



# California Drought: Current Conditions and Future Possibilities in a Changing Climate

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# Talk Overview

- Current Conditions
- 20<sup>th</sup> Century California Drought
- Paleodroughts
- Expected Impacts from Climate Change
- Future Drought Characteristics

# Daily Drought Information Summary (02/24/2014)

Report generated: 02/24/2014 12:05

## Reservoir Storage as of 02/23/2014 at midnight

Reservoir	River	Storage	%	%	Storage	% of Capacity	%
		(in Acre Feet)	of Capacity	Average	Year Ago This Date	Year Ago This Date	Average
Trinity Lake	Trinity	1,180,196	48	66	1,981,350	81	110
Shasta Lake	Sacramento	1,730,766	38	53	3,589,145	79	109
Lake Oroville	Feather	1,388,506	39	57	2,826,095	80	116
New Bullards Bar Res	Yuba	471,479	49	76	779,282	81	126
Folsom Lake	American	290,077	30	54	559,077	57	104
New Melones Res	Stanislaus	1,057,926	44	72	1,607,279	66	110
Don Pedro Res	Tuolumne	1,055,208	52	74	1,398,696	69	98
Lake McClure	Merced	213,924	21	41	452,793	44	86
Millerton Lake	San Joaquin	172,068	33	51	325,694	63	96
Pine Flat Res	Kings	185,805	19	36	319,540	32	62
Isabella	Kern	59,340	10	33	82,482	15	45
San Luis Res	(Offstream)	678,066	33	40	1,201,459	59	70

## Snowpack Water Content as of 02/24/2014

Region	Water Content	%	% of Apr 1	Water Content	%
	(in inches)	Average to Date	Average	(in inches)	Average
				Last Year This Date	Last Year This Date
Northern Sierra	3.20	13	11	17.50	72
Central Sierra	7.60	30	25	17.30	67
Southern Sierra	4.40	21	17	12.10	59
Statewide	5.50	23	19	15.80	67

## Precipitation Index Accumulation as of 02/24/2014

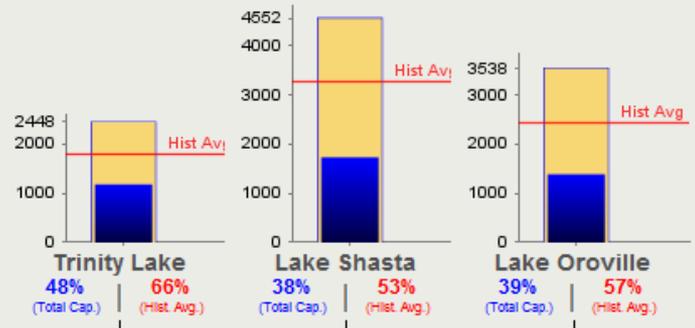
Index	Season to Date	% of Average	Season to Date	% of Average
	Last Year	Last Year	Last Year	Last Year
Northern Sierra	12.90	38	34.10	101
Southern Sierra	8.51	32	21.04	79

Provisional Data, Subject to Change

Data as of Midnight: 23-Feb-2014

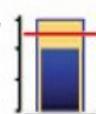
Change Date:  23-Feb-2014

[Refresh Data](#)



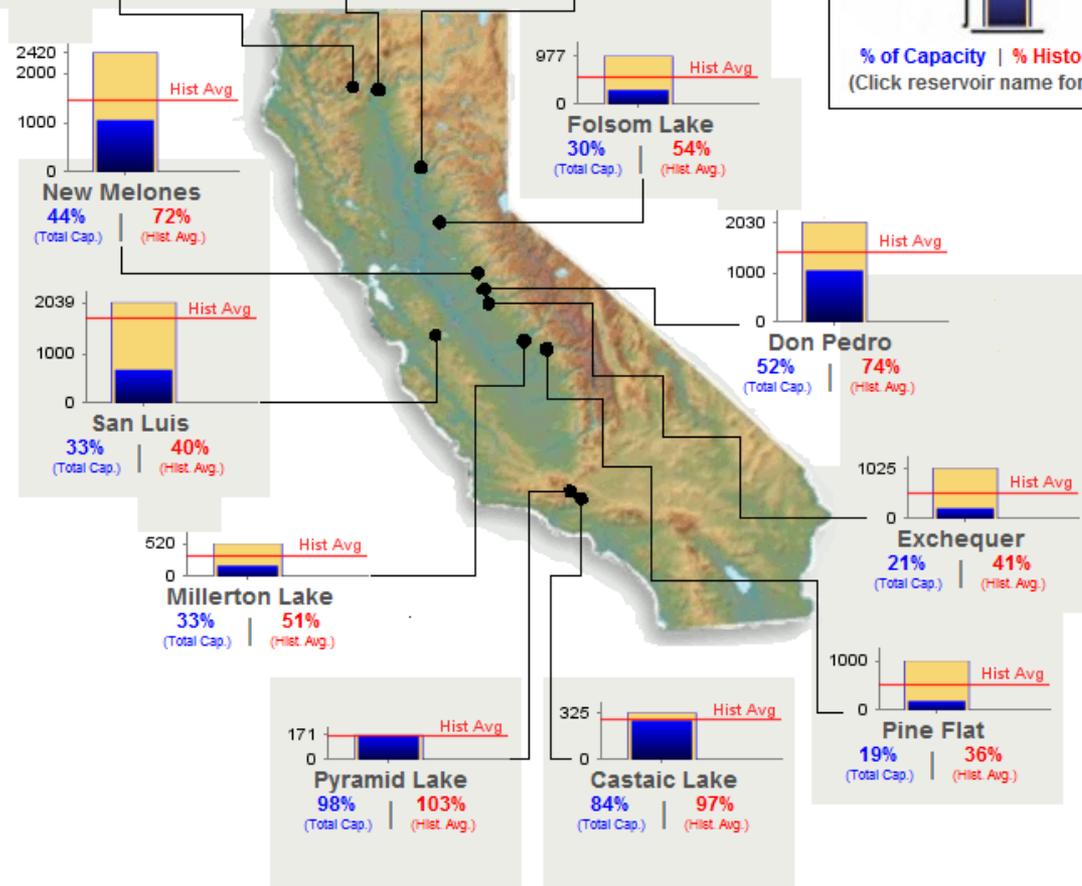
**LEGEND**

- Blue Bar:** Storage level for date
- Gold Bar:** Total reservoir capacity.
- Red Line:** Historic level for date.

