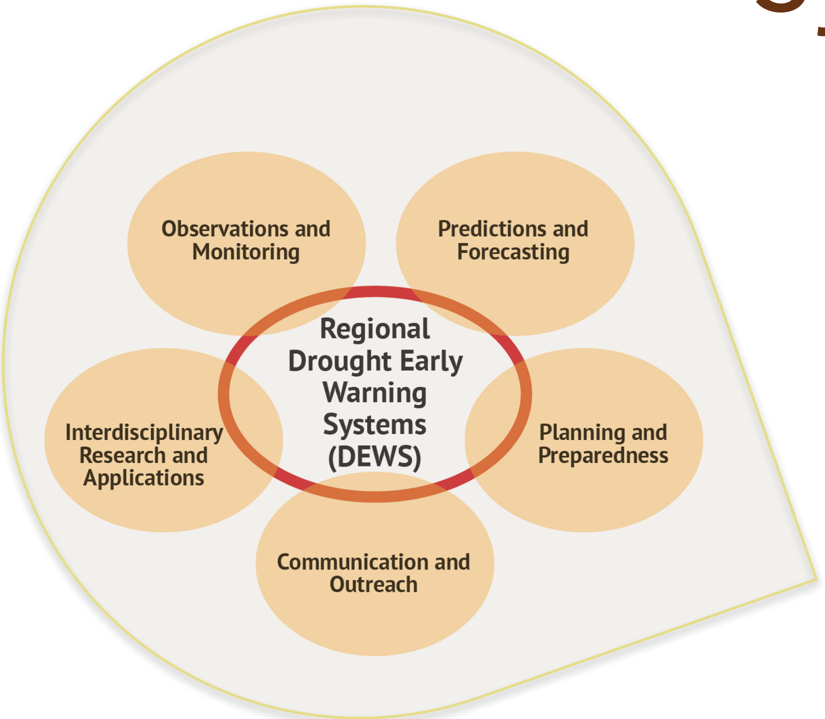
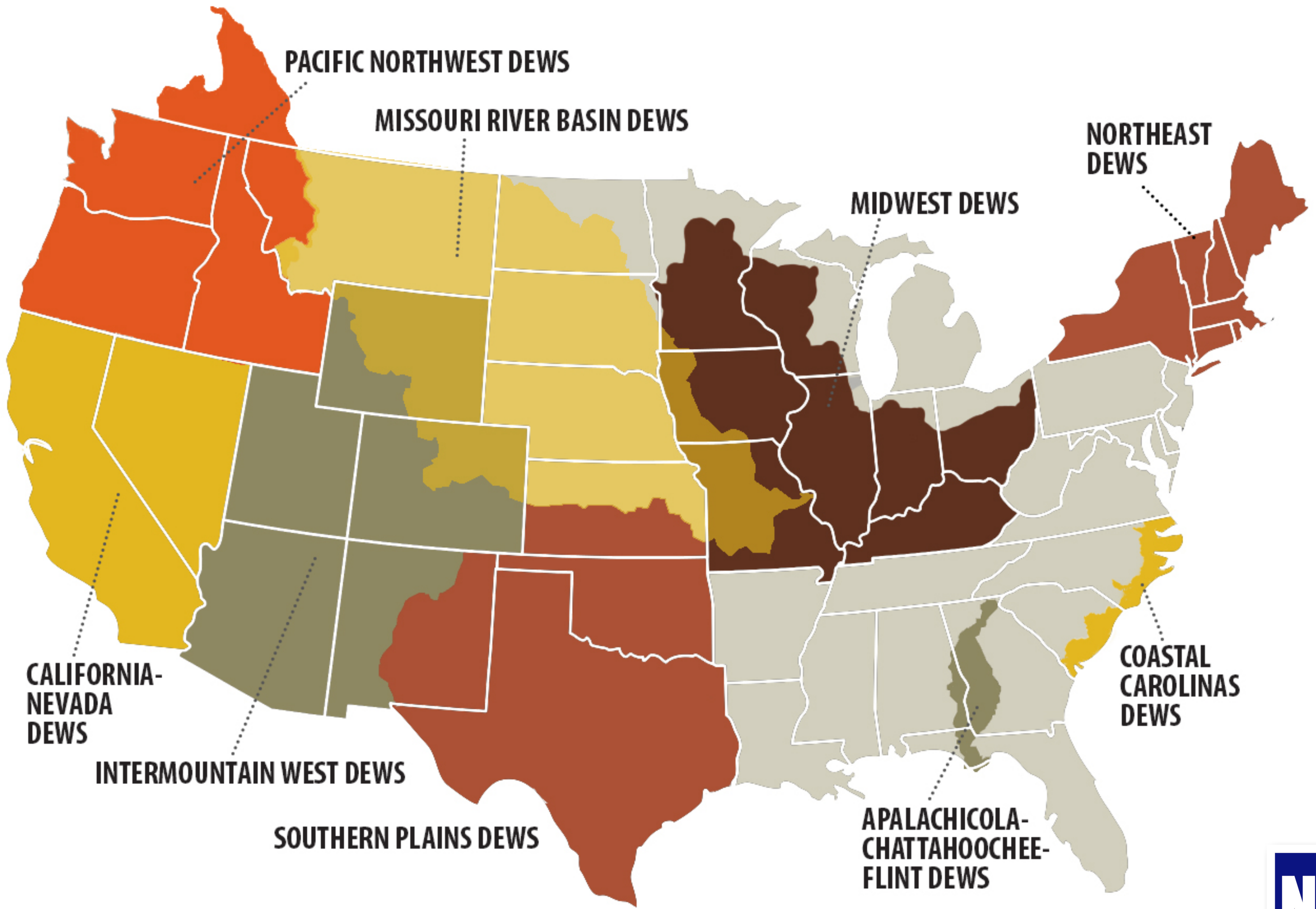
Recent & Future Drought in California: Implications for S2S Timescales within Multiyear Drought

