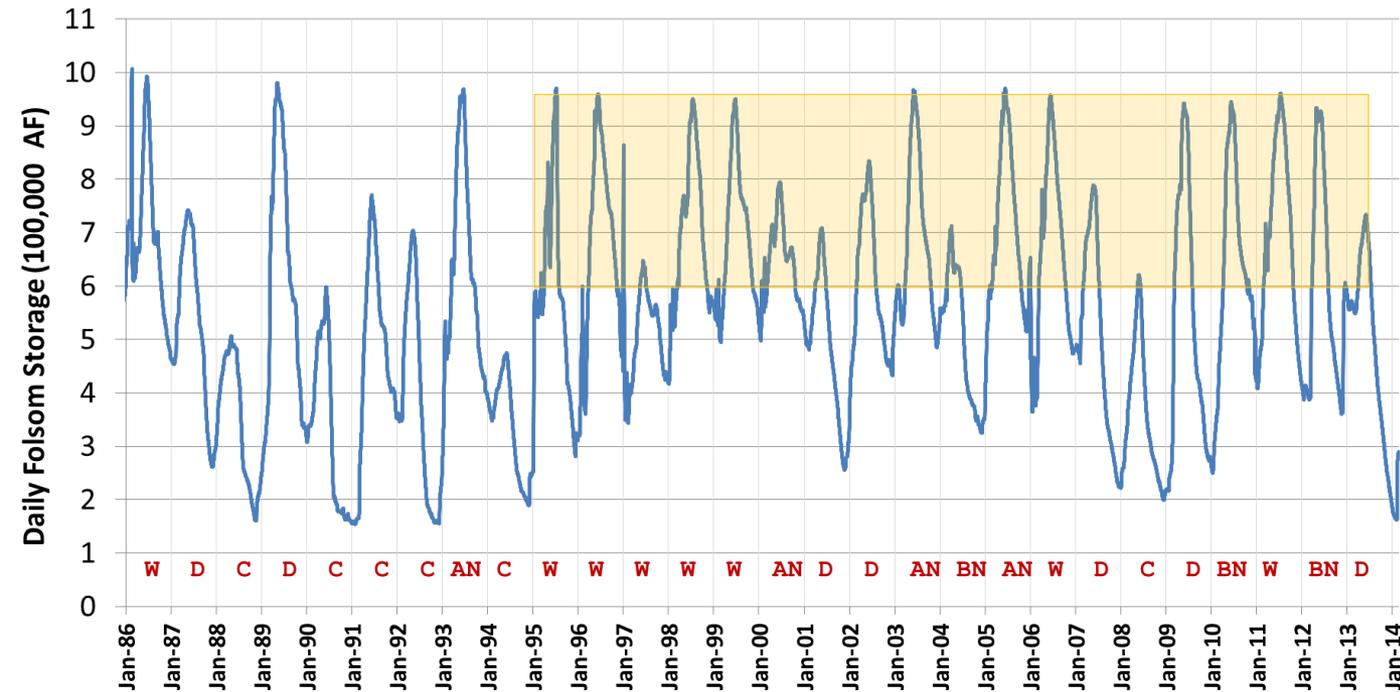


# Historical Folsom Storage

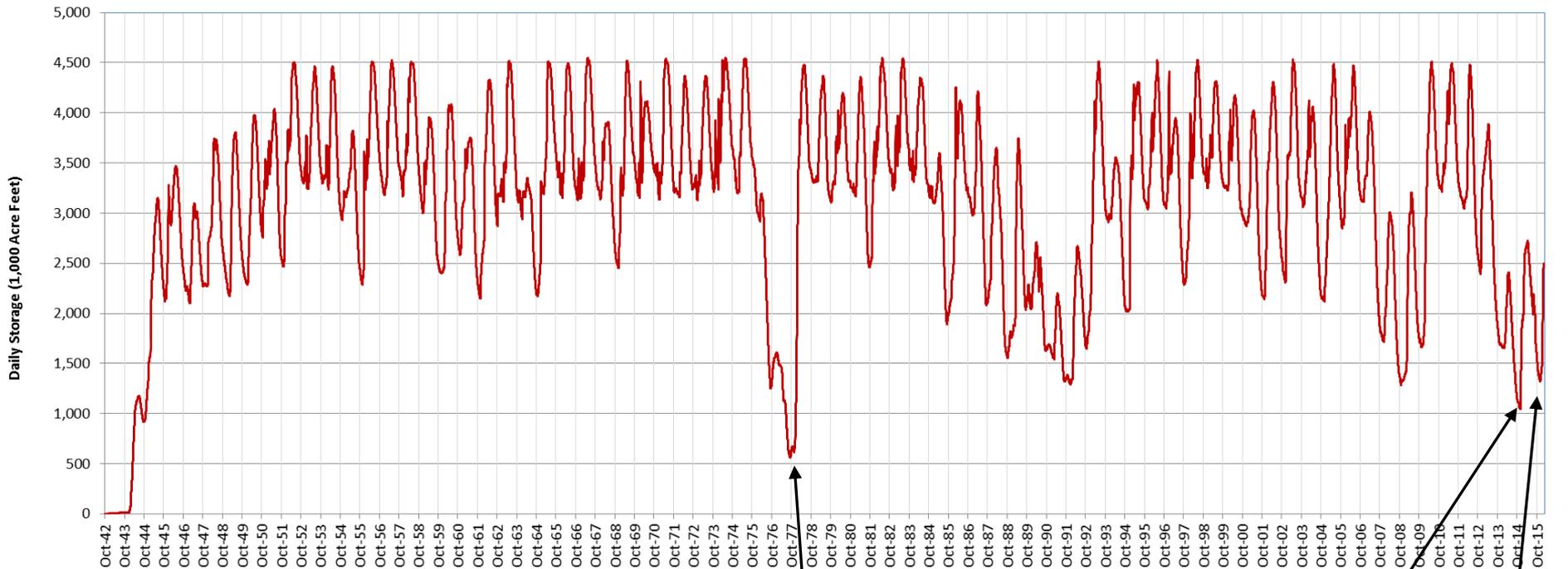


Lowest Storage:  
11/20/77 - 140,600 AF

*Folsom is being drawn down more now than it was prior to the 1990's drought*