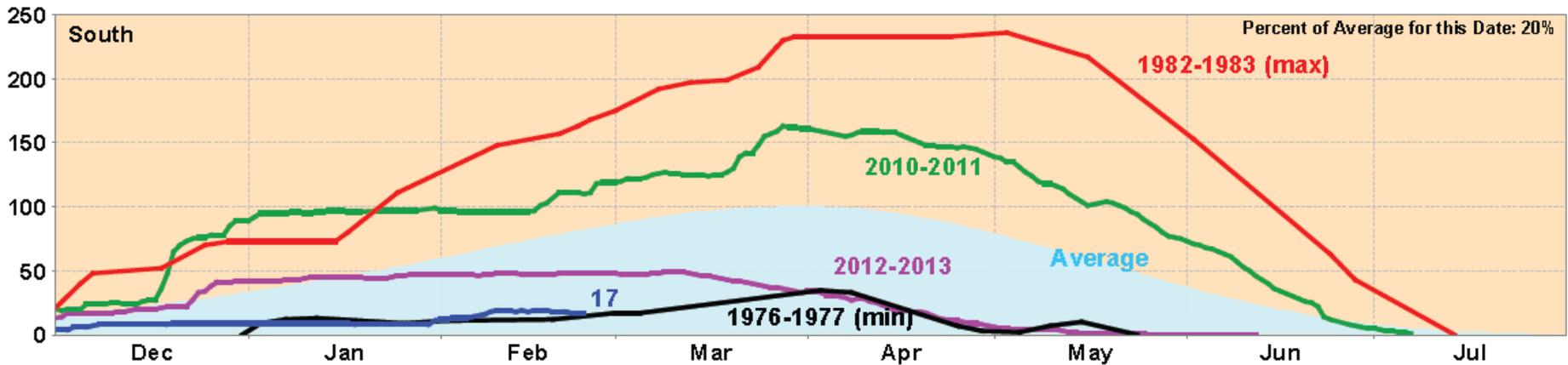
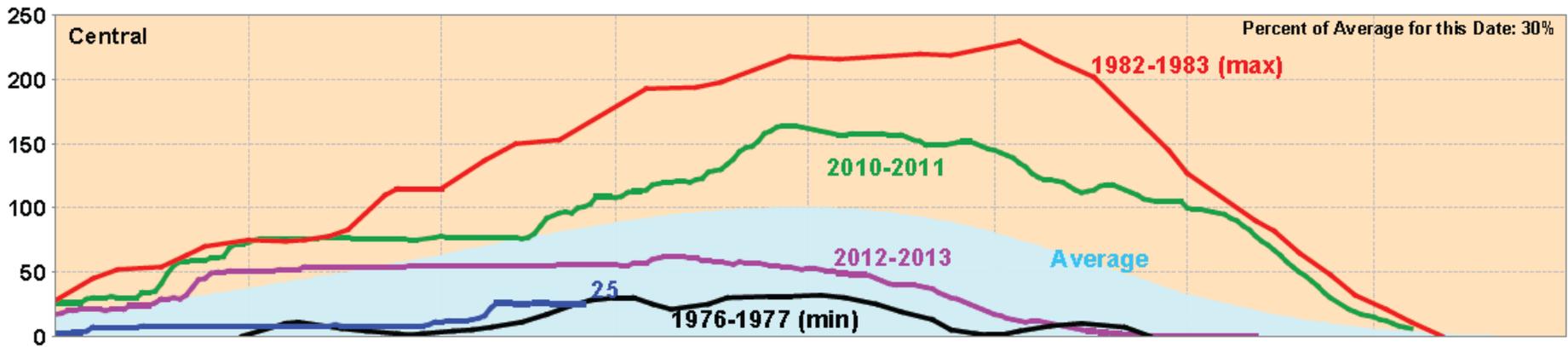
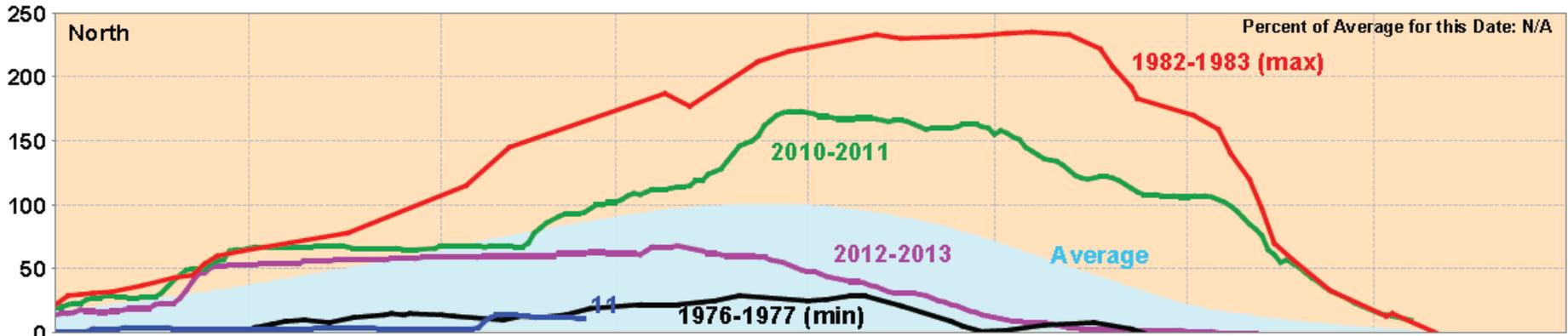


Capacity (TAF) | Historical Avg Mark

**% of Capacity | % Historical Avg**  
(Click reservoir name for details)



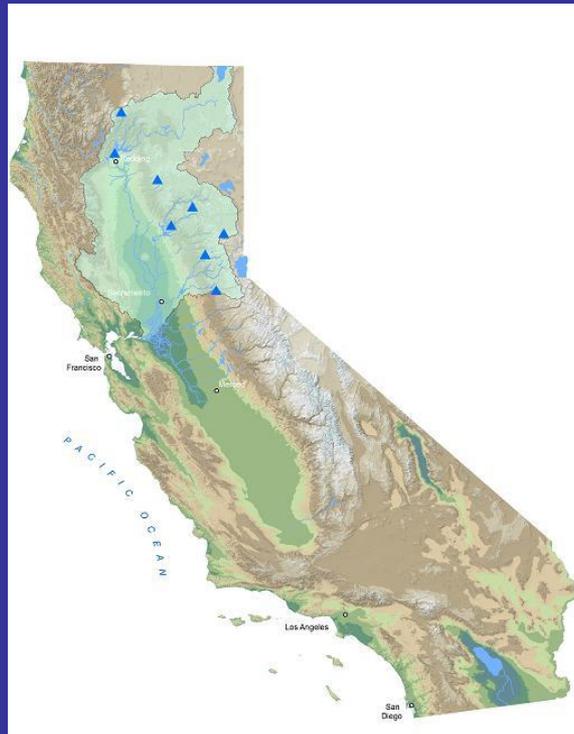
# California Snow Water Content, February 24, 2014, Percent of April 1 Average