Amanda M. Sheffield, PhD | NOAA/NIDIS

When the Rain Stops:
Drought on Subseasonal and Longer Timescales
Aspen, CO | September 11, 2018

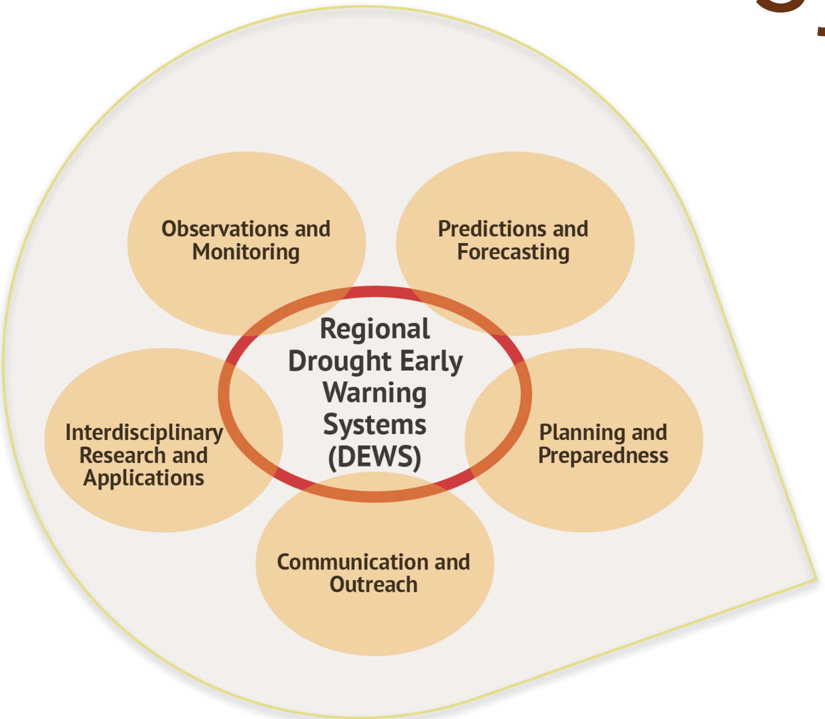
NIDIS Regional Drought Early Warning Systems (DEWS)