# Historical Shasta Storage Change in Priority

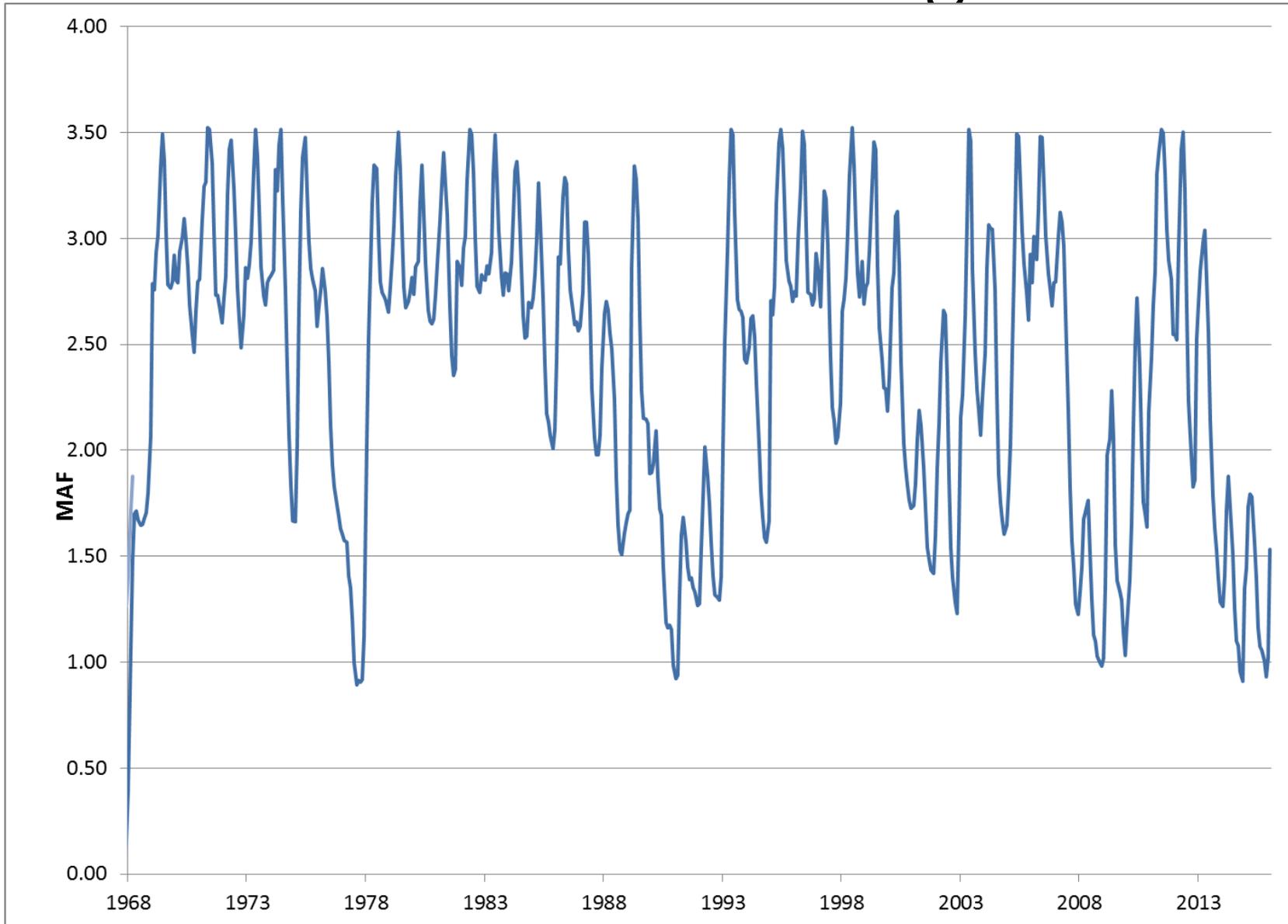


1977 – Almost dead pool  
Allocation  
Ag: 25%  
Urban: 25-50%  
SRSC & Exchange: 75%  
Friant - Class 1: 25%