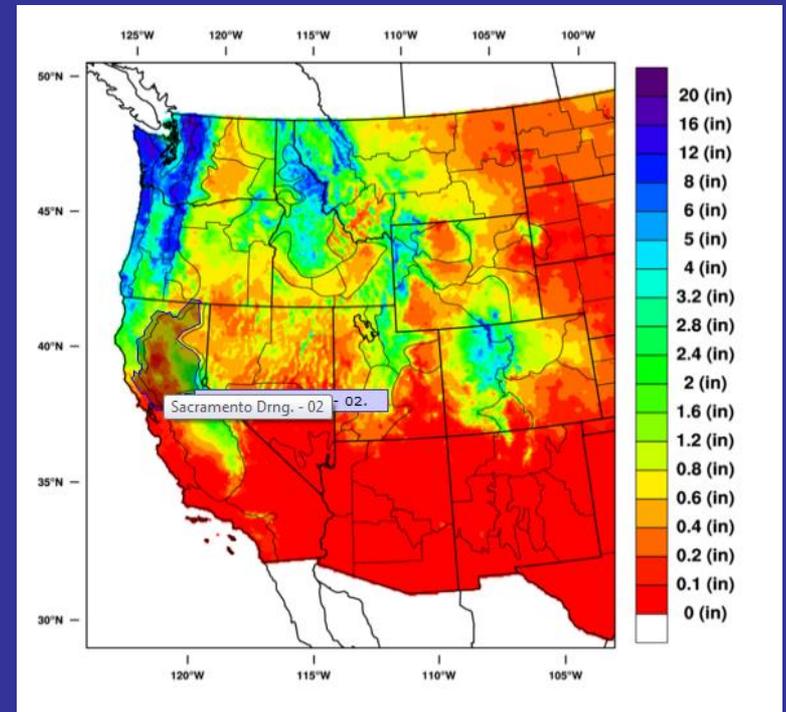
Statewide Percent of April 1: 20%

Statewide Percent of Average for Date: 25%

# Northern Sierra 8 Station Index

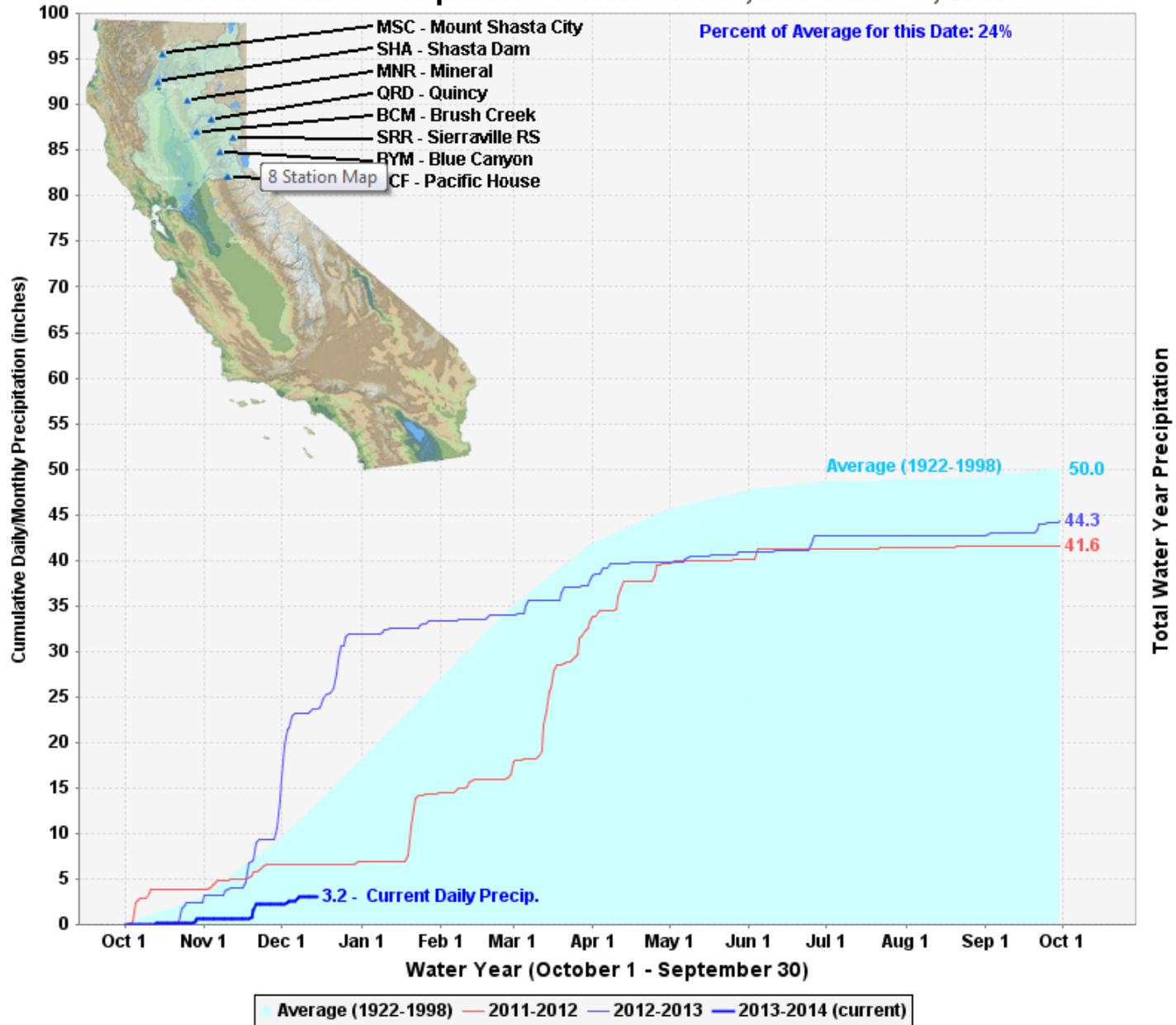


# WRCC WestMap

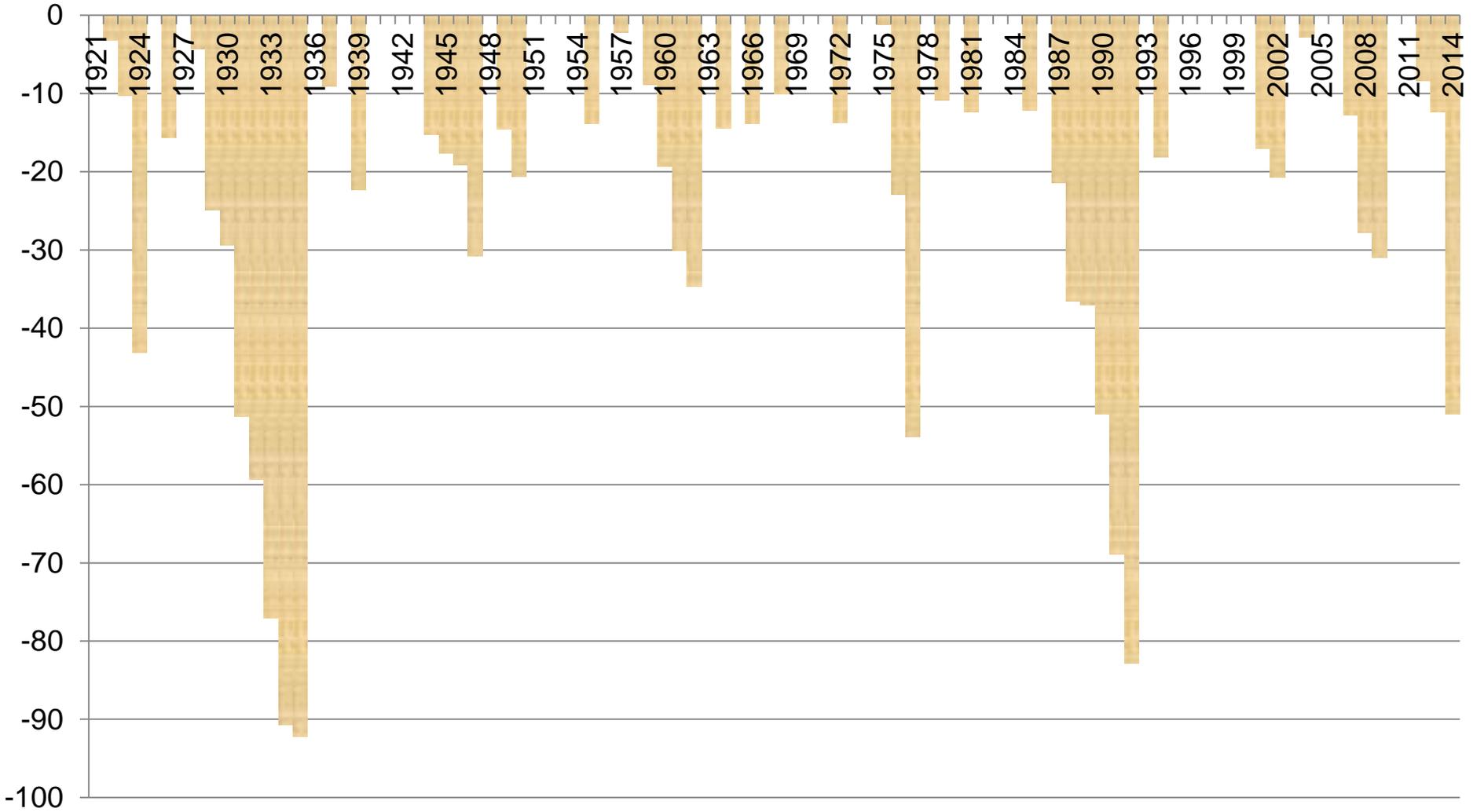


Annual Average: 50 inches  
Maximum Year (1983): 88.5 inches  
Minimum Year (1924): 17.1 inches  
Period of Record 1921- Present