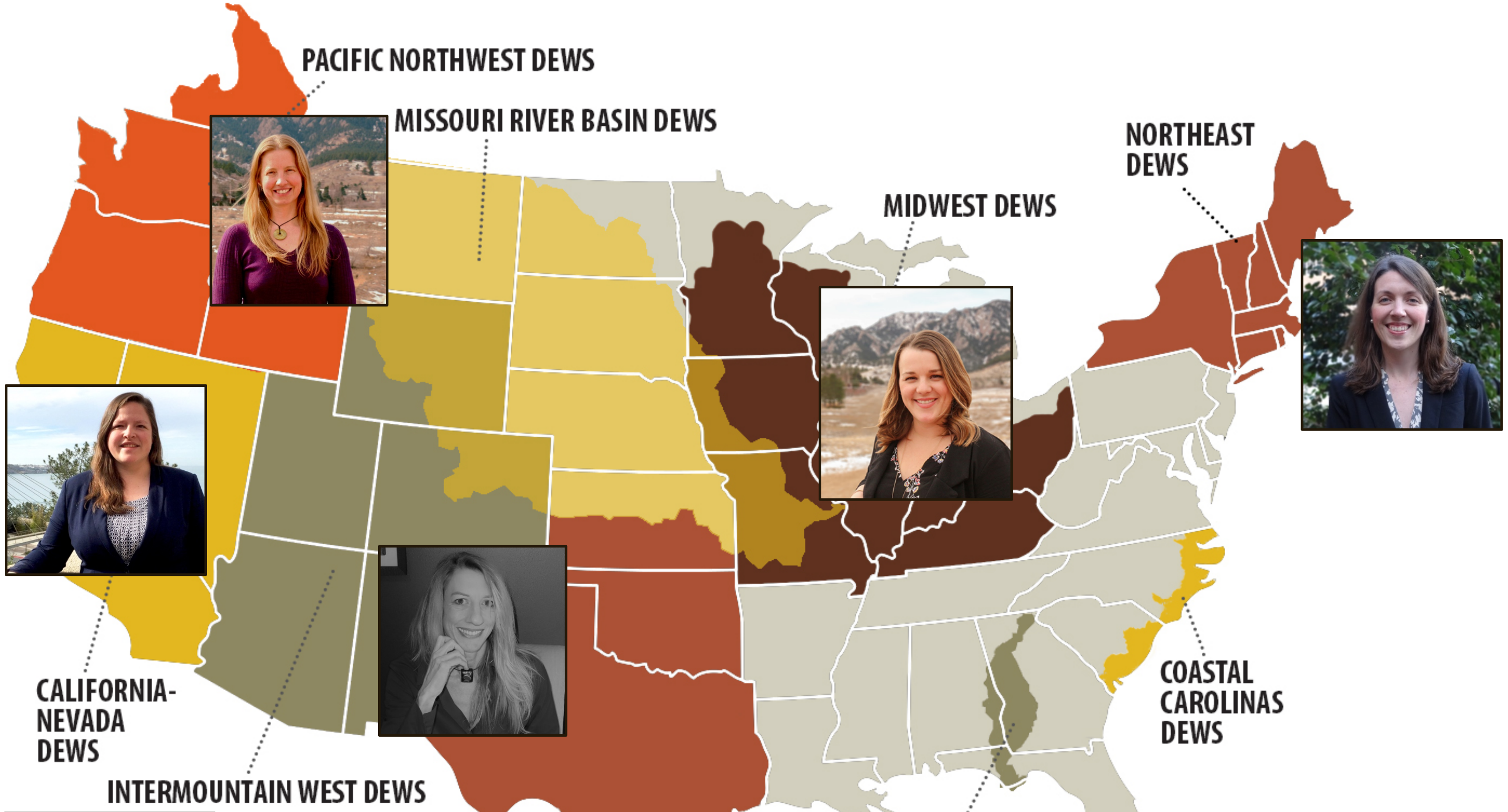




https://www.drought.gov/drought/what-nidis/who-we-are

NIDIS Regional Drought Early Warning Systems (DEWS)





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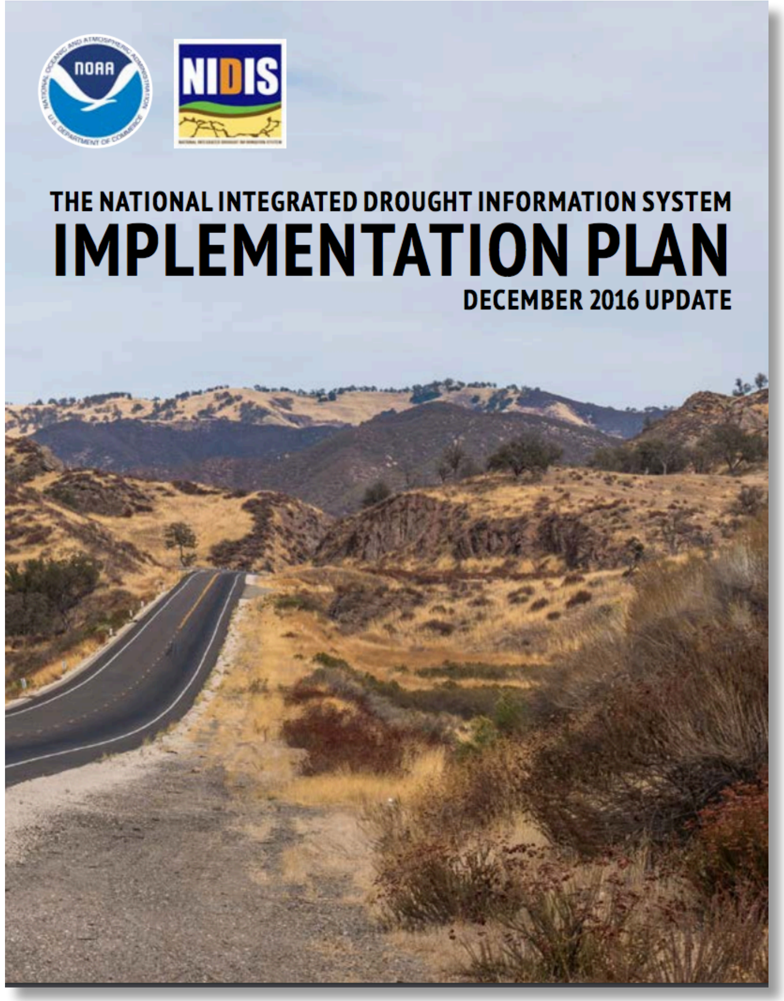
NIDIS Implementation Plan



