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

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State Climatologist, California
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Talk Overview

- Current Conditions
- 20th 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 (in Acre Feet)	% of Capacity	% Average	Storage Year Ago This Date	% of Capacity 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 (in inches)	% Average to Date	% of Apr 1 Average	Water Content (in inches) Last Year This Date	% Average 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 Last Year	% of Average Last Year
Northern Sierra	12.90	38	34.10	101
Southern Sierra	8.51	32	21.04	79

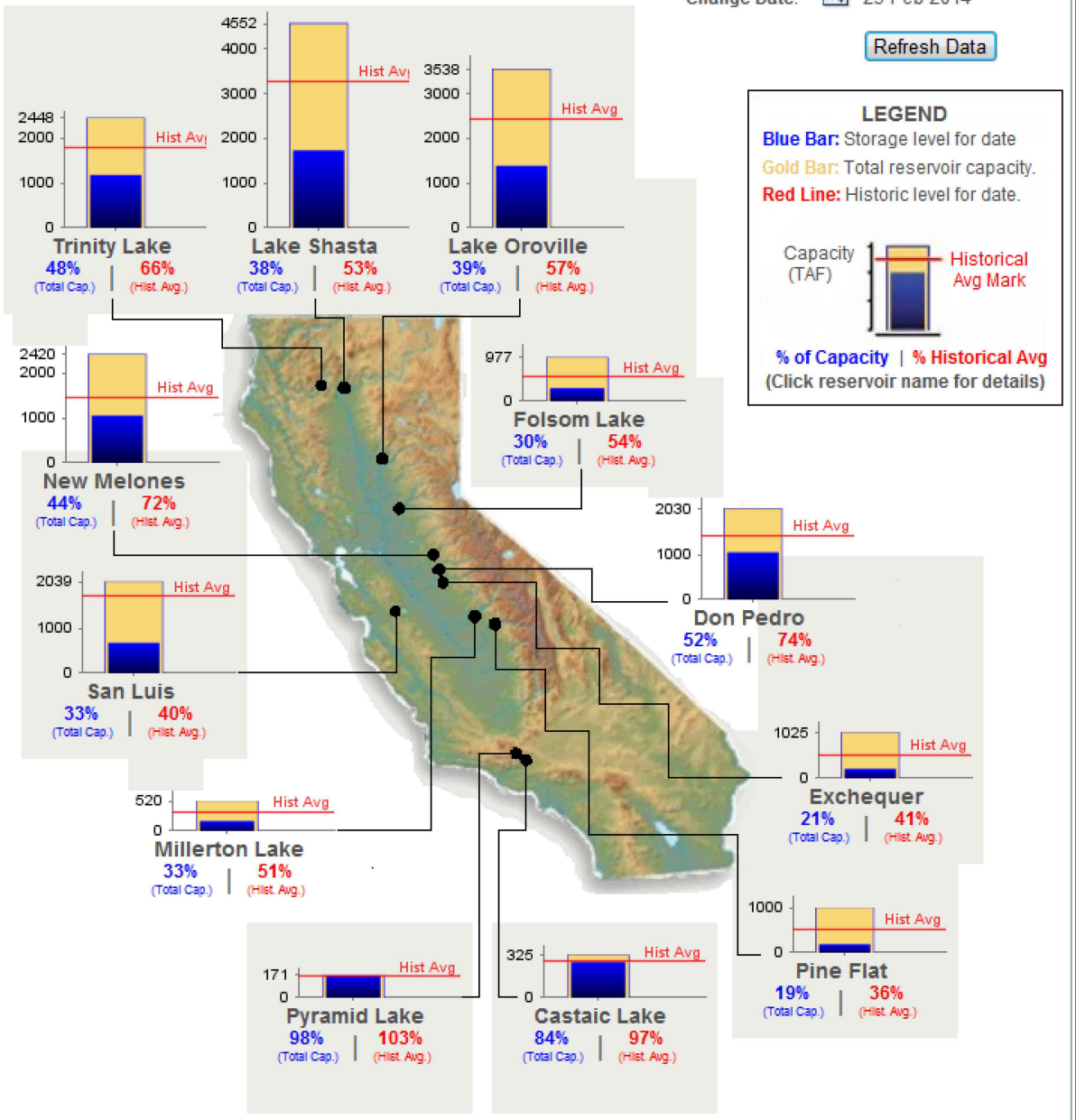
Provisional Data, Subject to Change

CONDITIONS FOR MAJOR RESERVOIRS: 23-FEB-2014

Data as of Midnight: 23-Feb-2014

Change Date: 23-Feb-2014

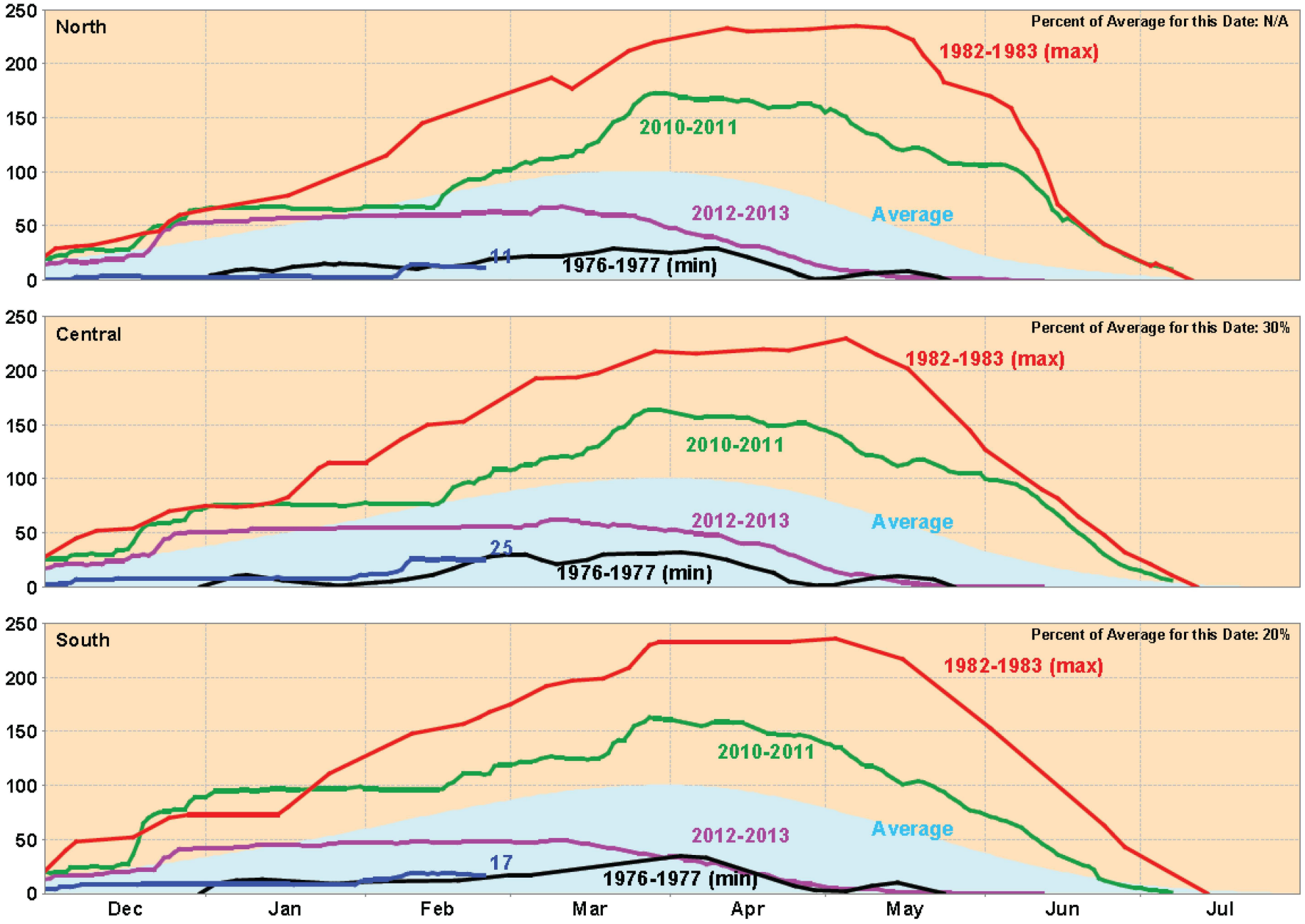
Refresh Data



Click for printable version of current data.