# Northern Sierra Precipitation: 8-Station Index, December 15, 2013

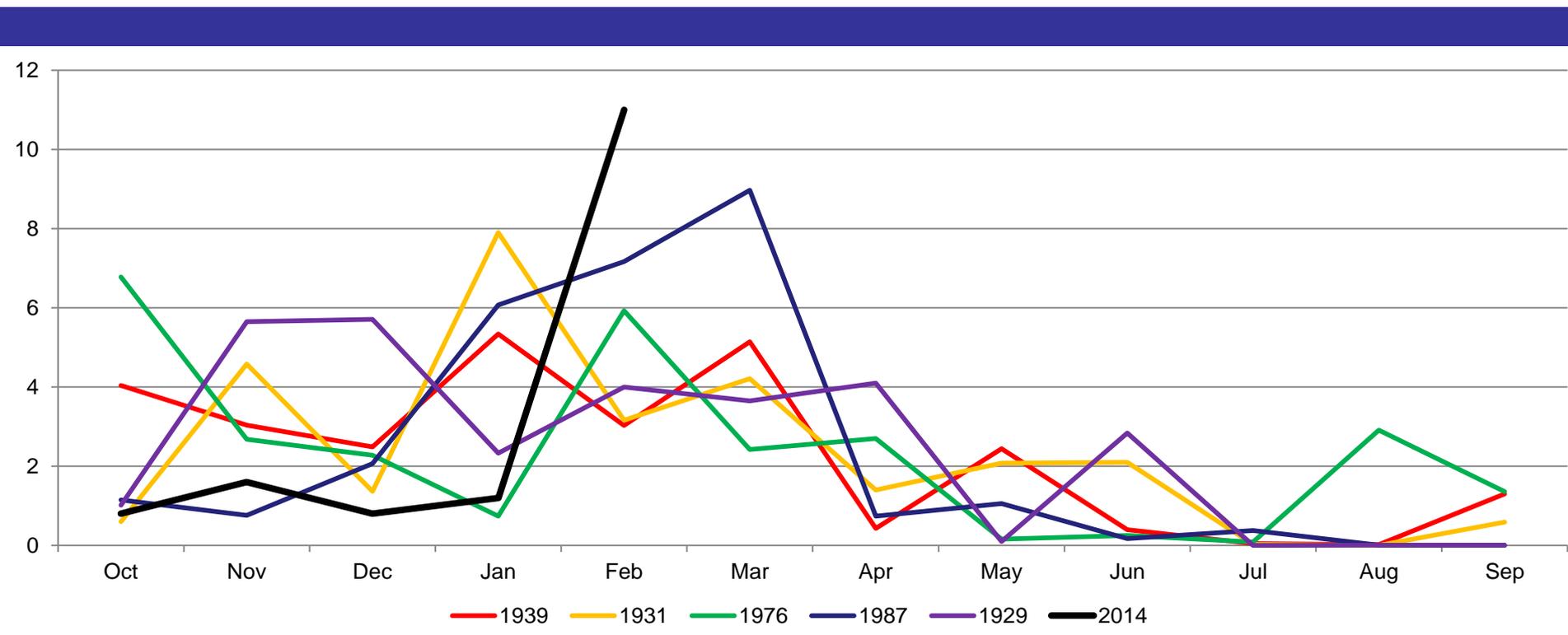
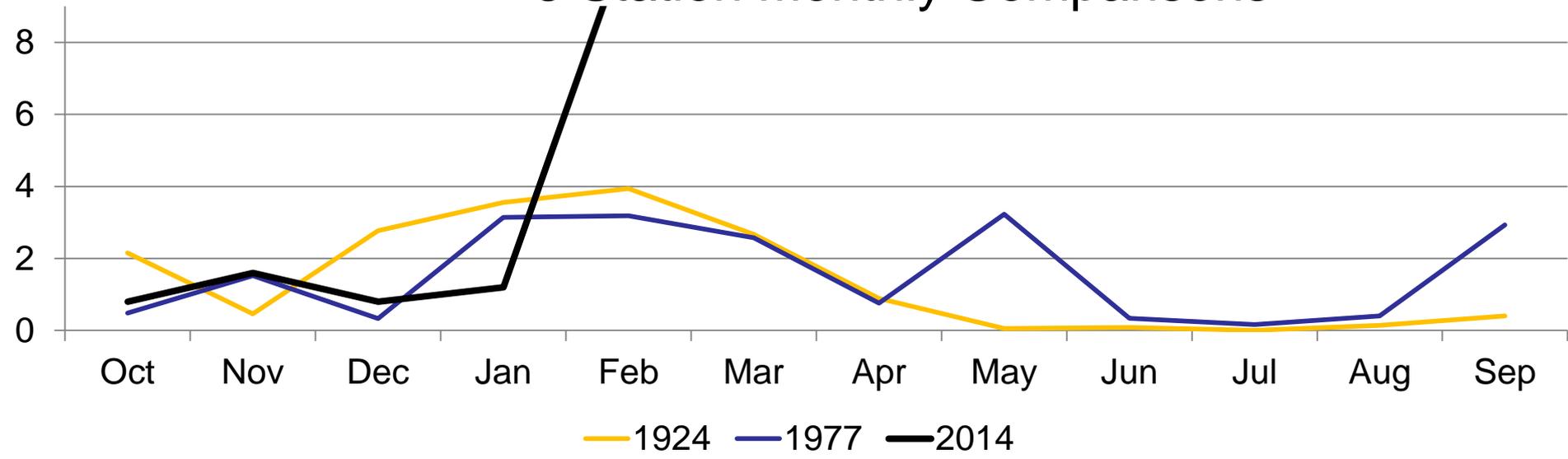