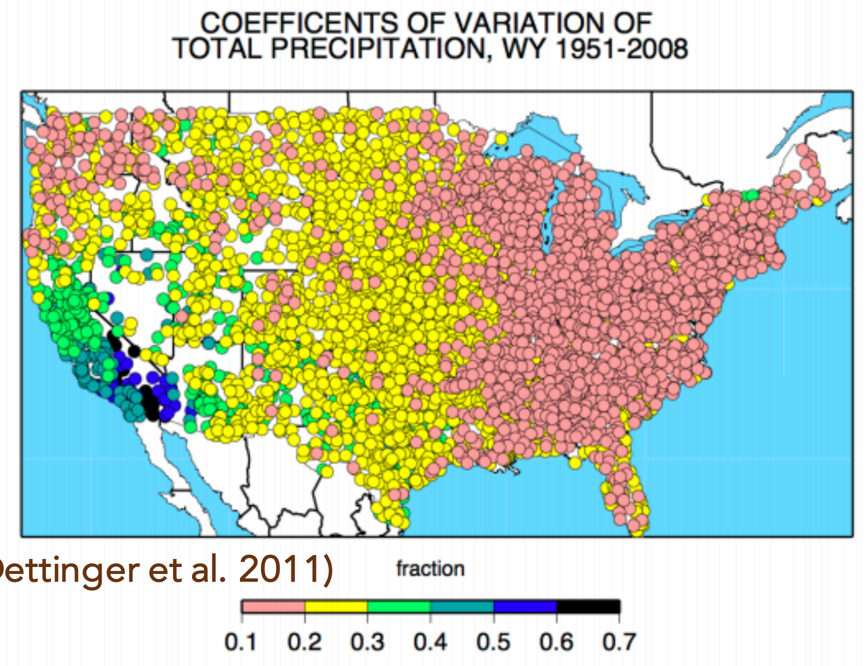
NIDIS Priorities for 2016-2020

This Implementation Plan identifies the following priorities, each of which is the result of consultation and information-sharing with relevant federal, tribal, regional, state, and local government agencies, research institutions, and the private sector.

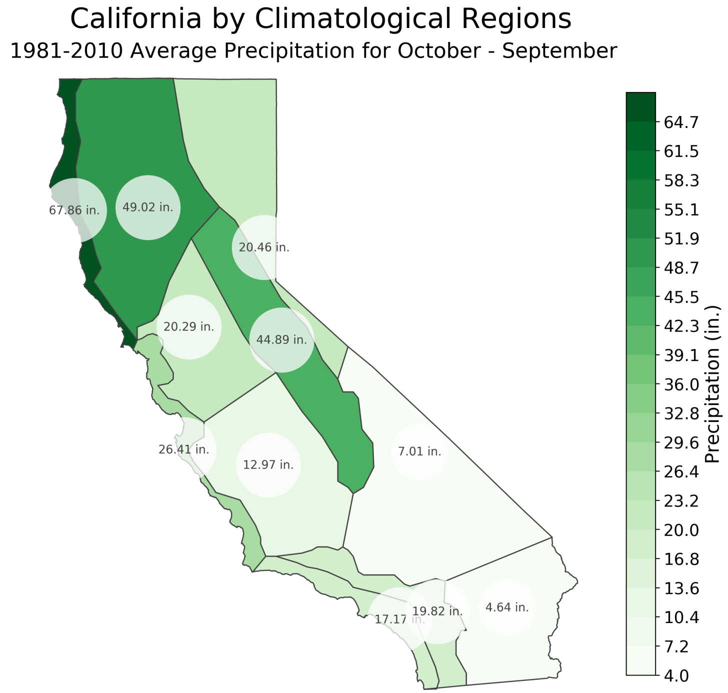
- **Improve the characterization and prediction of the onset, duration, and severity of drought across a variety of timescales**
- **Assess and respond to regionally-specific drought impacts, leveraging pre-existing networks and improving coordination**
- **Explore the role of extreme weather events in drought planning and risk management, and incorporate into drought early warning systems**
- **Strengthen National, tribal, regional, state, local, and international partnerships**
- **Expand the breadth of resources and accessibility of information available on the U.S. Drought Portal**