Report Generated: 24-Feb-2014 12:57 PM

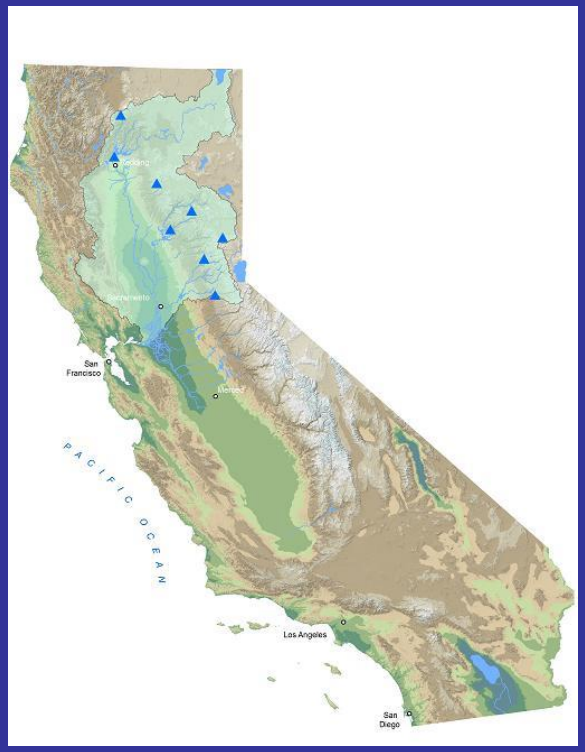
California Snow Water Content, February 24, 2014, Percent of April 1 Average