# 8-Station Index Cumulative Deviations WY1921 – WY2014\*

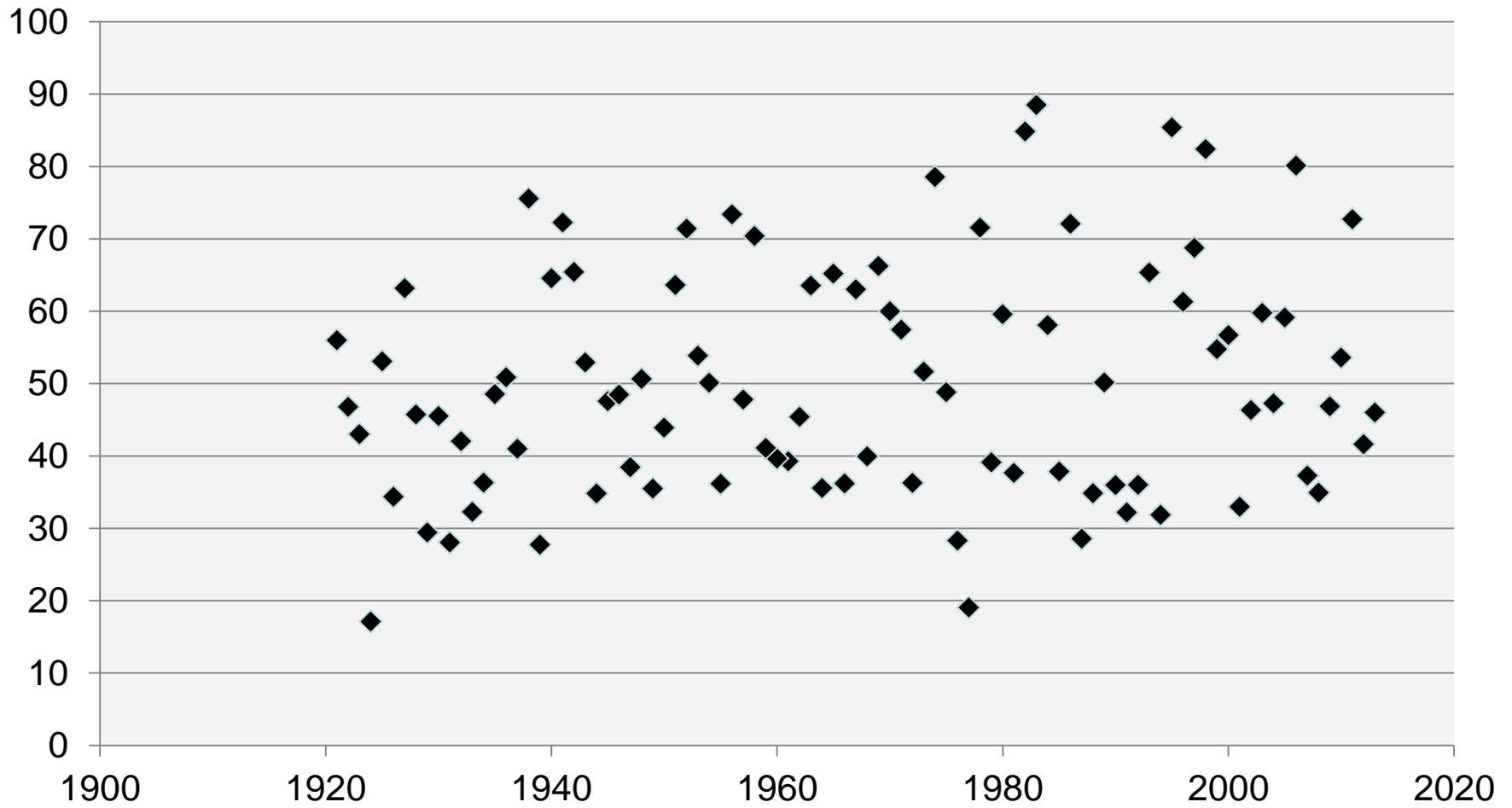


\*WY2014 assumes no further precipitation this year

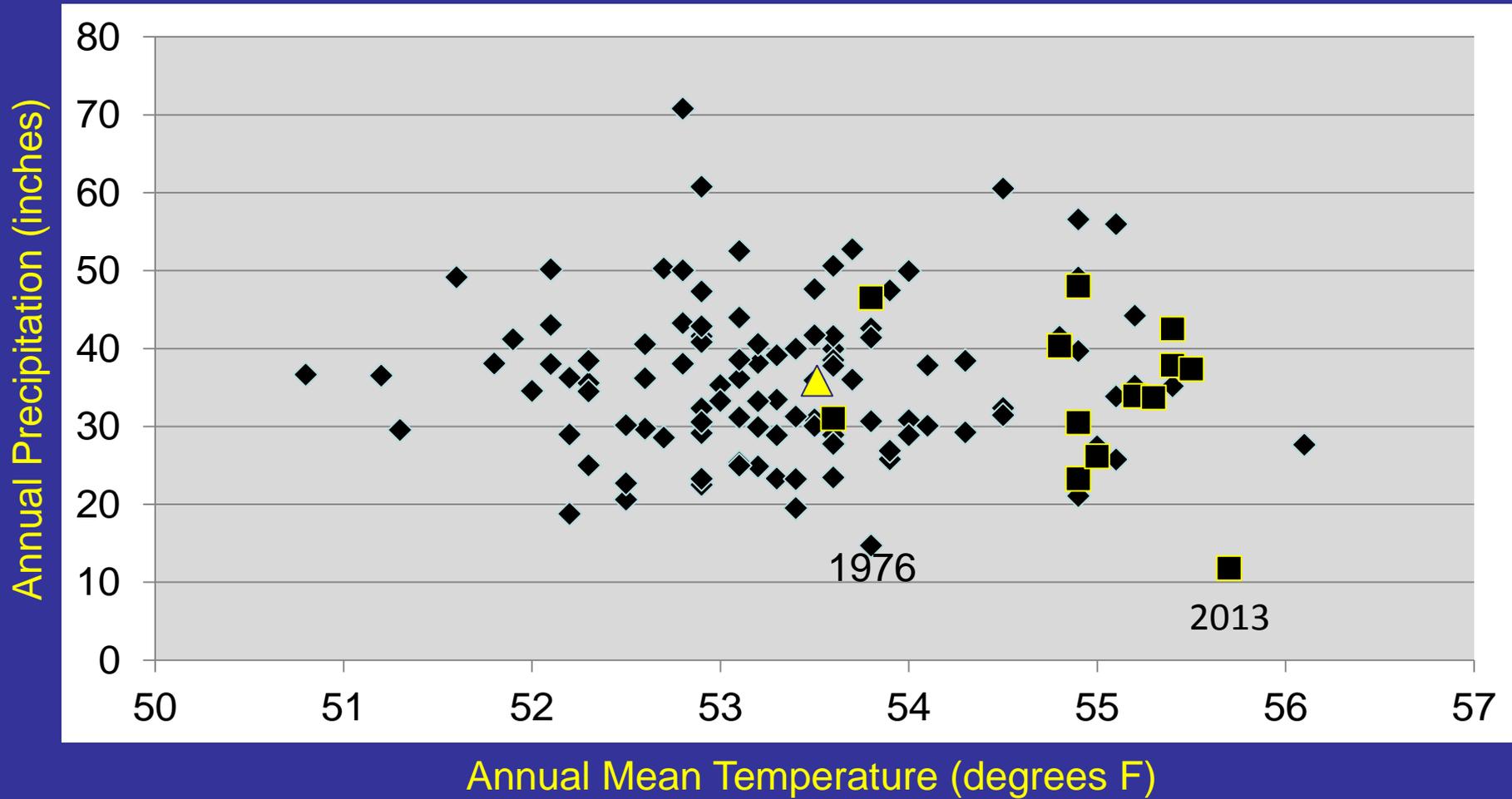
# 8 Station Monthly Comparisons



## 8-Station Index Water Year Totals

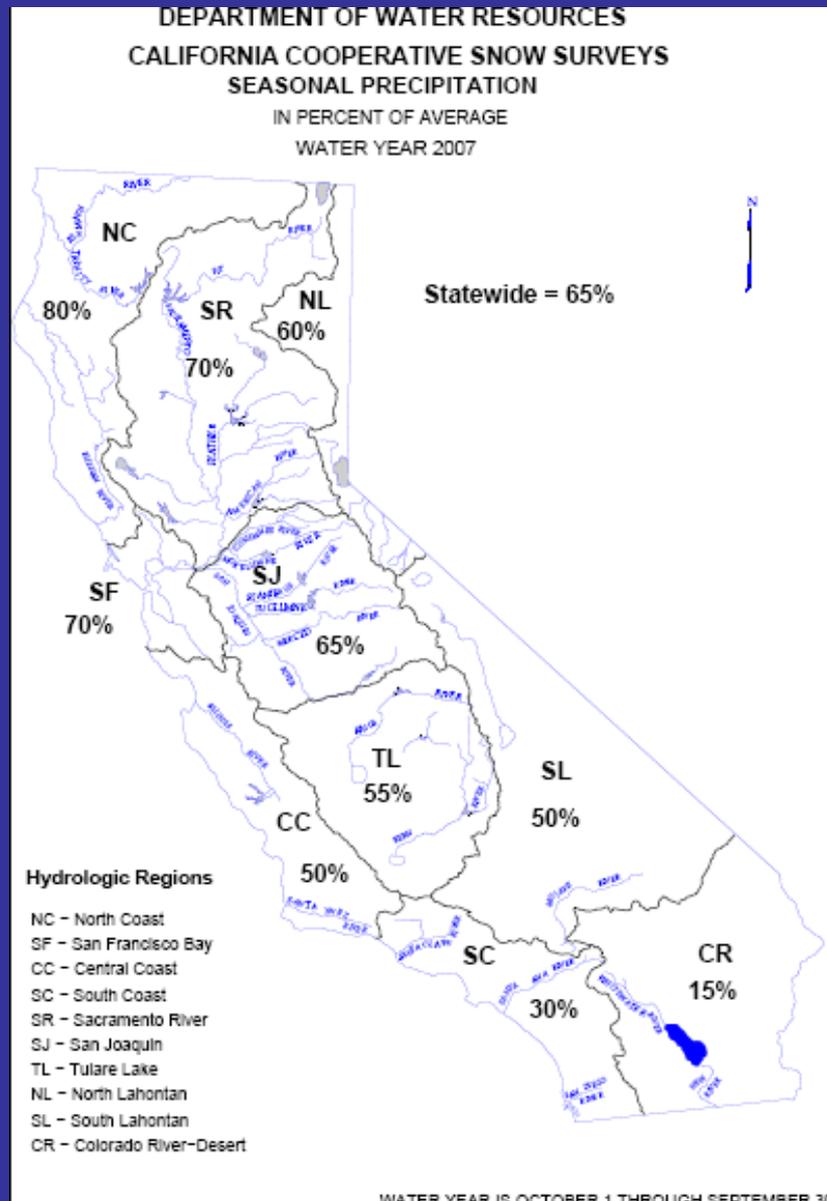


# NOAA Climate Division 2 Calendar Year Data 1895-2013



What will California drought look like in the next century as climate warms?