2014: 1.2 maf  
Allocation not met

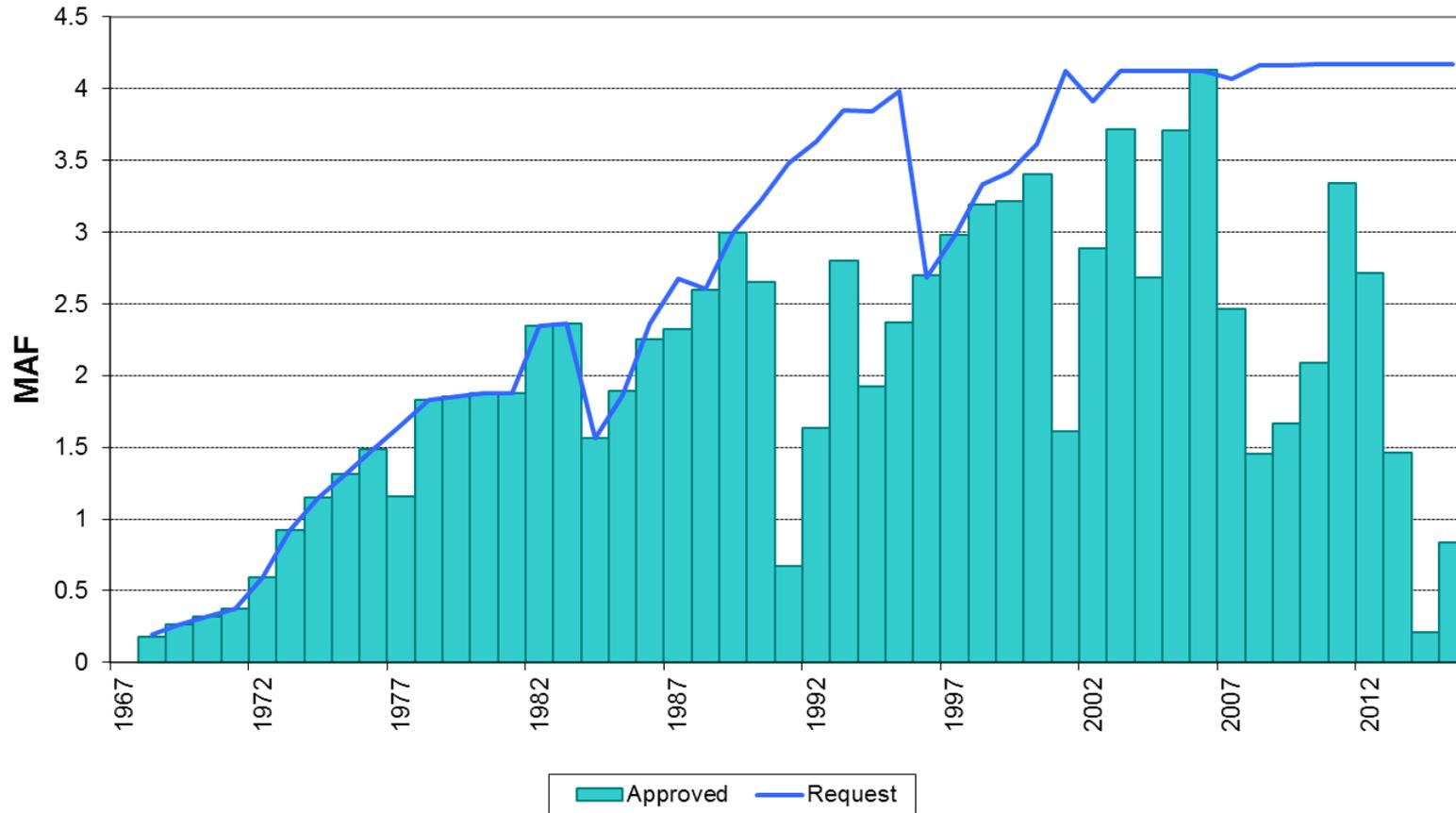
2015: 1.6 maf  
Allocation not met

# Historical Oroville Storage



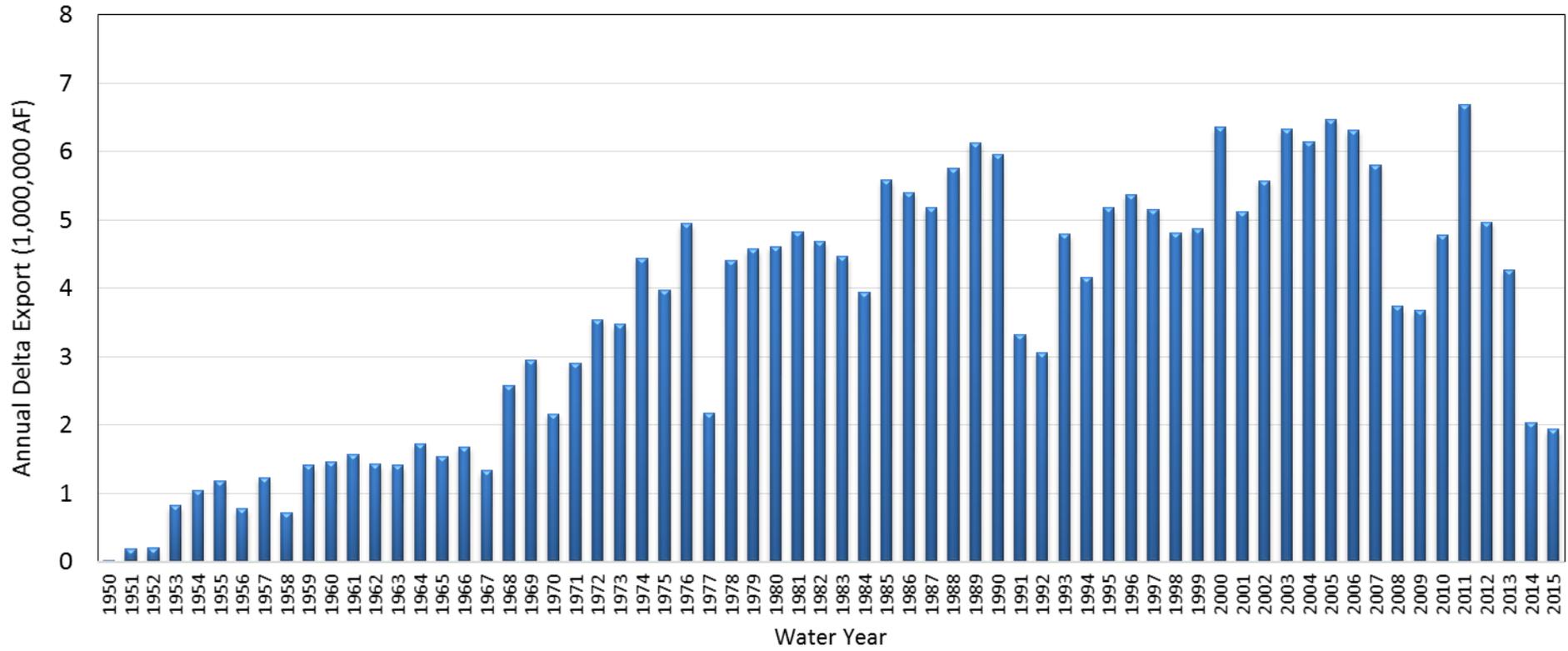