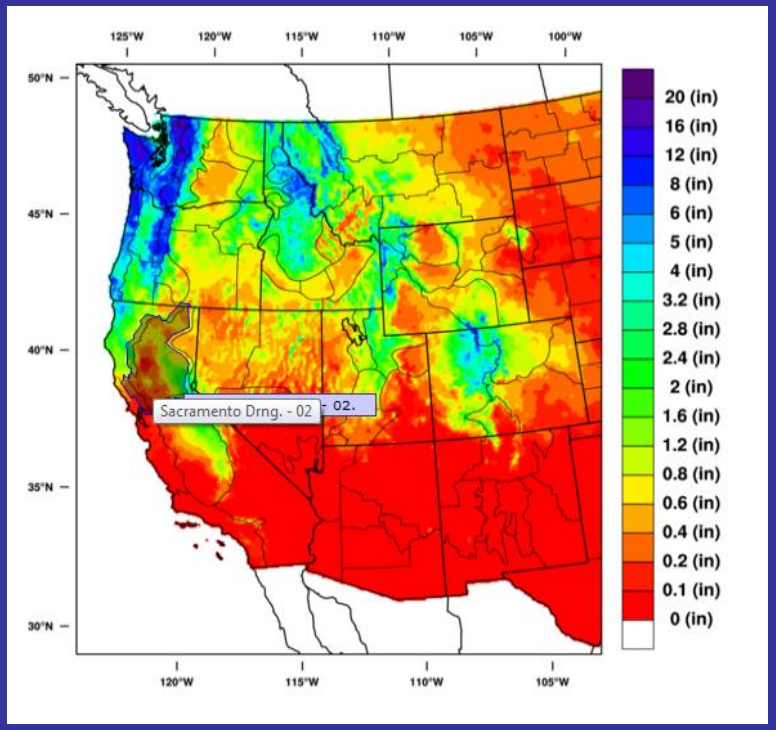
Statewide Percent of April 1: 20%

Statewide Percent of Average for Date: 25%

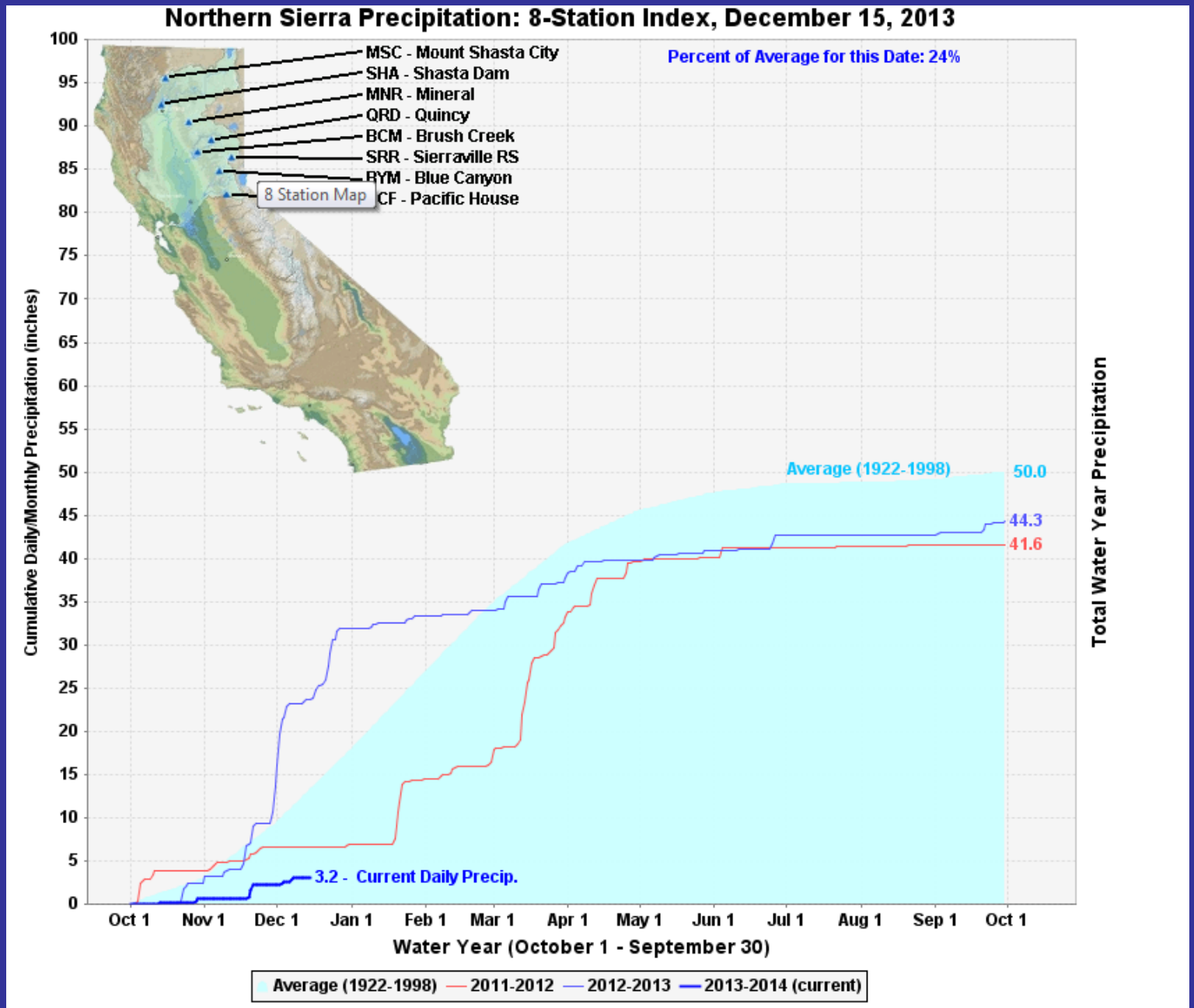
Northern Sierra 8 Station Index



WRCC WestMap



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