# Location Matters



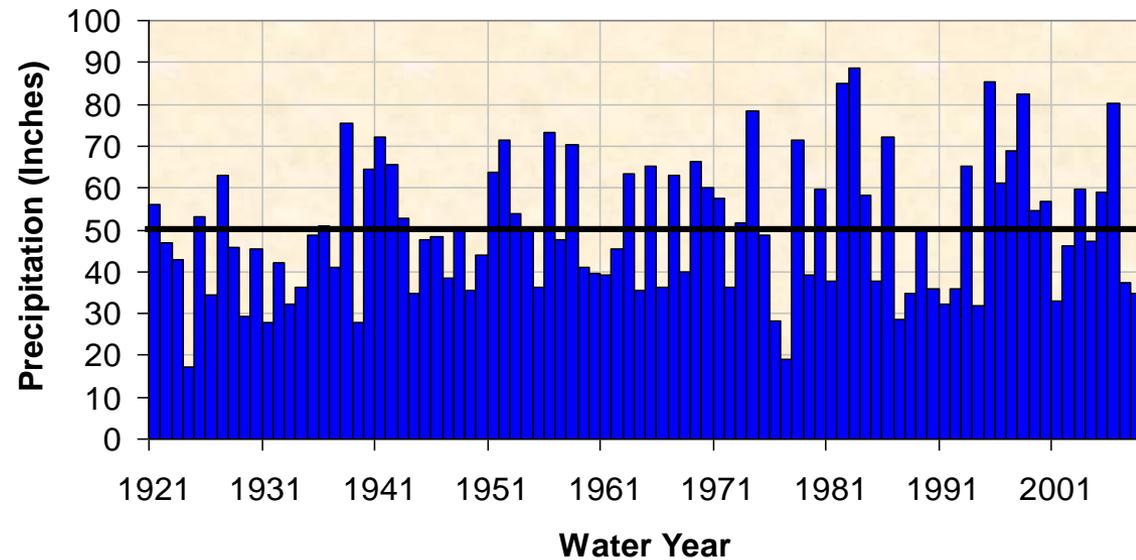
# Precipitation Characteristics



# The Northern CA 8-Station Index

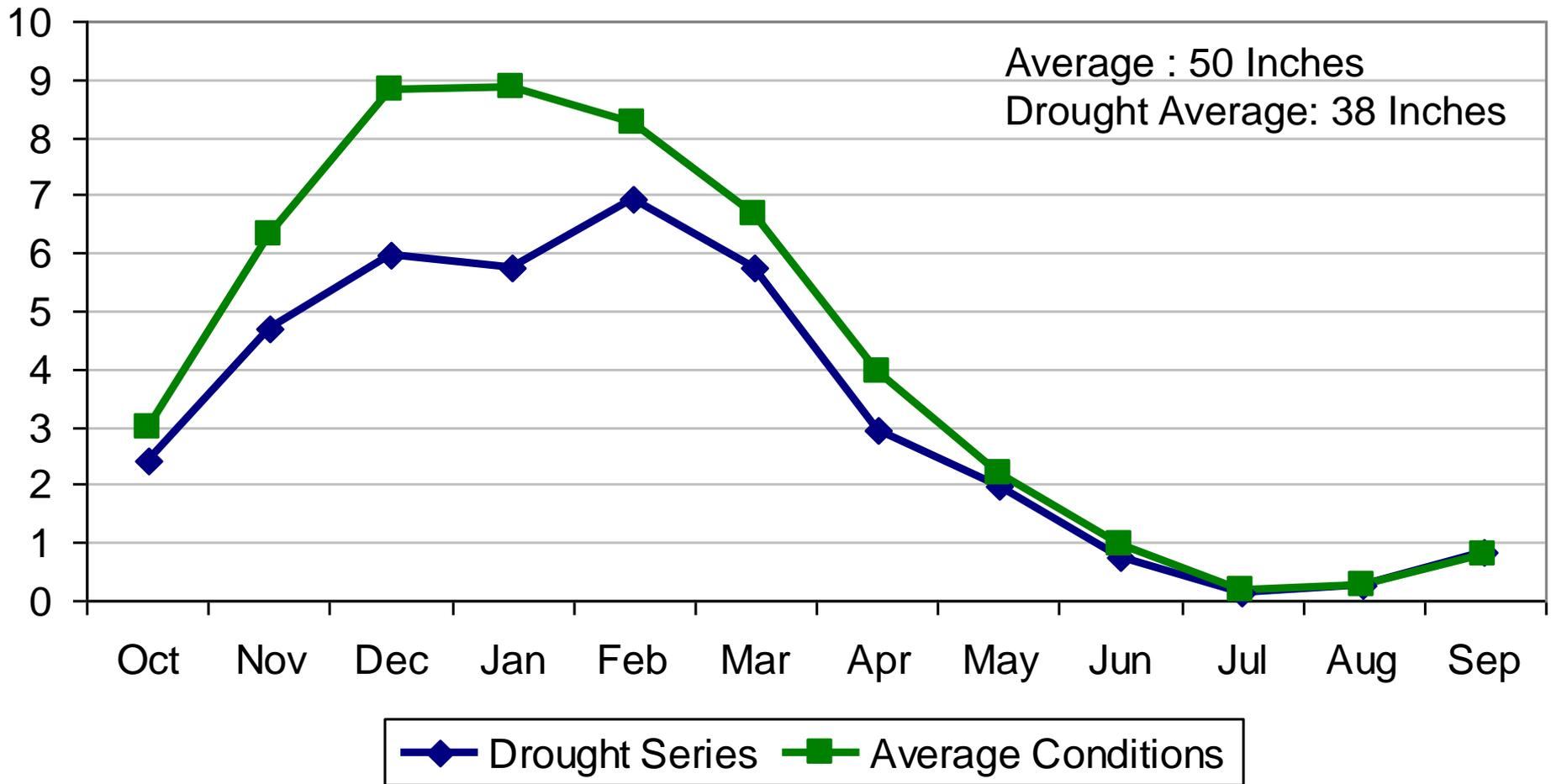


Northern California 8-Station Precipitation Index



Eight Stations: Mt. Shasta City, Shasta Dam, Mineral, Quincy, Brush Creek, Sierraville, Blue Canyon, and Pacific House