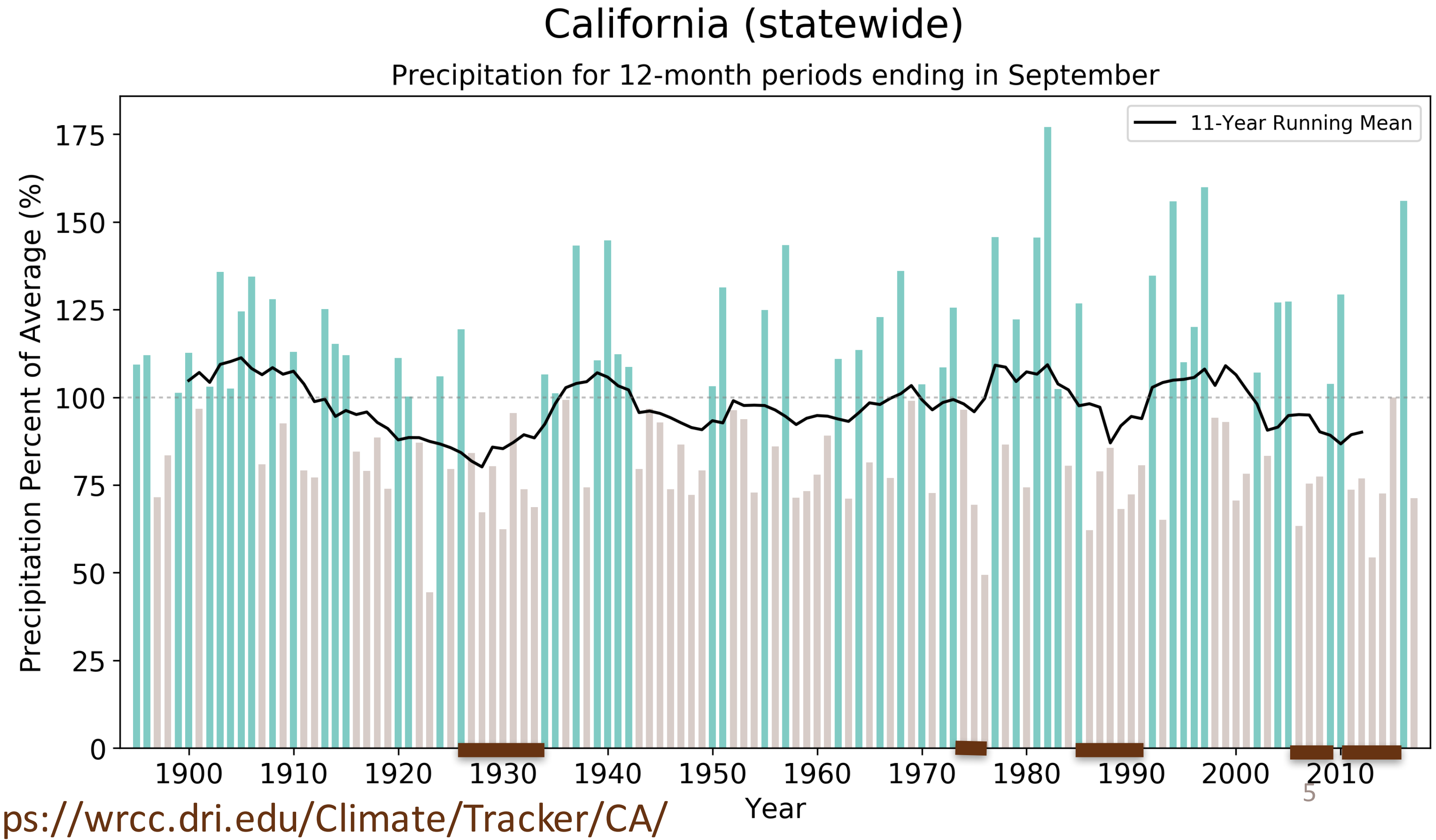
This Plan sets forth a process and approach for attaining the above priorities for the next phase of NIDIS.

California's History with Drought



(Dettinger et al. 2011)