# Historical SWP Deliveries

## SWP Table A Allocation



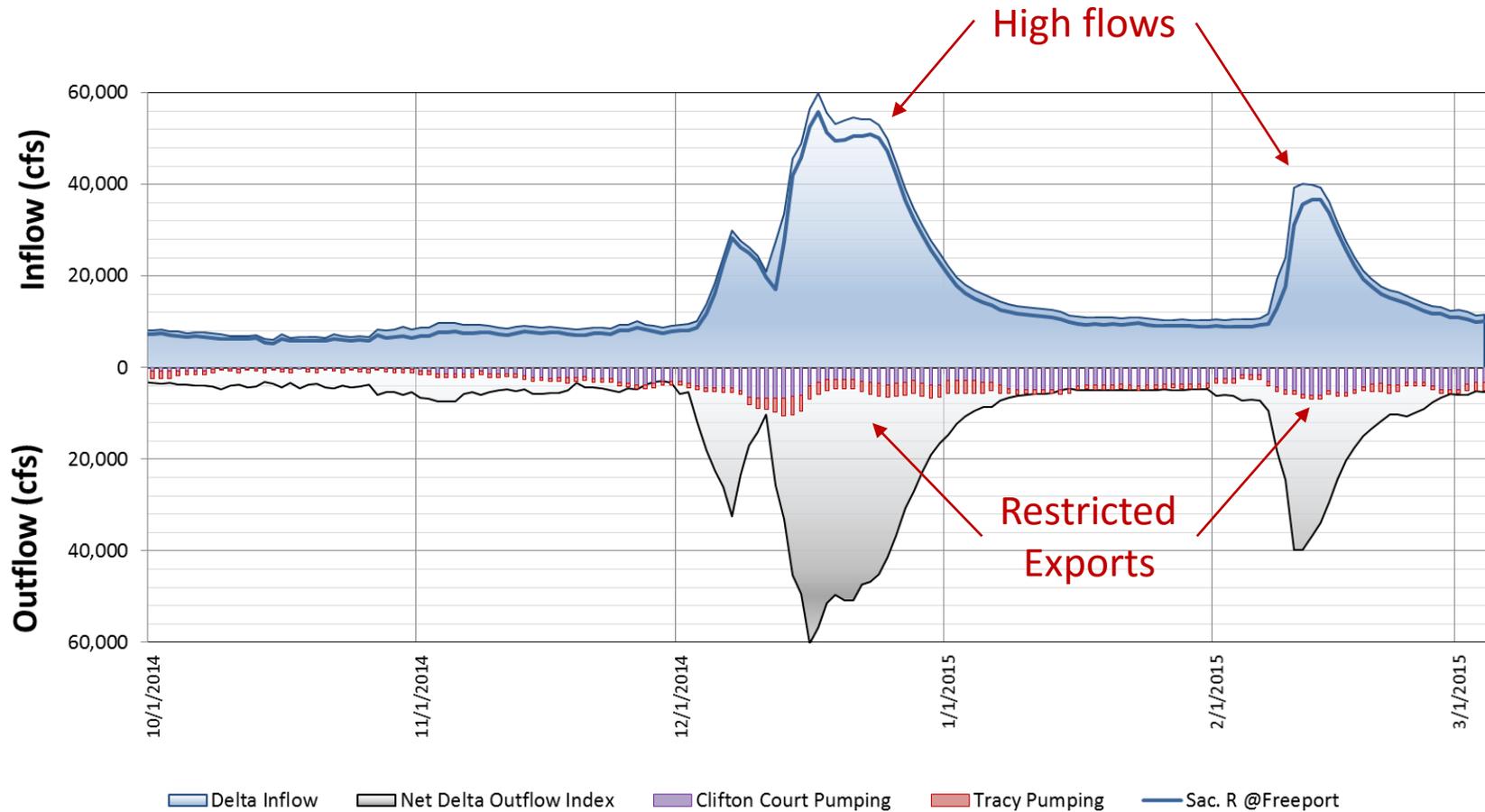
# Historical Delta Exports

Delta Export - Jones and Banks