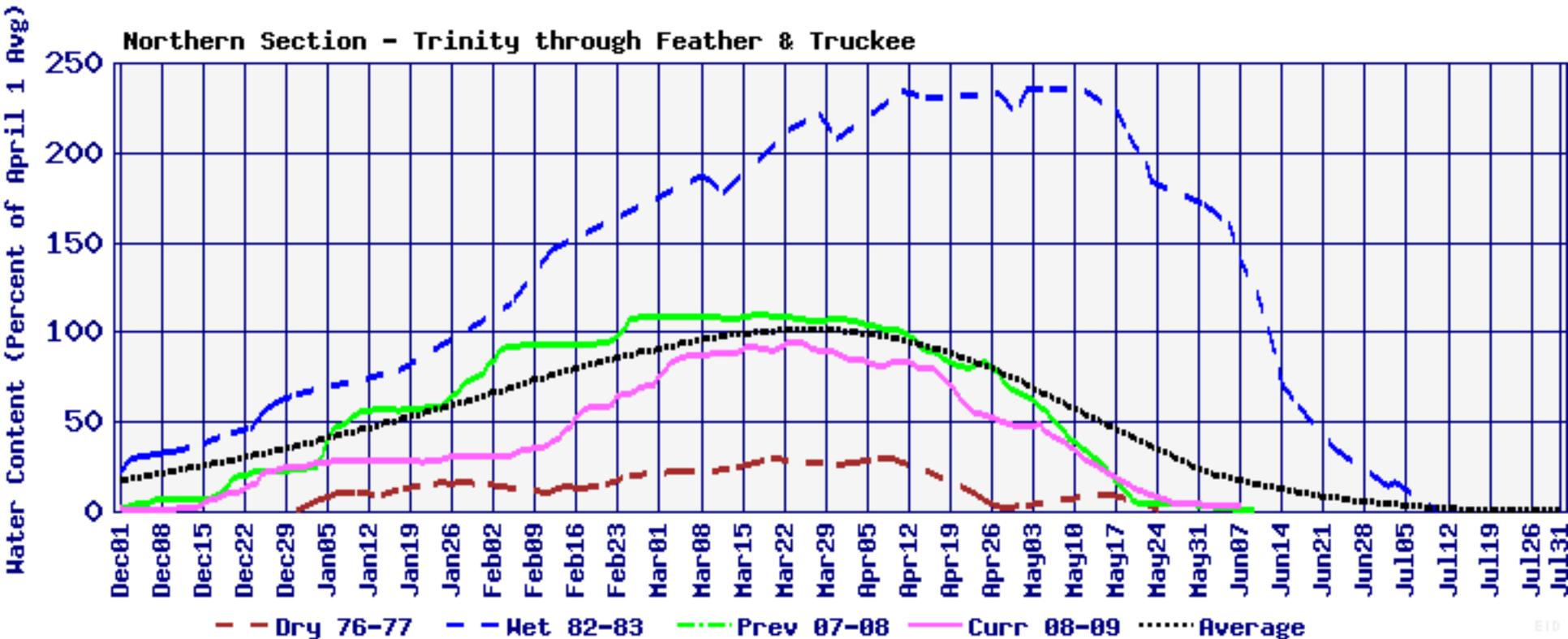
# Monthly 8 Station Distribution



# Snowpack



# Snowpack Characteristics

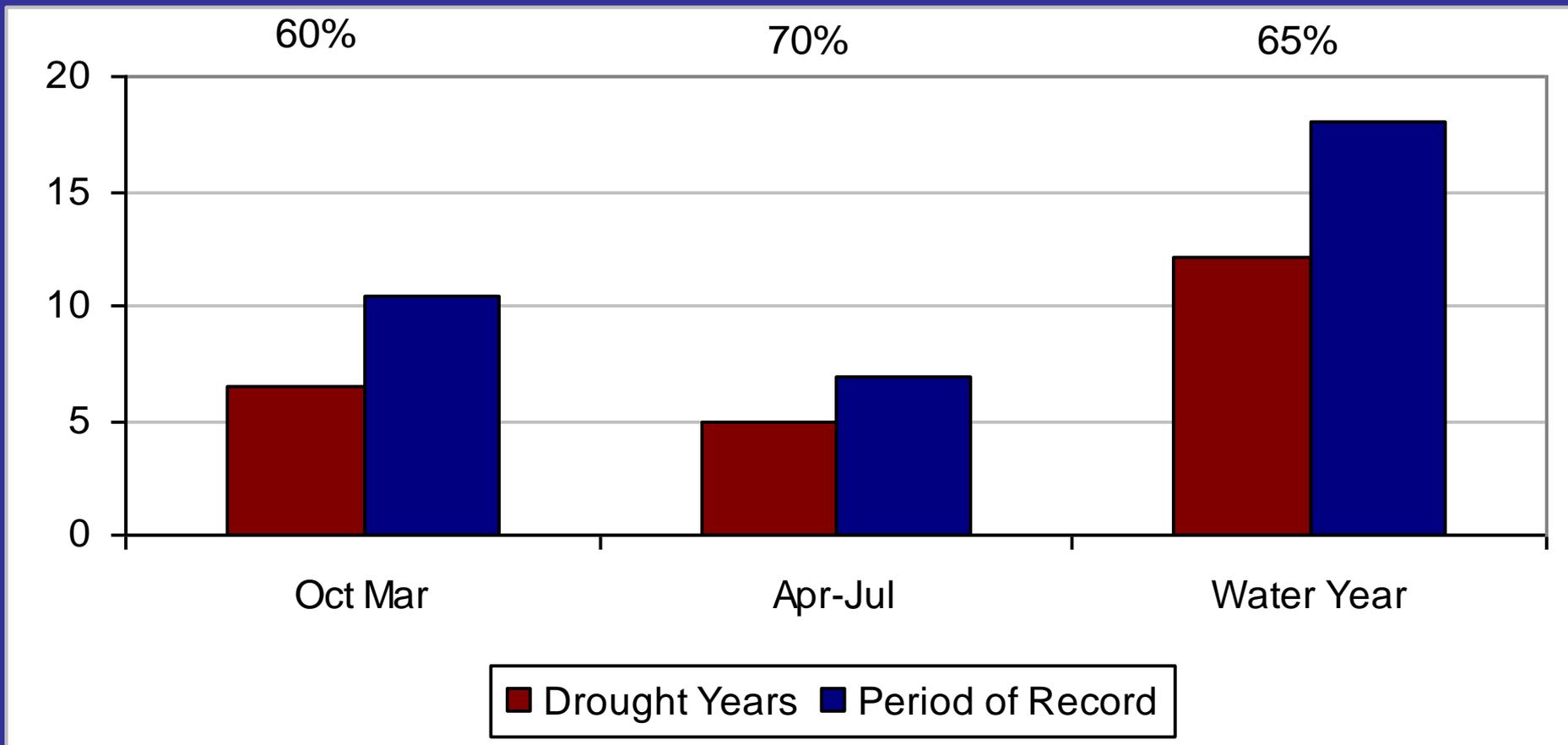


Drought Average April 1<sup>st</sup>: 60%

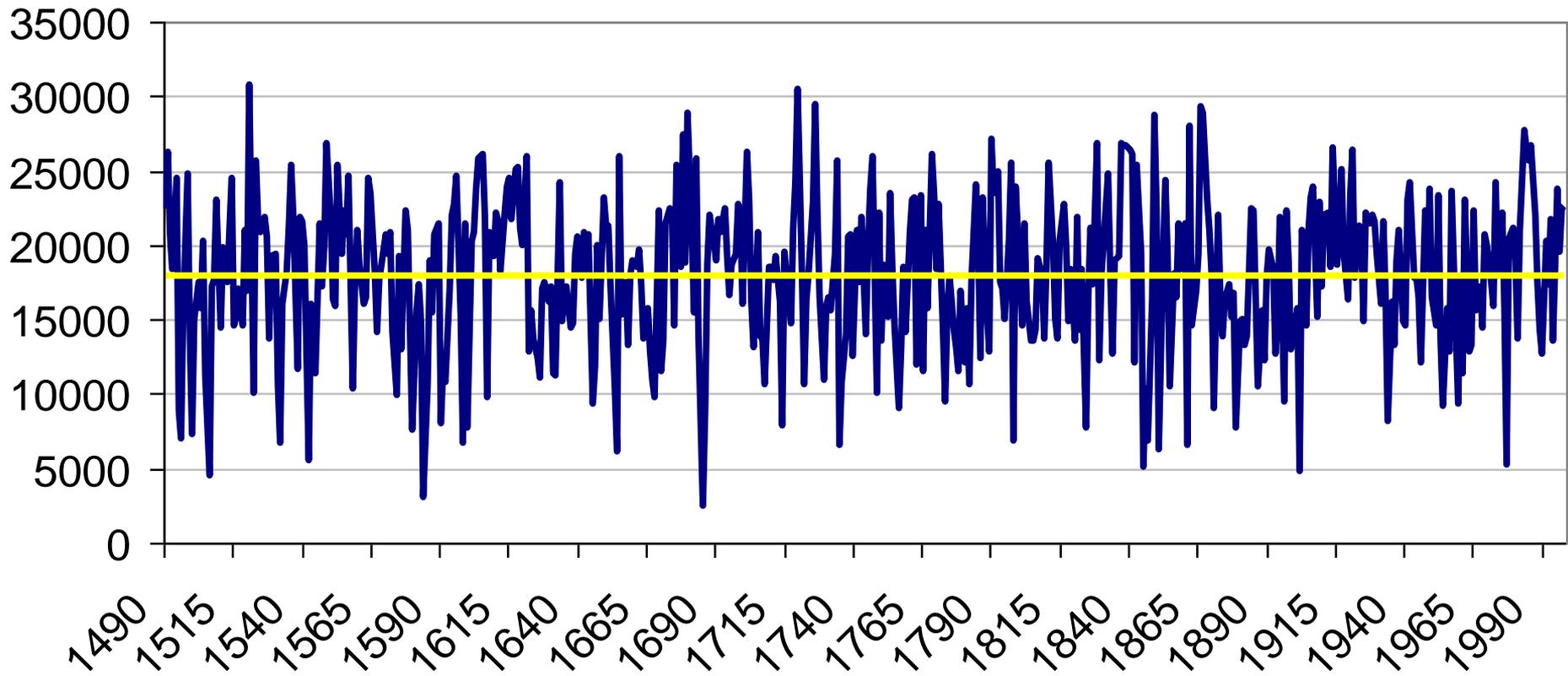
A landscape photograph showing a stream flowing through a grassy field. The stream is the central focus, winding from the middle ground towards the foreground. The water is clear and reflects the sky. The banks are covered in green grass and some shrubs. In the background, there is a dense forest of evergreen trees, and beyond that, rocky mountains under a clear blue sky. The overall scene is bright and sunny.

# Runoff Characteristics

# Drought Runoff Characteristics – Sacramento Basin



# Paleodroughts



# 100+yr. Droughts in California?

“Here I present a study of relict tree stumps rooted in present-day lakes, marshes and streams, which suggests that California’s Sierra Nevada experienced extremely severe drought conditions for more than 2 centuries before AD~1112 and for more than 140 years before AD~1350.”

“Future natural or anthropogenically induced warming may cause a recurrence of the extreme drought conditions”

“California's mediaeval precipitation regime, if it recurred with today's burgeoning human population, would be highly disruptive environmentally and economically.”