http://cdec4gov.water.ca.gov/cdecapp/precipapp/get8SIPrecipIndex.a
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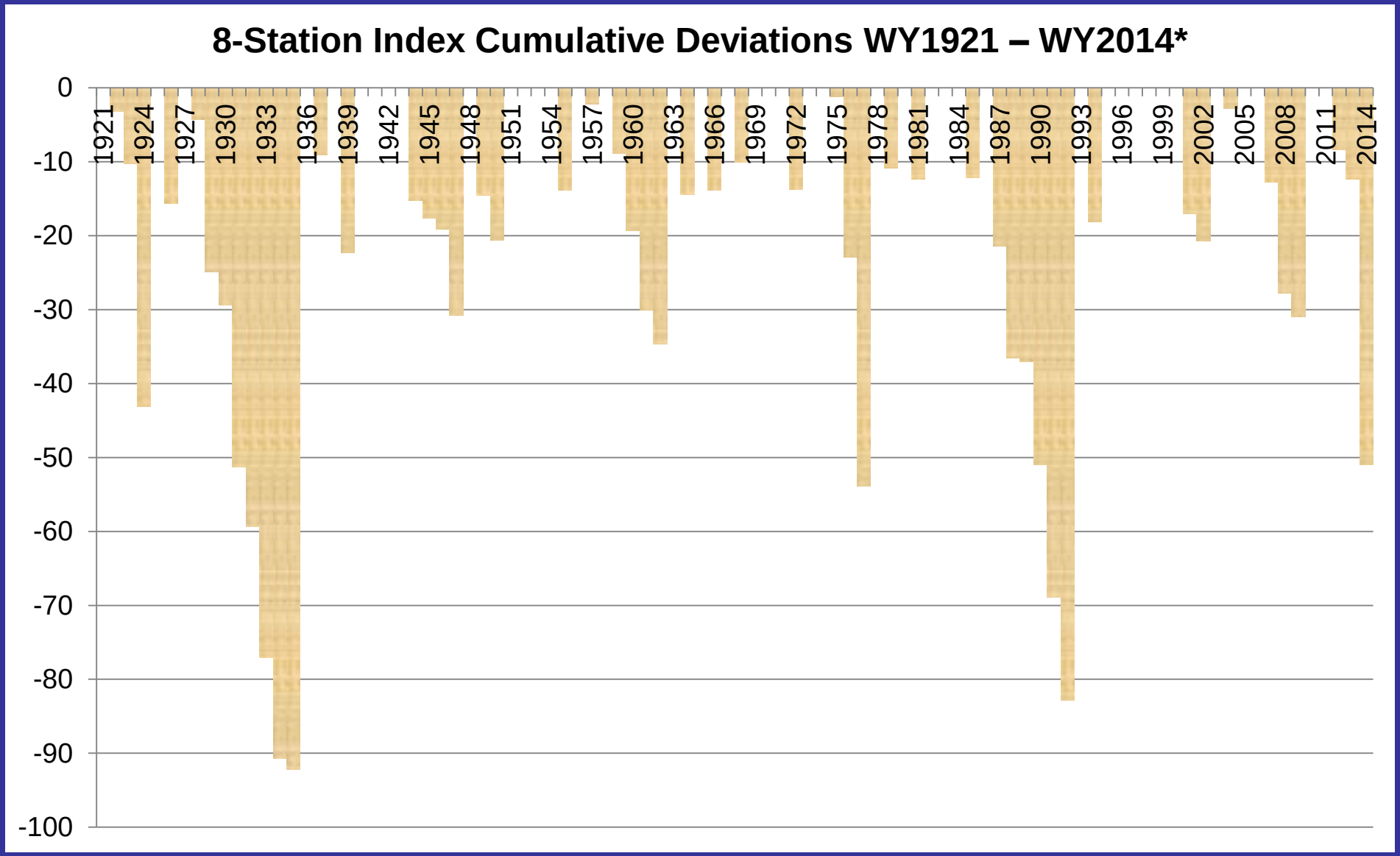
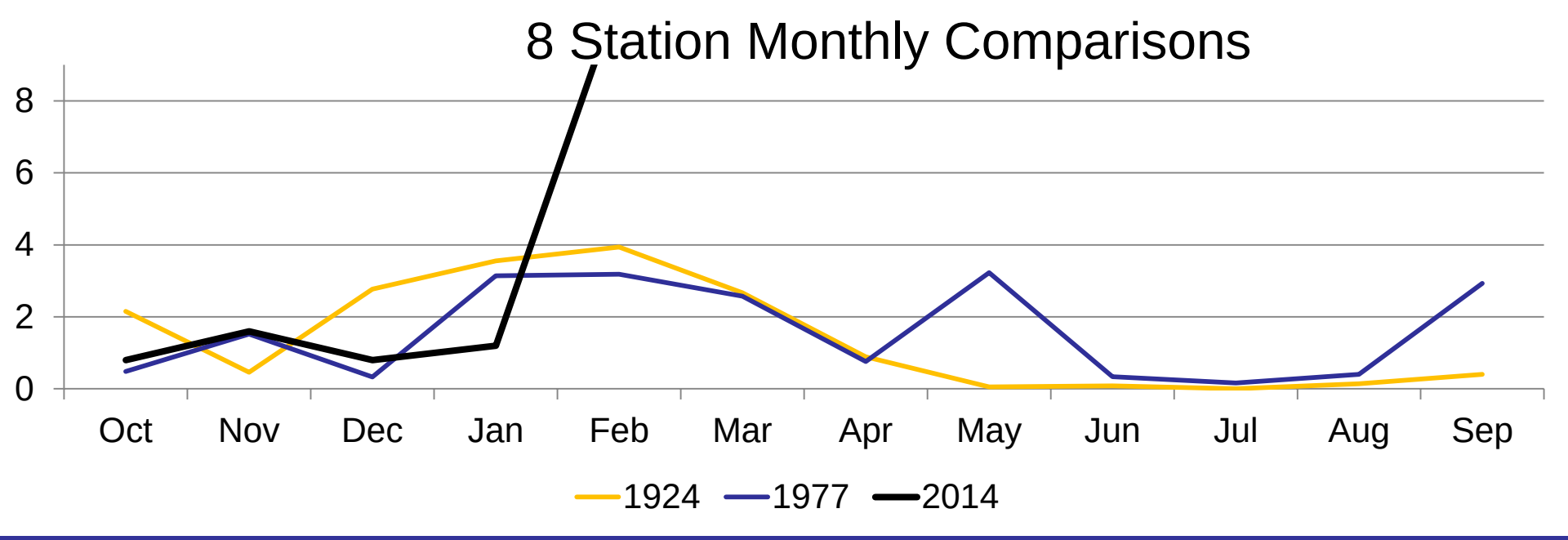
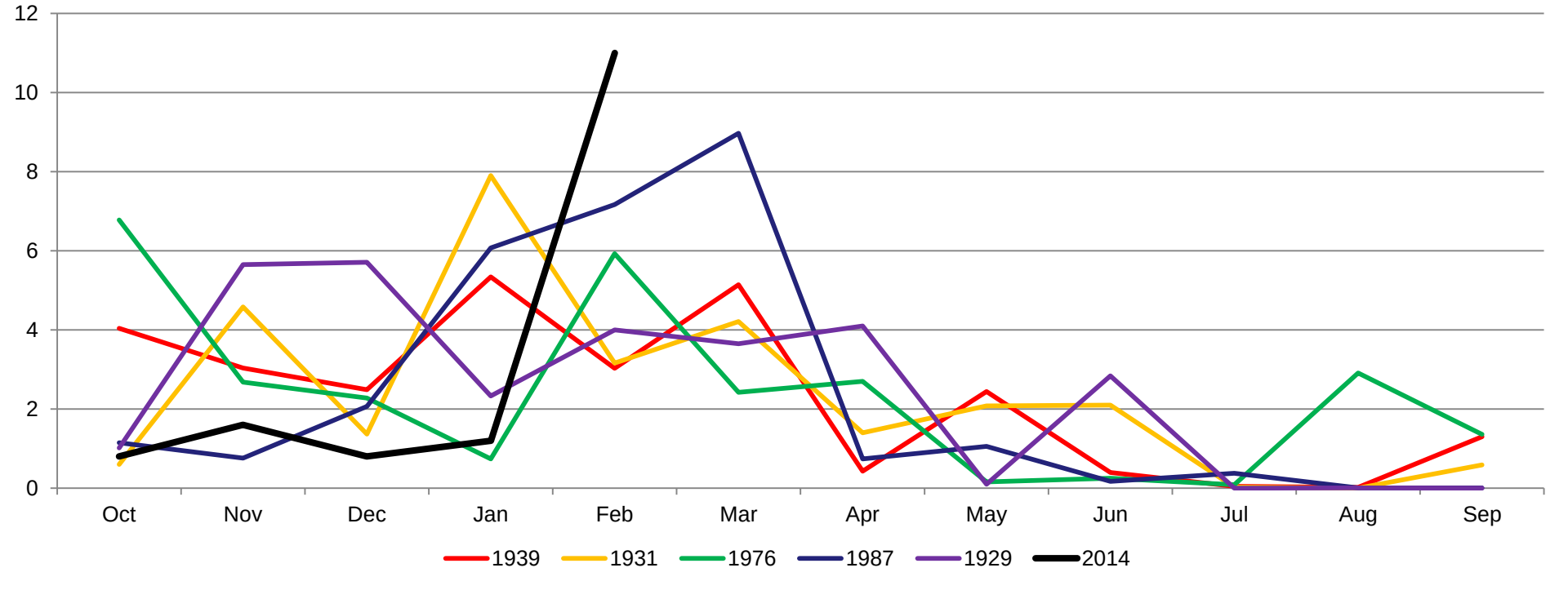
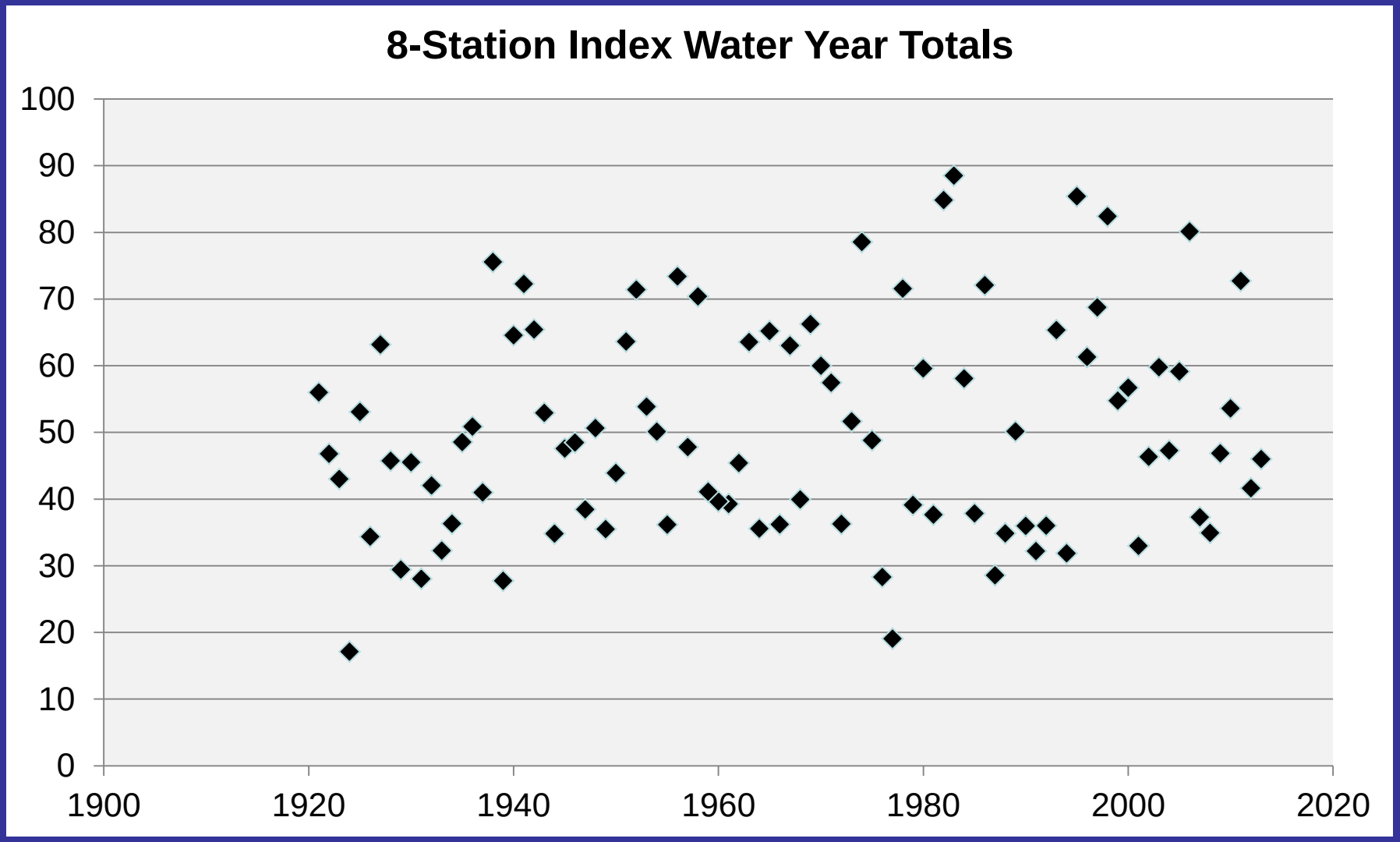