# Increasing Reliability - Lost Opportunity

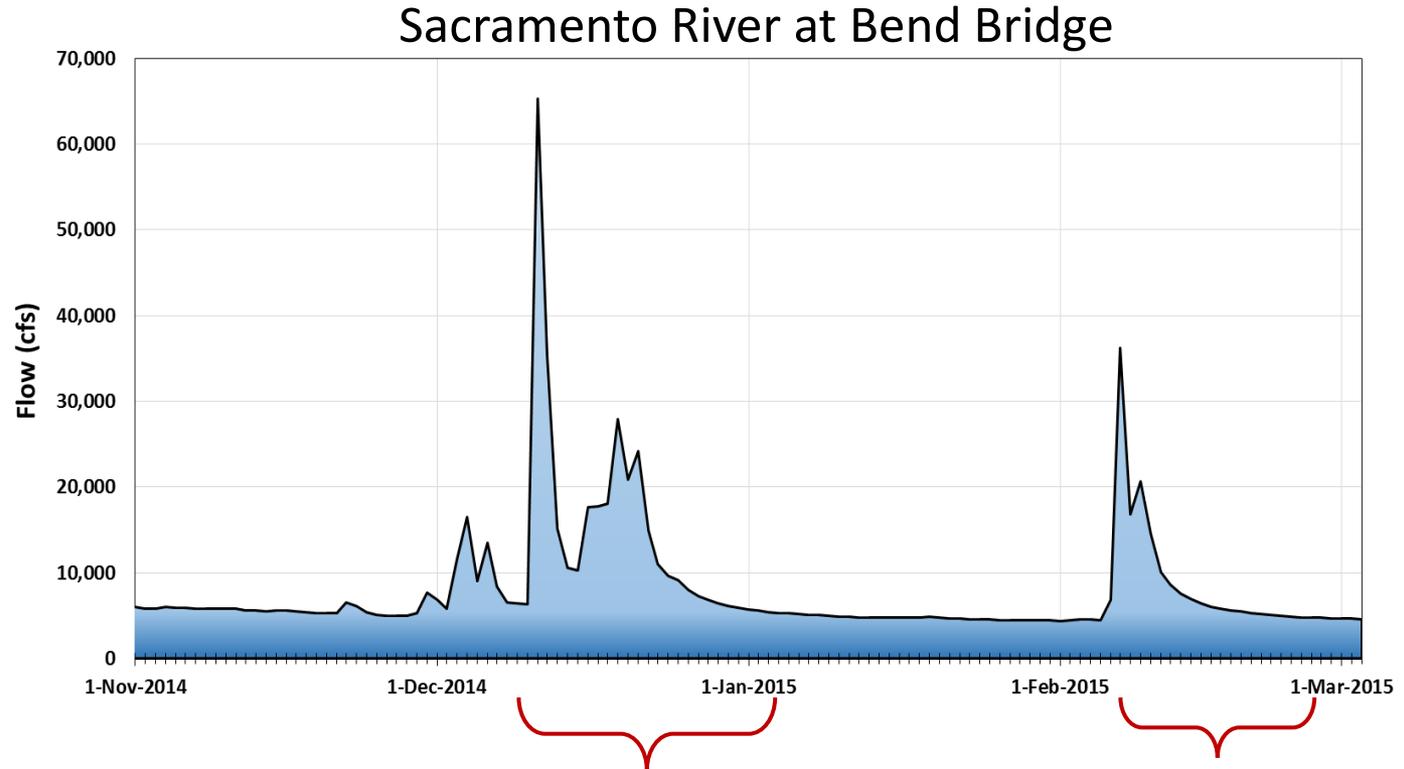
## Delta Inflow and Outflow 2014



# Dry Year Potential of Sites Reservoir

As of March 1, over 400,000 AF could have been diverted to Sites Reservoir

Sites is in a unique location where excess system flows that can not be captured elsewhere may be diverted and stored.