(ref. Scott Stine, *Nature*, June 1994)

# 1921-1940 Sacramento Basin

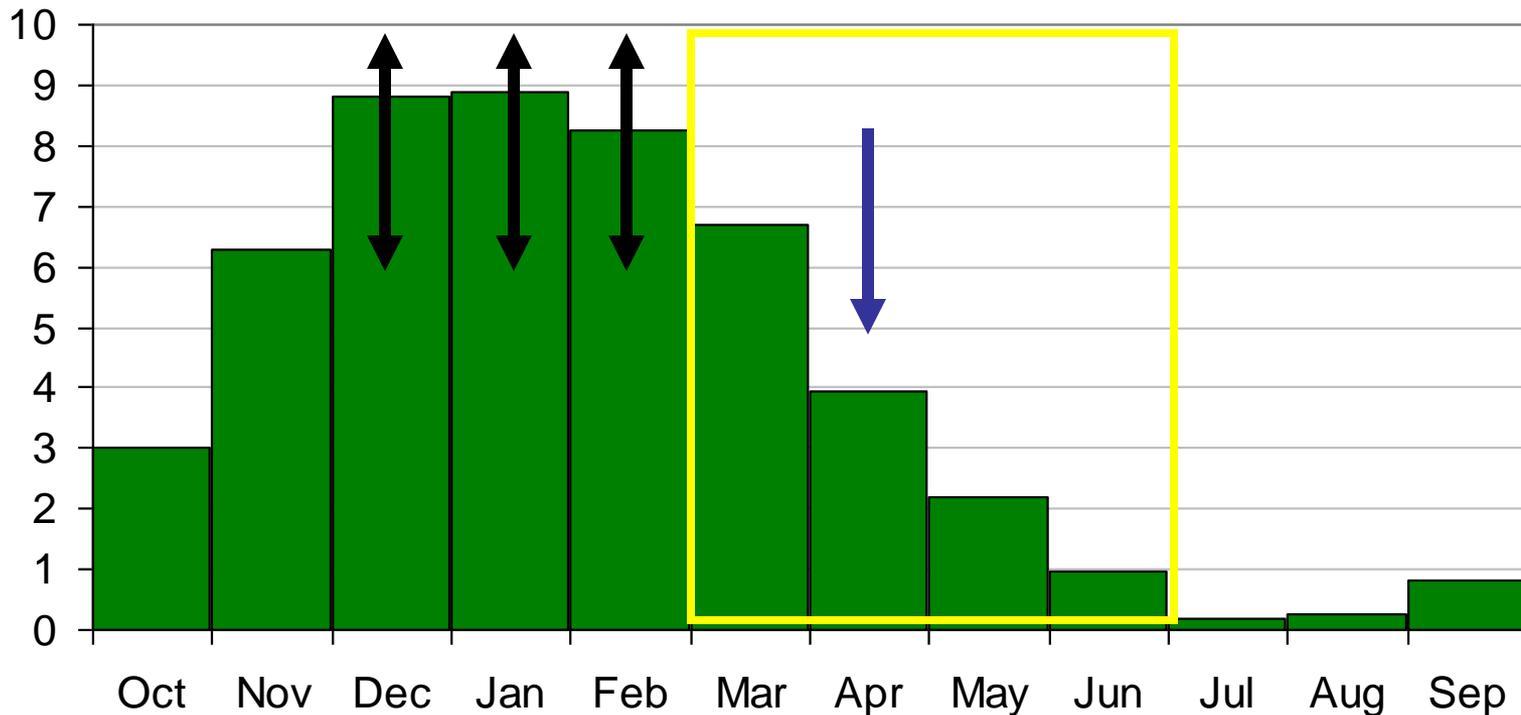
- Only 6 years with above average rainfall in 8 Station Index (1921, 1925, 1927, 1936, 1938, 1940)
- Average annual precipitation 44 inches during this time
- Water year runoff average 14.9 MAF
- WSI Class Distribution:  
2W, 4AN, 4BN, 5D, 5C



Climate Change

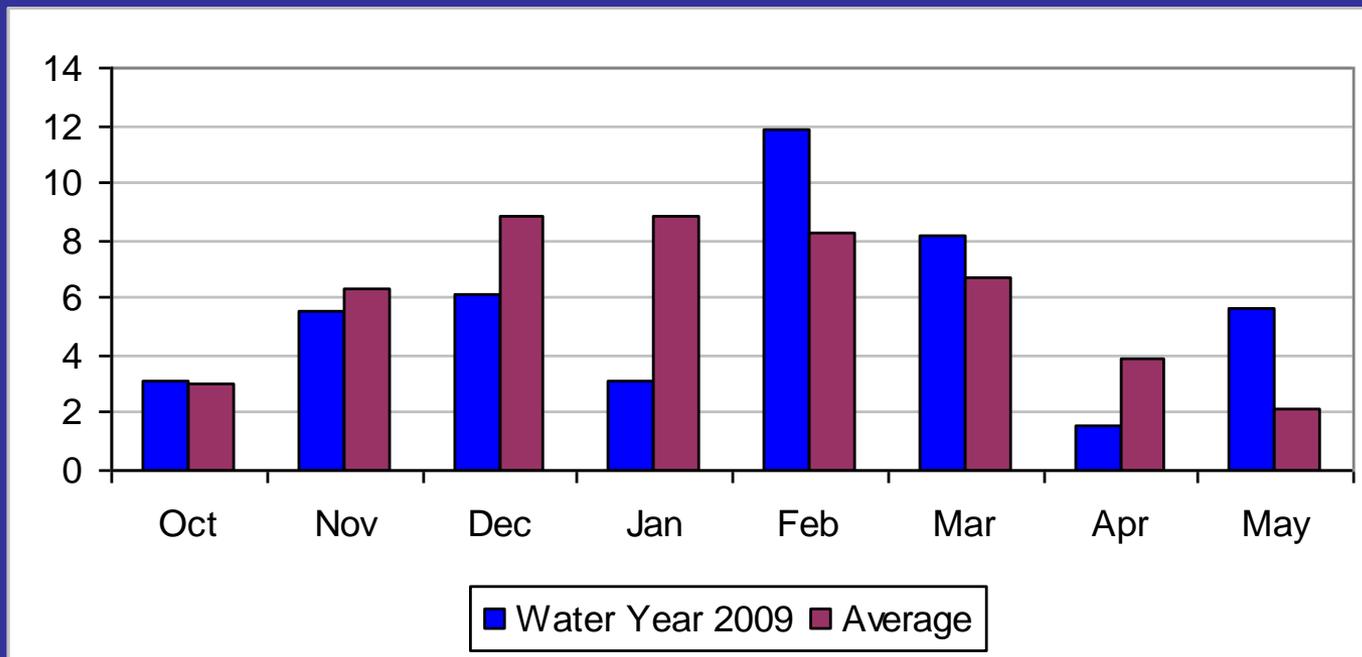
# Climate Change Impacts

- Less Precipitation Falling as Snow
- Drier Springs
- Increased Variability



# Signs of Change?

- Driest Precipitation Year Southern CA 2007
- Driest Spring Northern Sierra 2008
- Water Year 2009 Precipitation Distribution



# Future Drought Characteristics

- Decrease in Spring Precipitation decreases odds of “March Miracles”
- Dry springs and smaller snowpacks will yield lower base flow values earlier in year
- Ability to manage water increasingly constrained by hydrologic conditions and regulatory decisions

# What If Drought Year – 8 Station Index

- Blend elements of past drought years to represent climate change drought year
- Low 10 Monthly Average: 6.91 inches
- Low 10 Seasonal Total Average: 17.10 inches
- 1977/1991/1924 Seasonal Mix: 11.07 inches

# What If Drought Year - Runoff

- No snowpack for spring runoff
- Fall runoff increase requires more precipitation
- Winter flows harder to maintain
- Average of 10 Lowest Drought Flows:
  - Oct-Mar: 3.8 MAF (10.4 MAF)
  - Apr-Jul: 2.6 MAF (6.8 MAF)
  - Water Year: 7.5 MAF (18 MAF)

# Multi-Year Sequencing

- 20<sup>th</sup> Century shows 2, 3, 4, and 6 Yr droughts
- 20-year dry period 1921-1940 in observed record for 8 Station Index & Sacramento Basin Runoff
- Paleorecord shows multiple 10+ year droughts as well as 2 century-long dry periods (climate shifts)

# Conclusions

- 20<sup>th</sup> century drought characteristics show wintertime precip/runoff deficits sometimes offset by wetter than average springs
- Climate change is expected to have fewer wet springs potentially increasing drought occurrence and severity risk.

# Conclusions

- The expectation of increased variability means future conditions can change quickly with 2013 serving as an example.
- Planning for future droughts can take advantage of information in the historical record including paleoreconstructions. The trick will be to increase our understanding of causal mechanisms and watershed response.

An aerial photograph showing a vast, hilly landscape. The foreground is dominated by a grid of agricultural fields in various shades of green and brown. The middle ground and background consist of rolling hills and mountains with sparse vegetation, appearing in shades of tan and brown. A small, white, snow-capped peak is visible in the upper center of the image.

Questions?

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