https://wrcc.dri.edu/Climate/Tracker/CA/

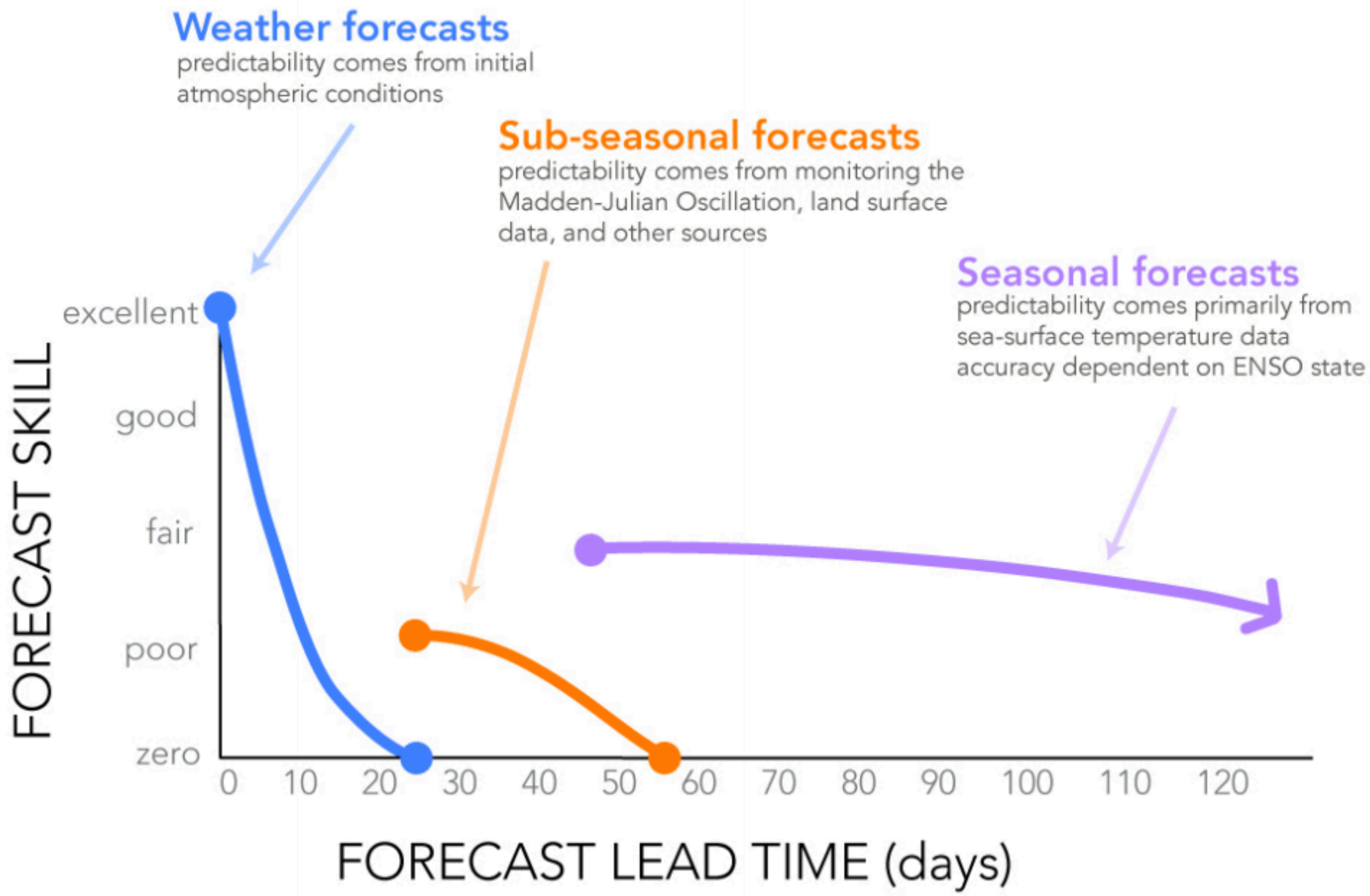
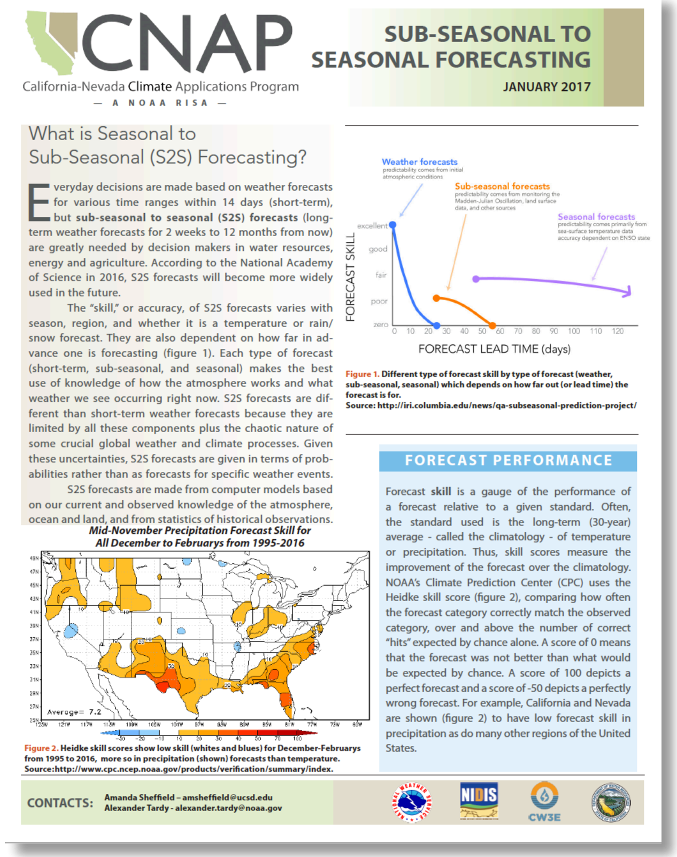


Figure 1. Different type of forecast skill by type of forecast (weather, sub-seasonal, seasonal) which depends on how far out (or lead time) the forecast is for.
Source: http://iri.columbia.edu/news/qa-subseasonal-prediction-project/



CNAP
California-Nevada Climate Applications Program
— A NOAA RISA —

SUB-SEASONAL TO SEASONAL FORECASTING
JANUARY 2017

What is Seasonal to Sub-Seasonal (S2S) Forecasting?

Everyday decisions are made based on weather forecasts for various time ranges within 14 days (short-term), but **sub-seasonal to seasonal (S2S) forecasts** (long-term weather forecasts for 2 weeks to 12 months from now) are greatly needed by decision makers in water resources, energy and agriculture. According to the National Academy of Science in 2016, S2S forecasts will become more widely used in the future.

The "skill," or accuracy, of S2S forecasts varies with season, region, and whether it is a temperature or rain/snow forecast. They are also dependent on how far in advance one is forecasting (figure 1). Each type of forecast (short-term, sub-seasonal, and seasonal) makes the best use of knowledge of how the atmosphere works and what weather we see occurring right now. S2S forecasts are different than short-term weather forecasts because they are limited by all these components plus the chaotic nature of some crucial global weather and climate processes. Given these uncertainties, S2S forecasts are given in terms of probabilities rather than as forecasts for specific weather events.