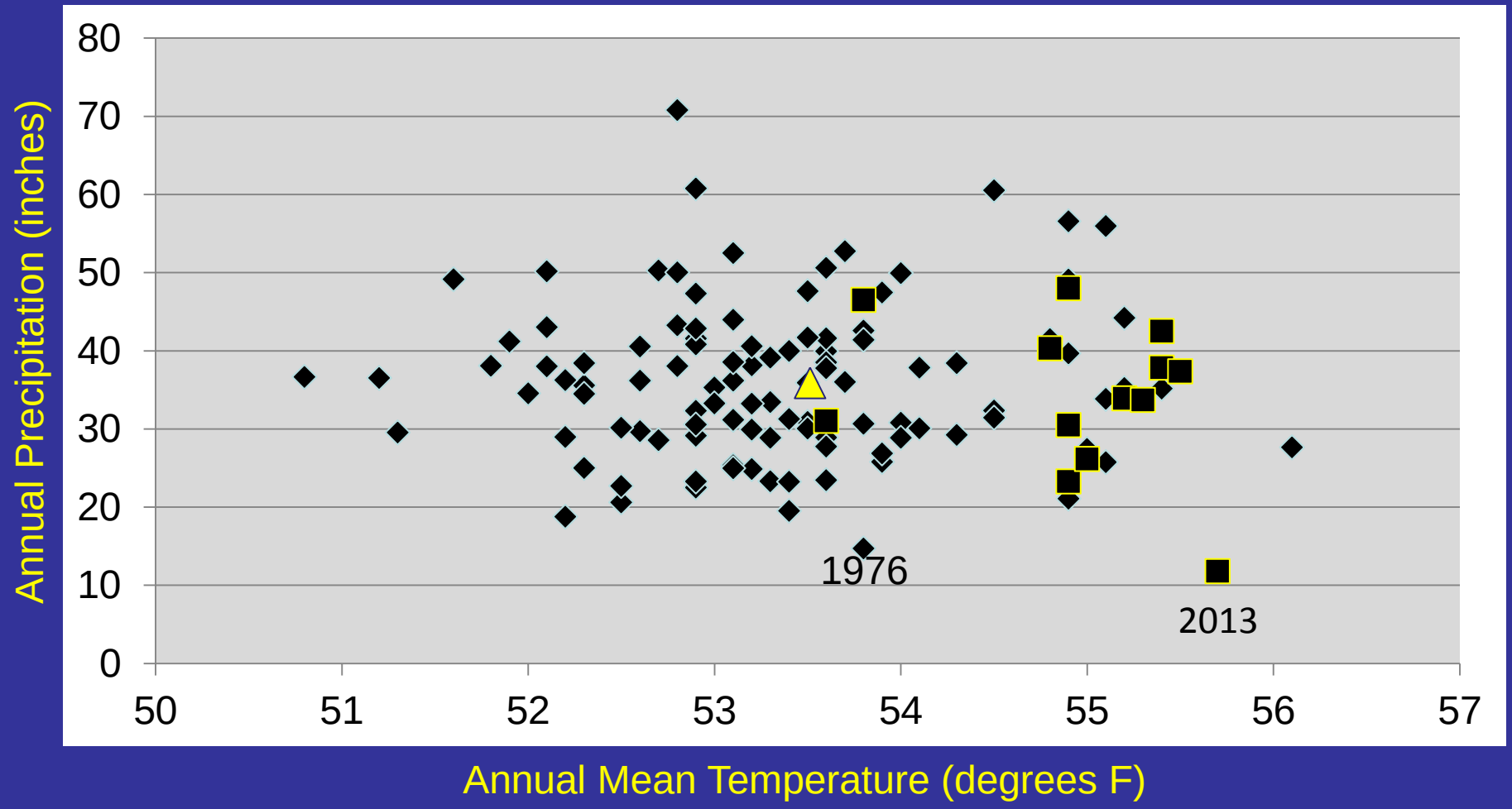
*WY2014 assumes no further precipitation this year


8 Station Monthly Comparisons
8
6
4
2
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
1924
1977
2014


12
10
8
6
4
2
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
1939
1931
1976
1987
1929
2014