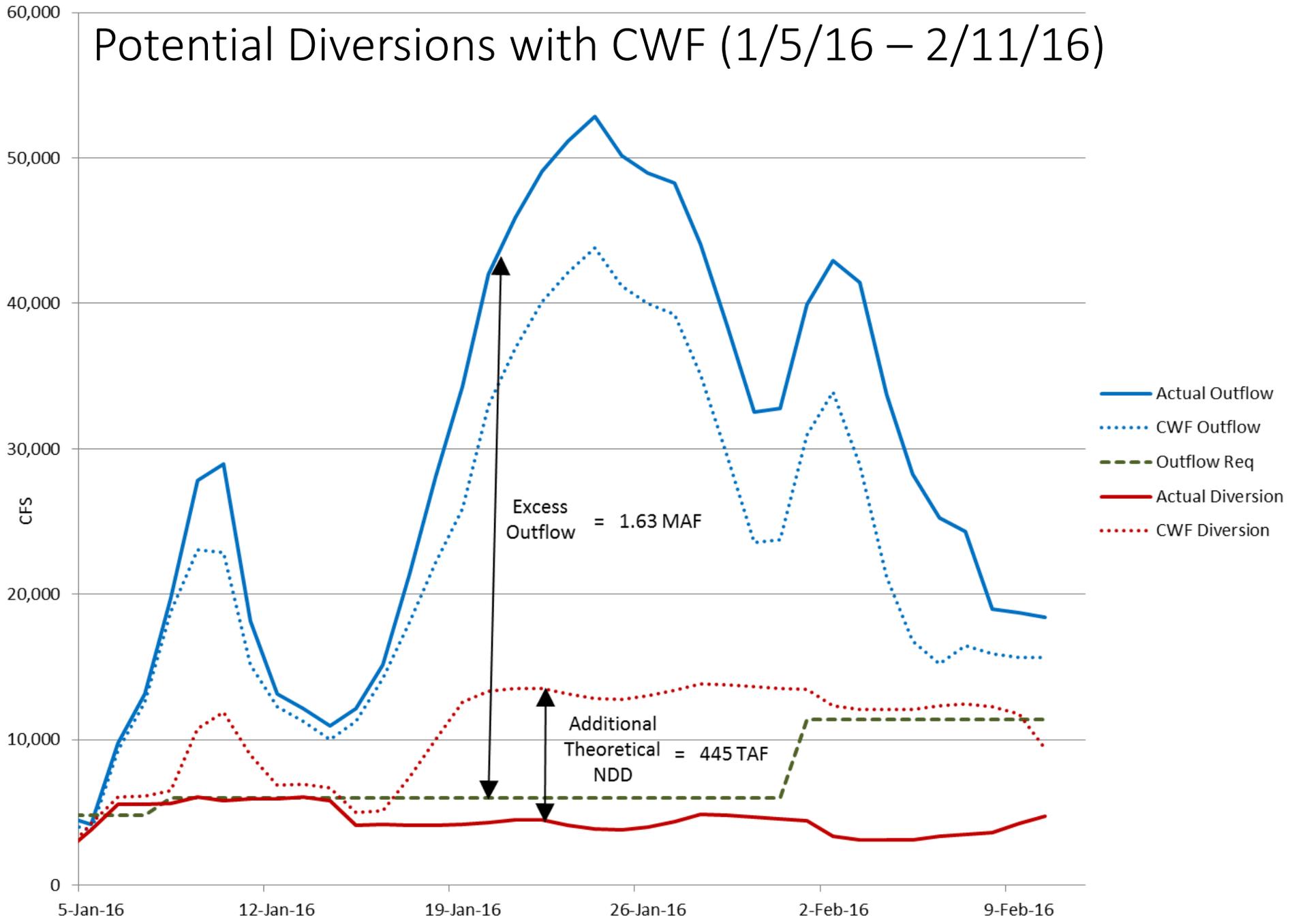
#### Benefits may include:

- Improved Sacramento River flow and temperature management
- Improved American River flow and temperature management
- Improved Delta conditions
- Improved water supply reliability
- More

Dec. 9 to Jan. 3  
26 days of diversion

Feb. 3 to Feb 23  
21 days of diversion

# Potential Diversions with CWF (1/5/16 – 2/11/16)



# Questions