S2S forecasts are made from computer models based on our current and observed knowledge of the atmosphere, ocean and land, and from statistics of historical observations.

Mid-November Precipitation Forecast Skill for All December to Februarys from 1995-2016

Average= 7.2

Figure 2. Heidke skill scores show low skill (whites and blues) for December-Februarys from 1995 to 2016, more so in precipitation (shown) forecasts than temperature. Source:http://www.cpc.ncep.noaa.gov/products/verification/summary/index.

Figure 1. Different type of forecast skill by type of forecast (weather, sub-seasonal, seasonal) which depends on how far out (or lead time) the forecast is for. Source: http://iri.columbia.edu/news/qa-subseasonal-prediction-project/

FORECAST PERFORMANCE

Forecast **skill** is a gauge of the performance of a forecast relative to a given standard. Often, the standard used is the long-term (30-year) average - called the climatology - of temperature or precipitation. Thus, skill scores measure the improvement of the forecast over the climatology. NOAA's Climate Prediction Center (CPC) uses the Heidke skill score (figure 2), comparing how often the forecast category correctly match the observed category, over and above the number of correct "hits" expected by chance alone. A score of 0 means that the forecast was not better than what would be expected by chance. A score of 100 depicts a perfect forecast and a score of -50 depicts a perfectly wrong forecast. For example, California and Nevada are shown (figure 2) to have low forecast skill in precipitation as do many other regions of the United States.

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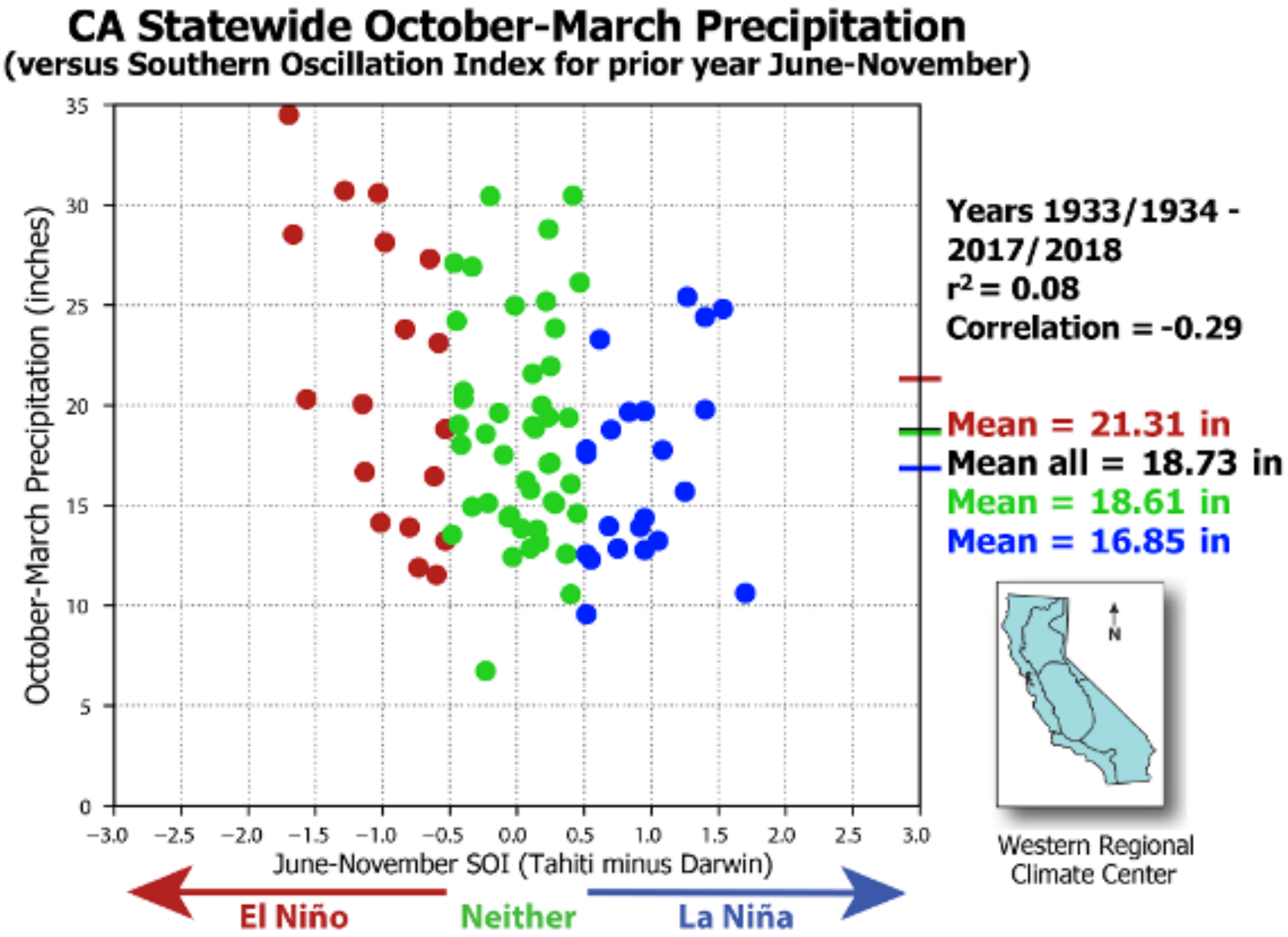
Alexander Tardy - alexander.tardy@noaa.gov