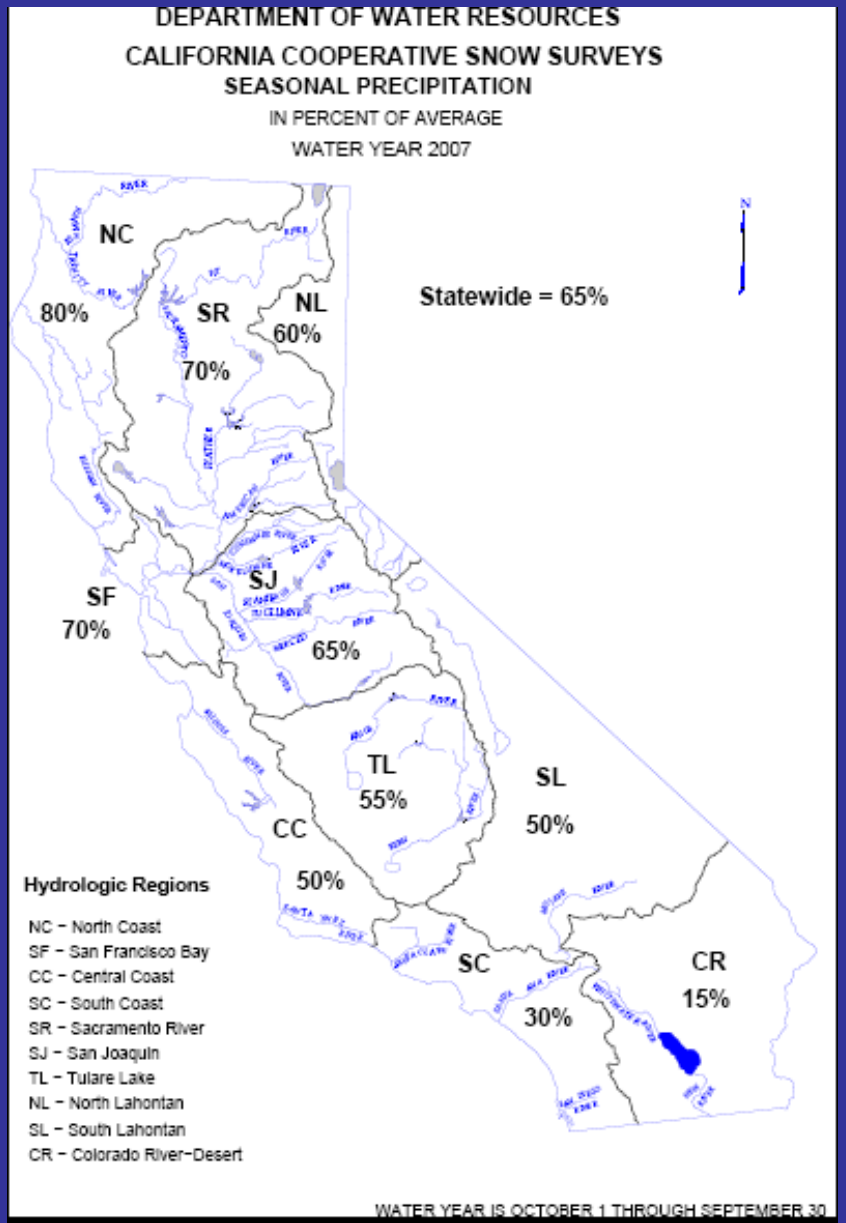

8-Station Index Water Year Totals
100
90
80
70
60
50
40
30
20
10
0
1900
1920
1940
1960
1980
2000
2020

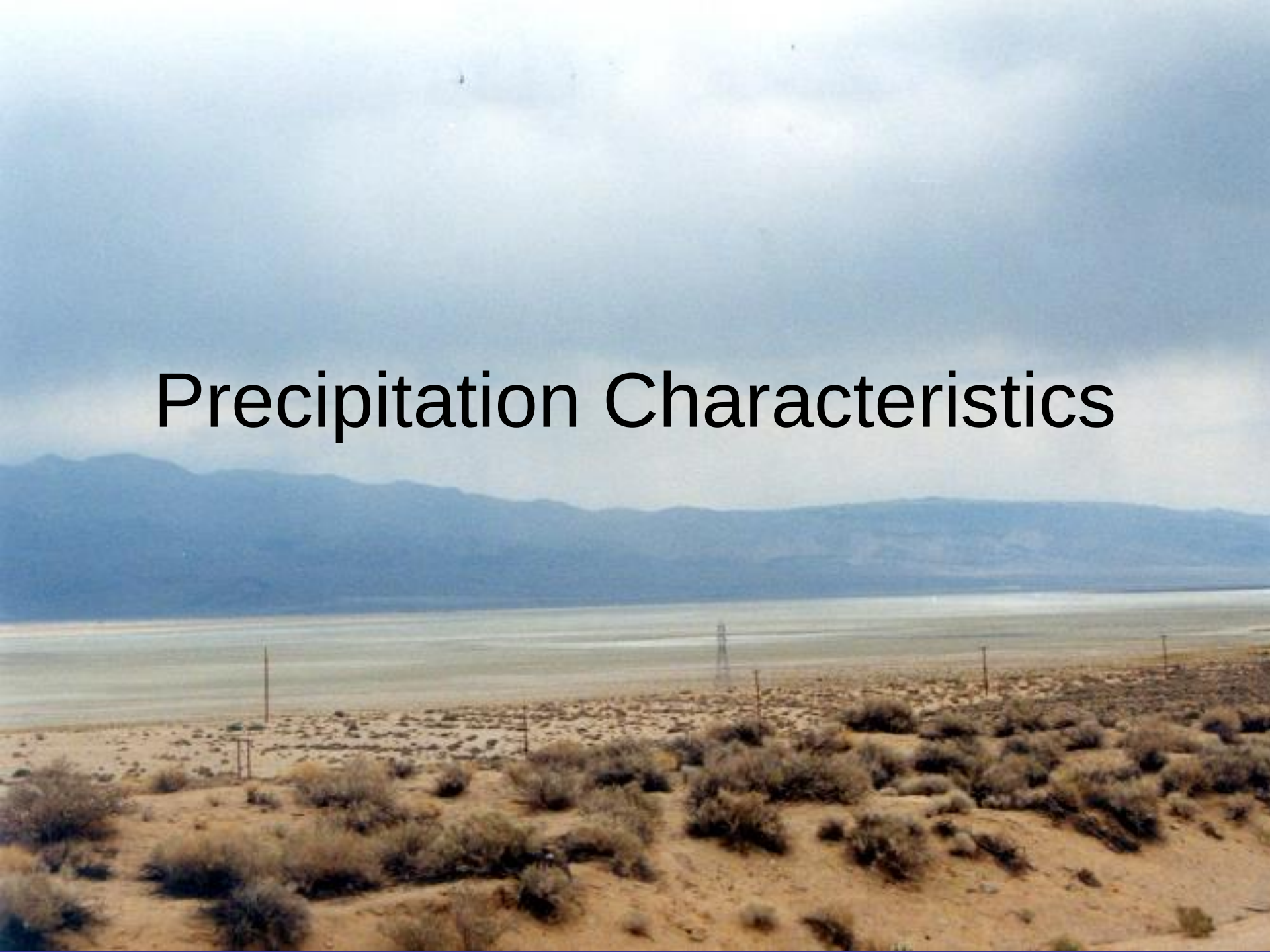
NOAA Climate Division 2 Calendar Year Data 1895-2013



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

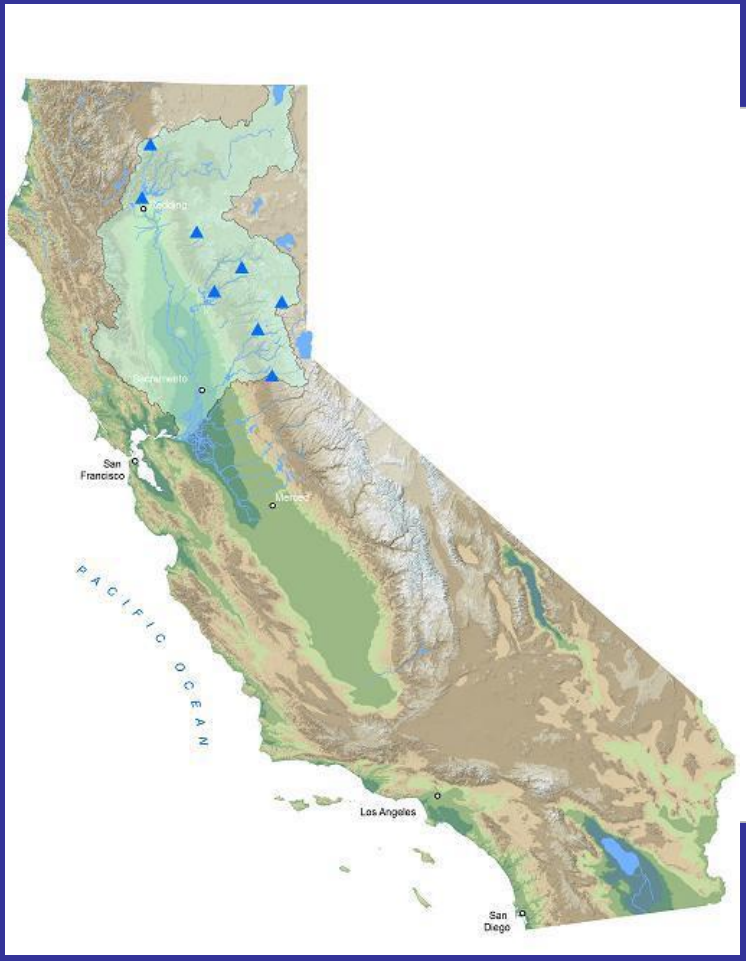
Location Matters

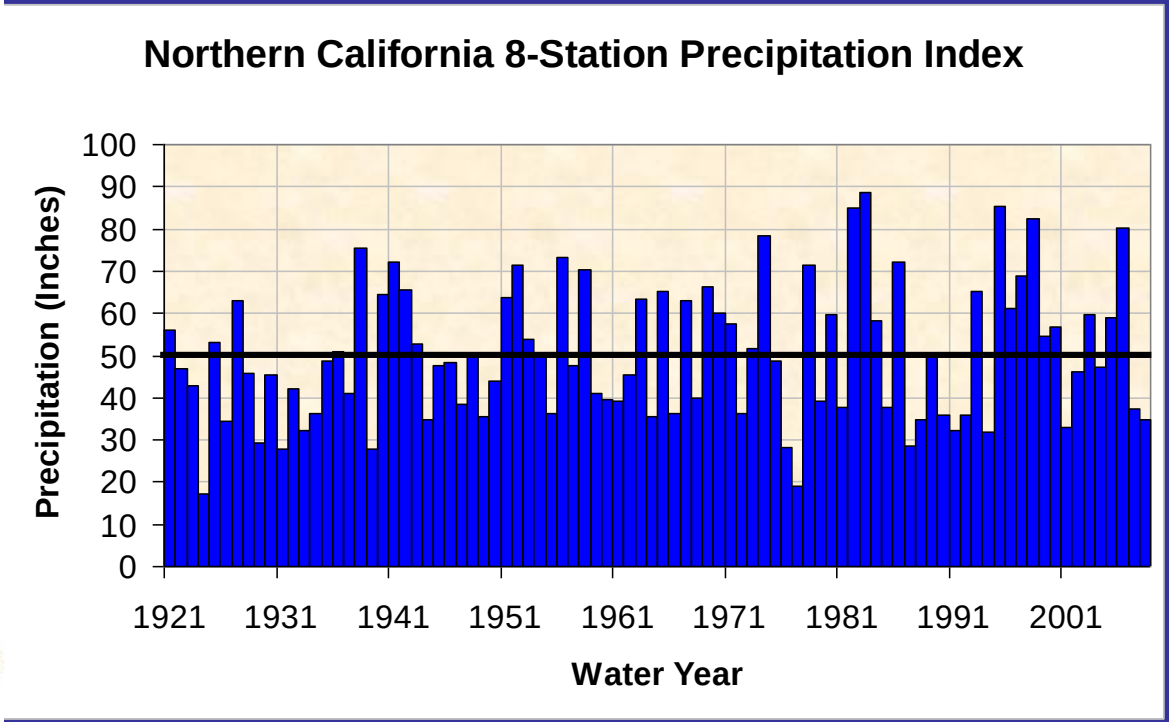




Precipitation Characteristics

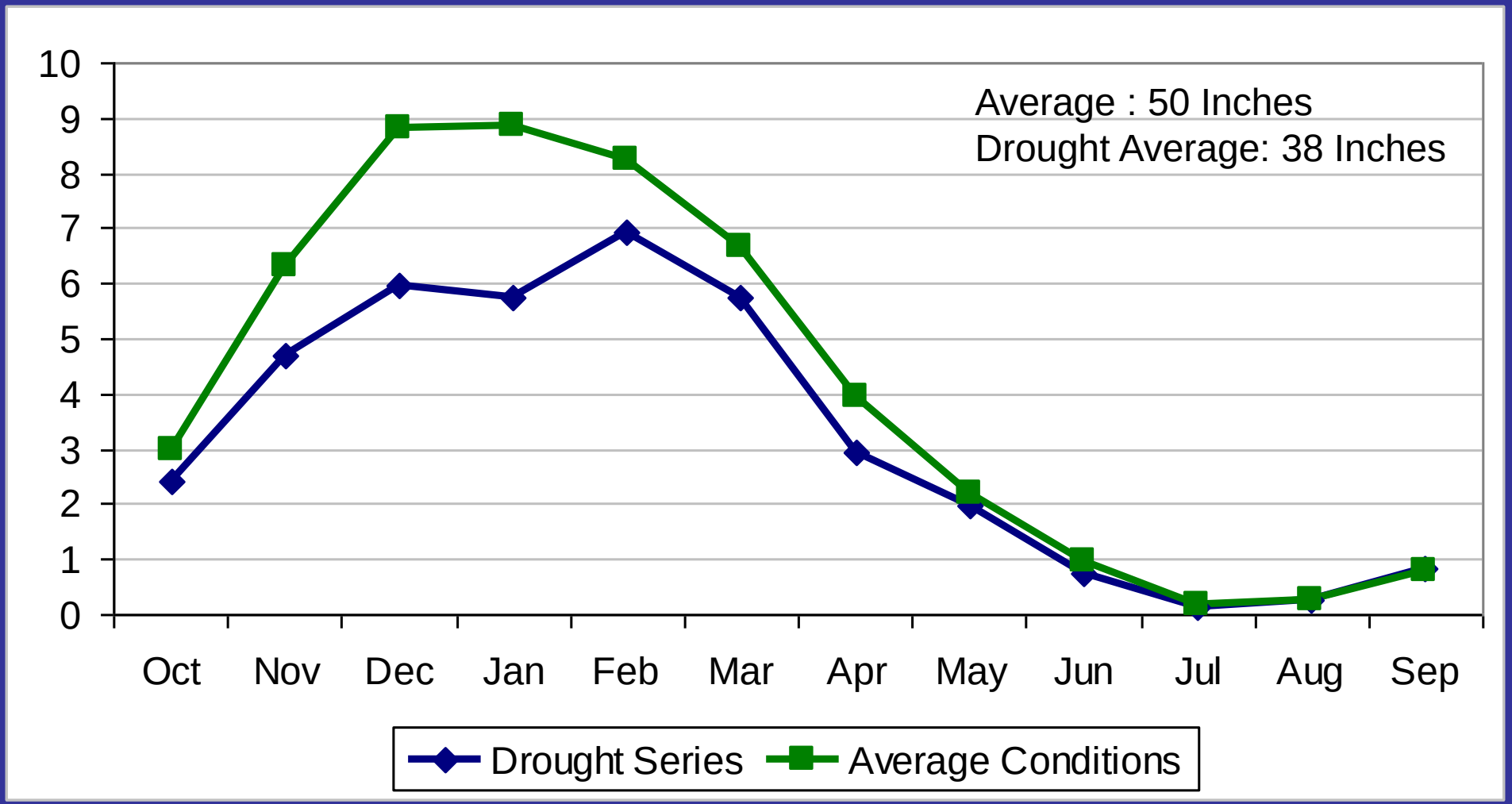
The Northern CA 8-Station Index





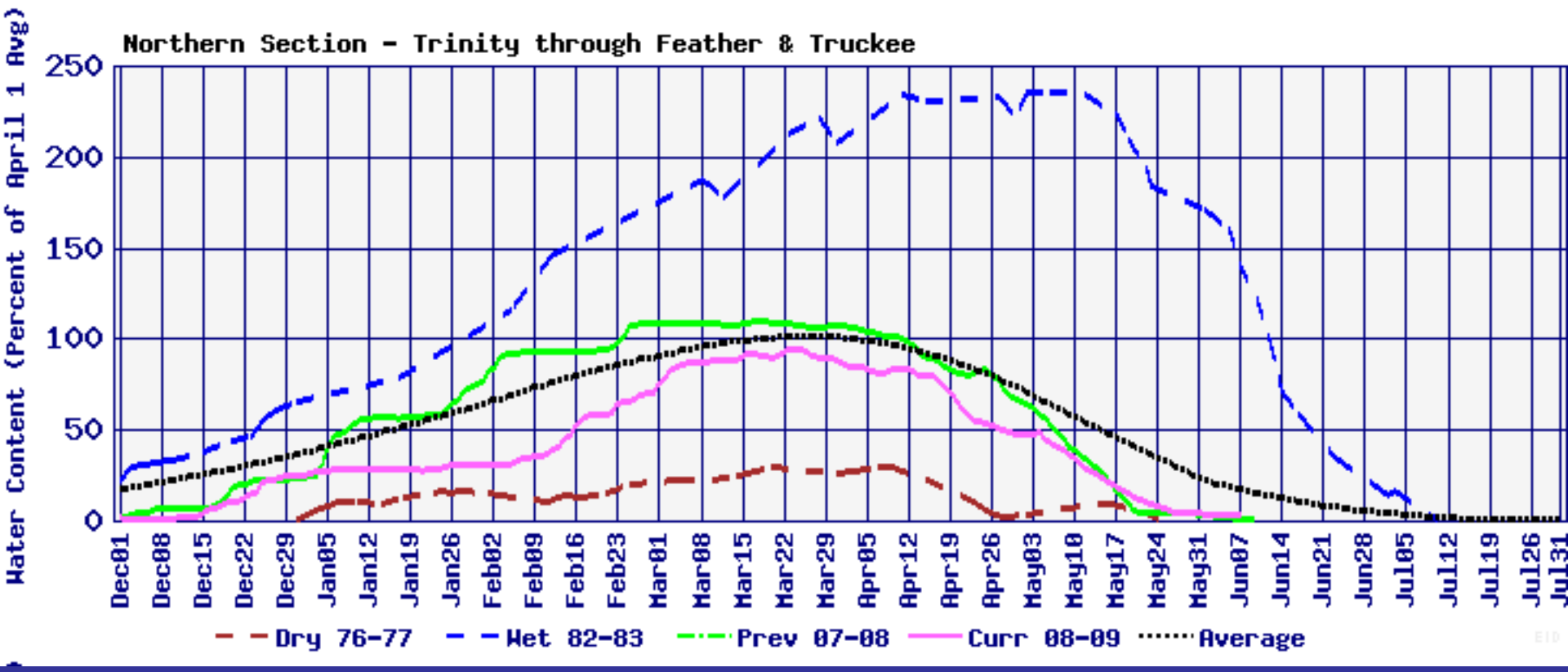
Eight Stations: Mt. Shasta City, Shasta Dam, Mineral, Quincy, Brush Creek, Sierraville, Blue Canyon, and Pacific House

Monthly 8 Station Distribution




Snowpack

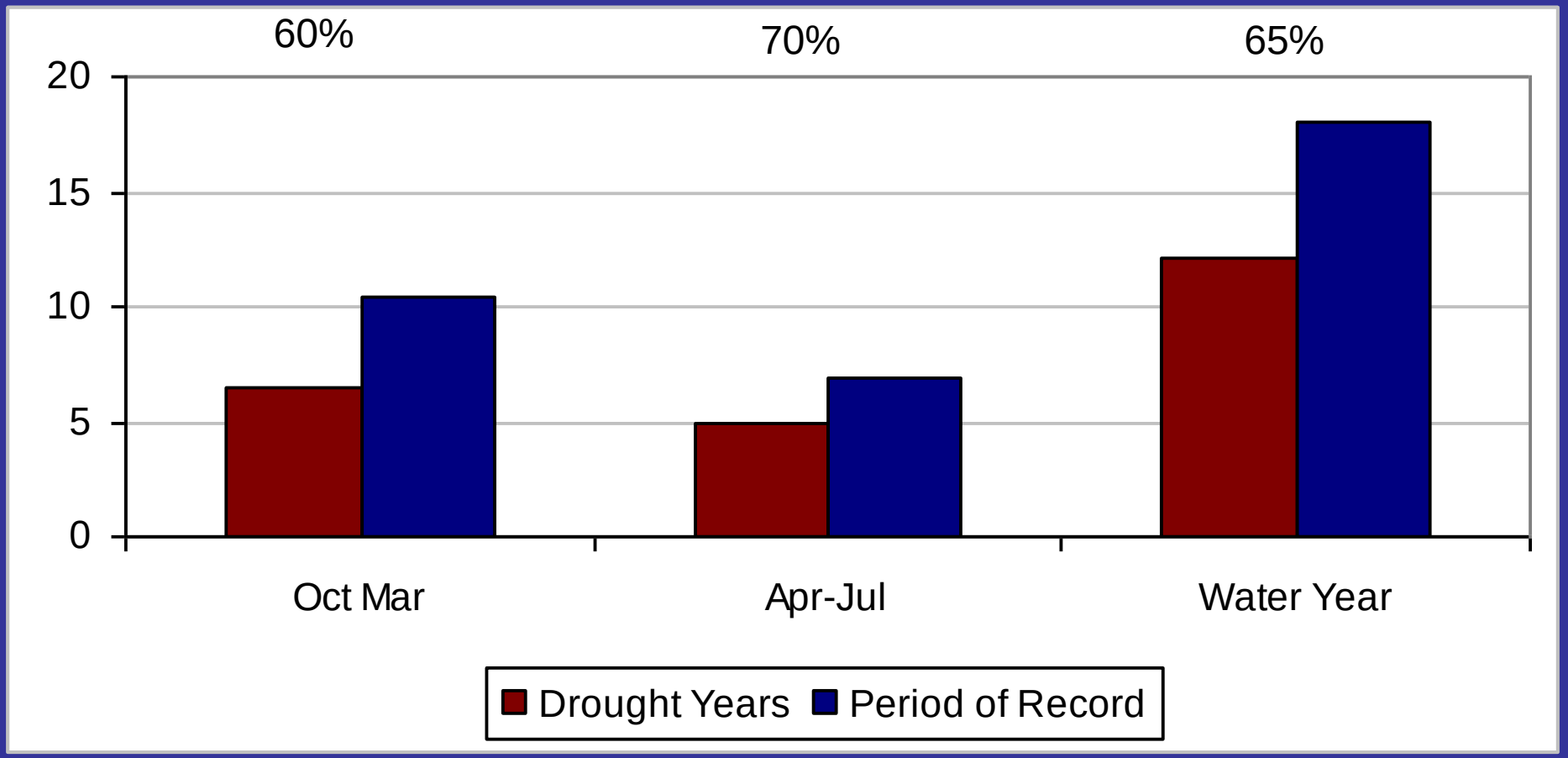
Snowpack Characteristics



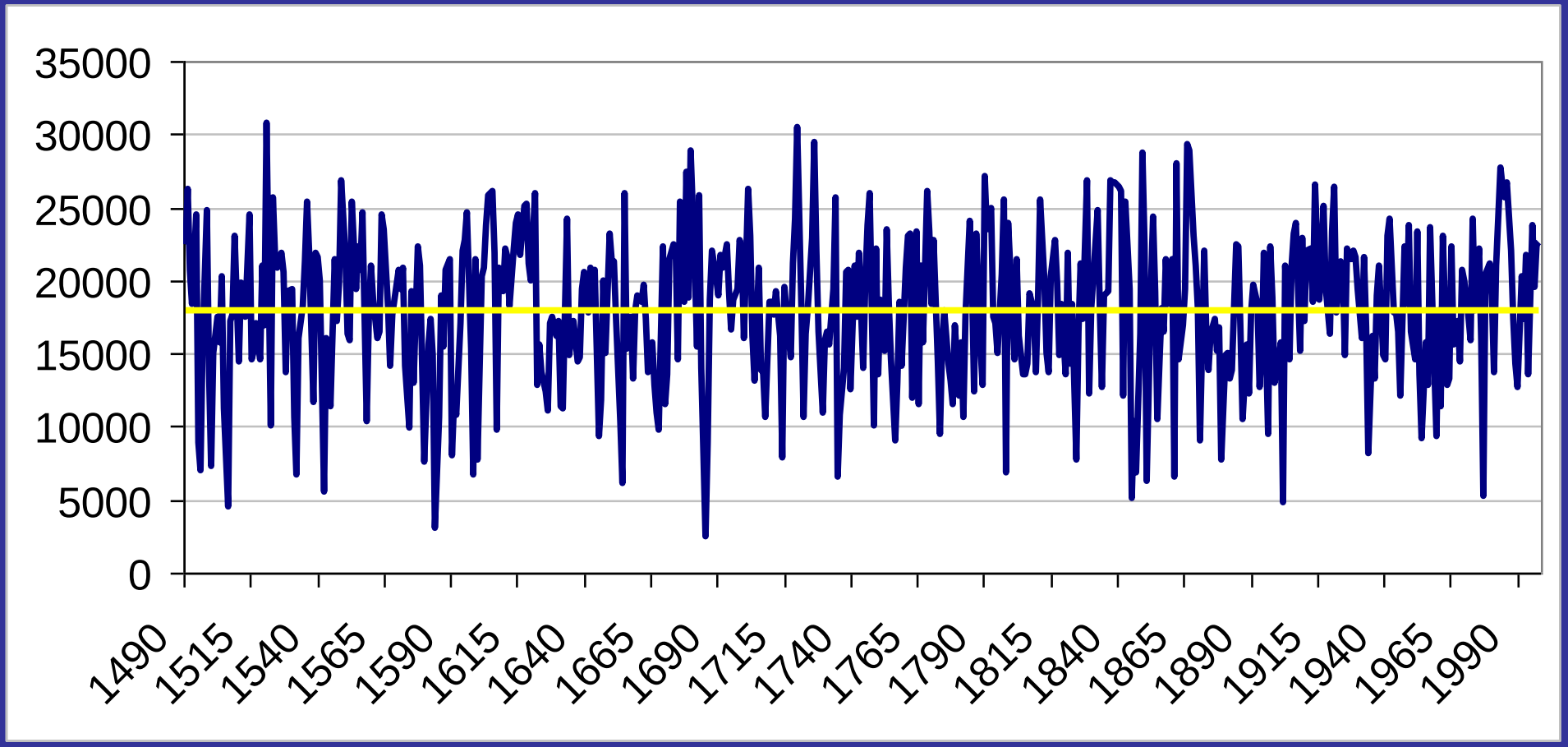
Drought Average April 1st: 60%


Runoff Characteristics

Drought Runoff Characteristics – Sacramento Basin



Paleodroughts



Woodhouse et al., 2006: Upper Colorado River Basin Streamflow Reconstruction

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)

Slide Acknowledgement: Jay Lund

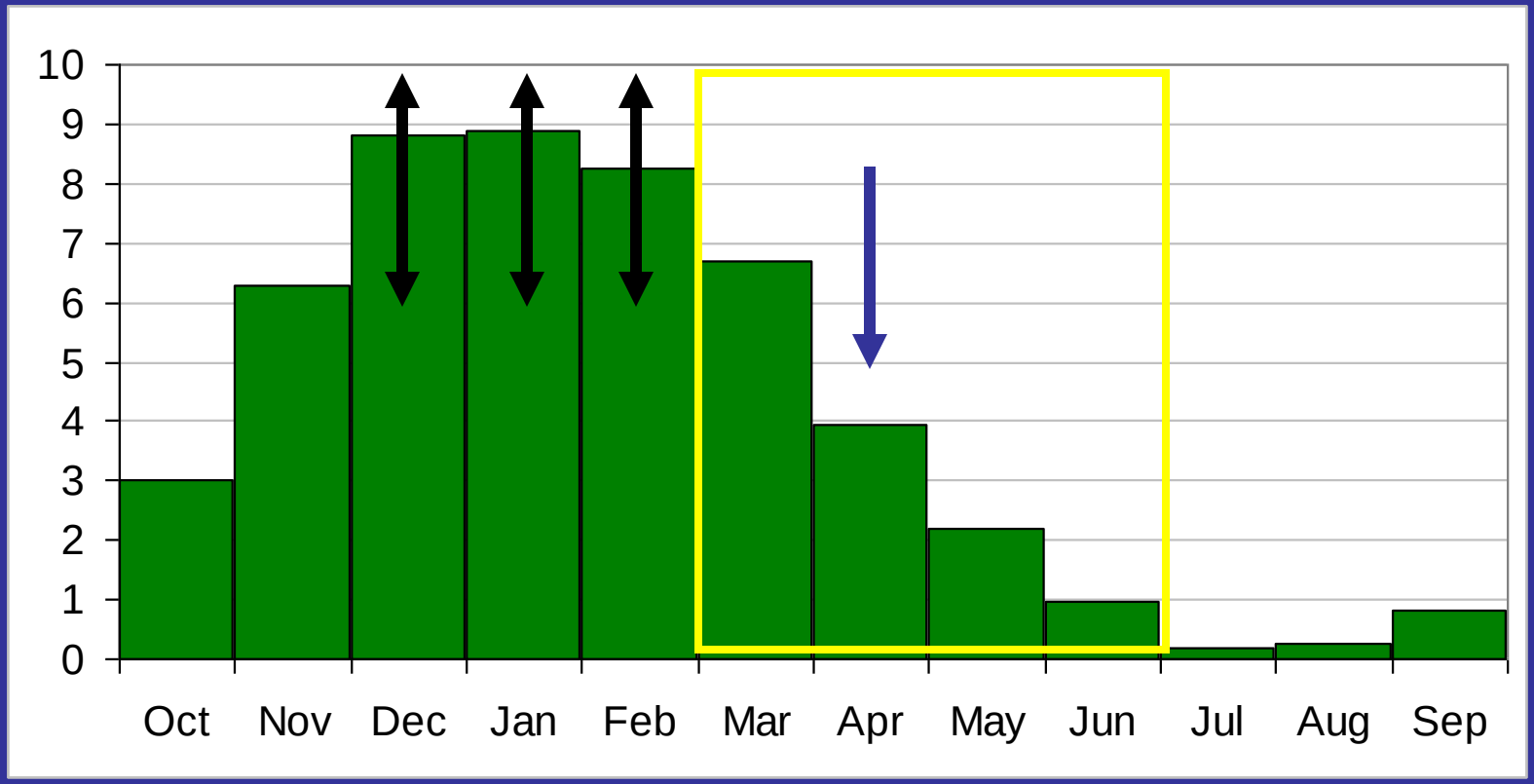
1921-1940 Sacramento Basin

- 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

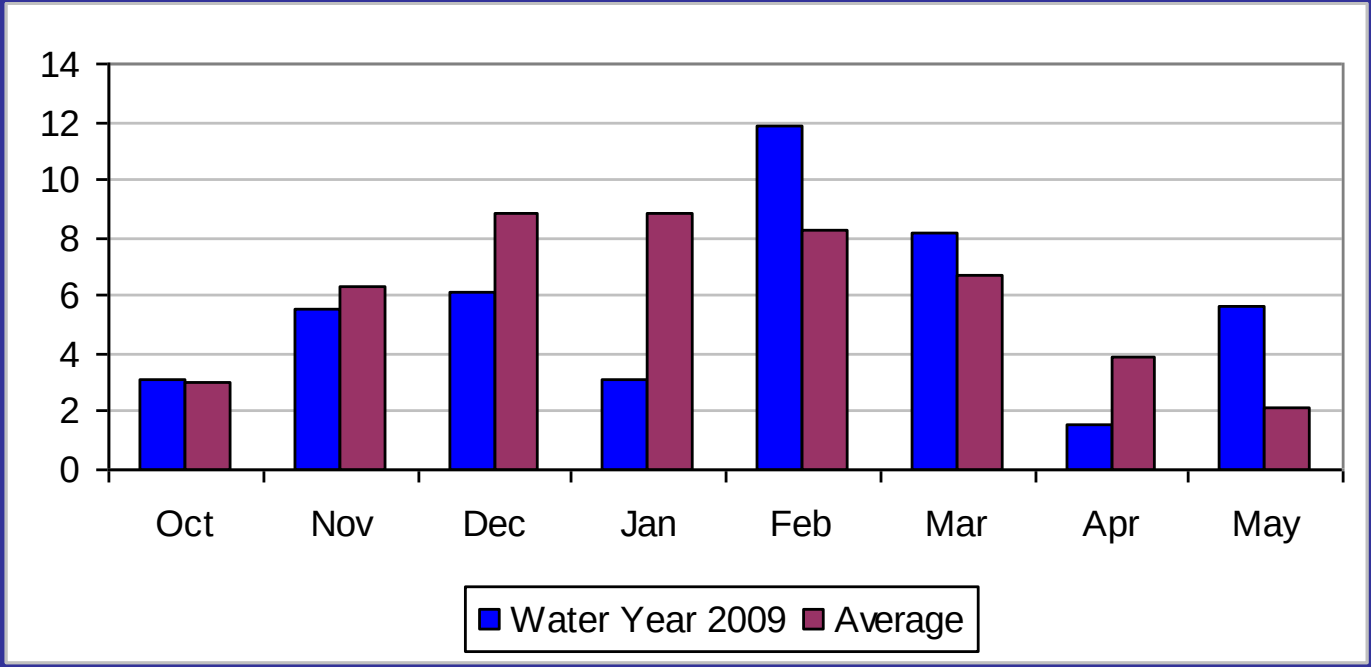
Climate Change Impacts

- 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

- 20th 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

- 20th 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.

Questions?

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