https://wrcc.dri.edu/Climate/soi_precip.php

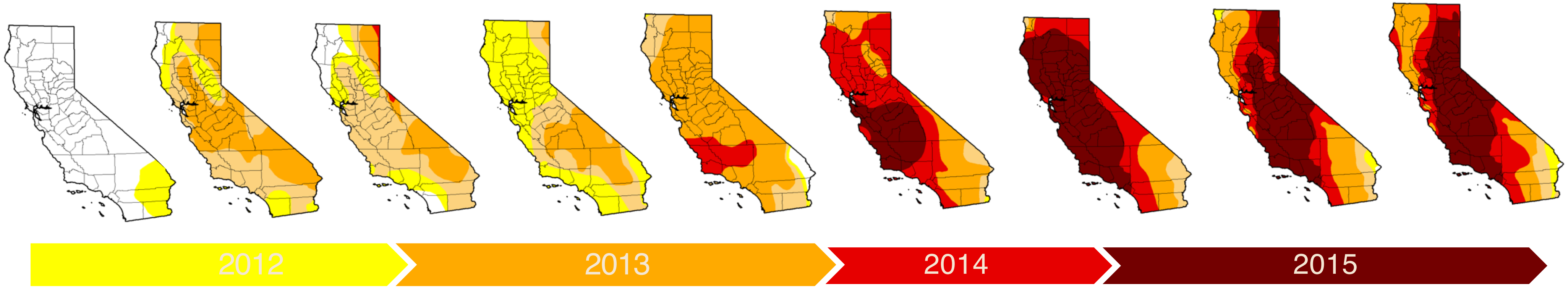
MAPP Modeling, Analysis, Predictions, and Projections | NIDIS

A Story Map

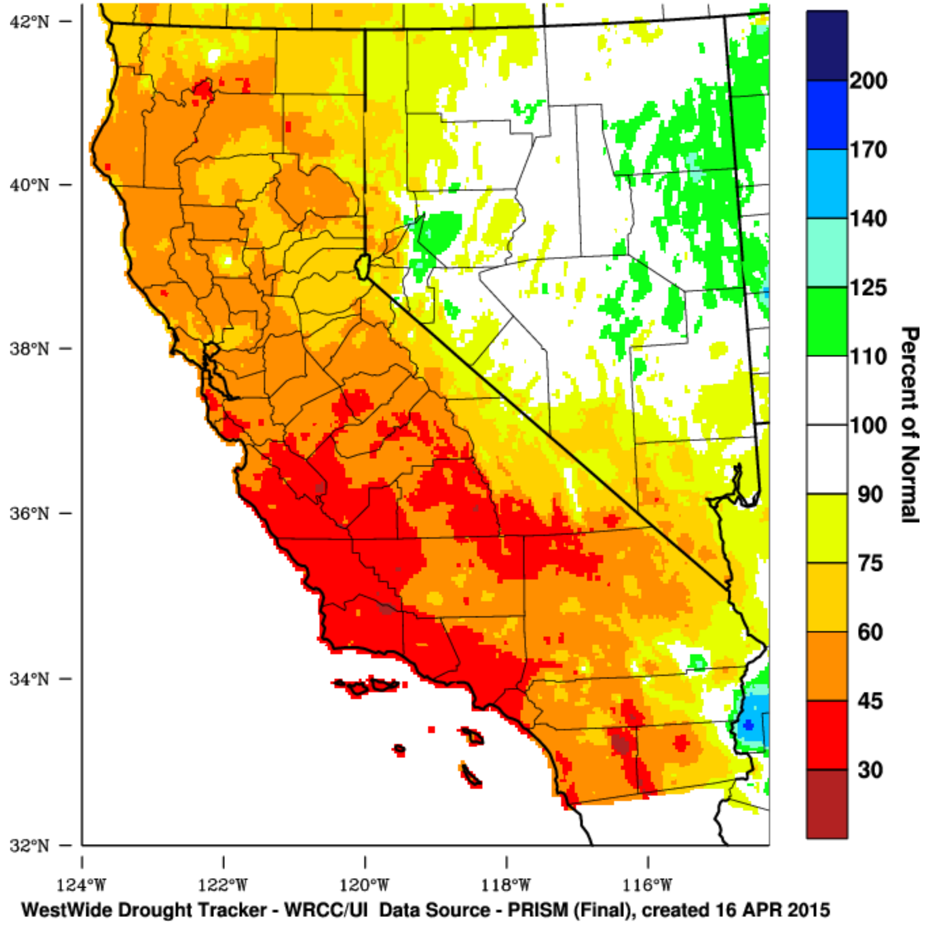
California Drought: 2011-2017

A story about the historic drought.

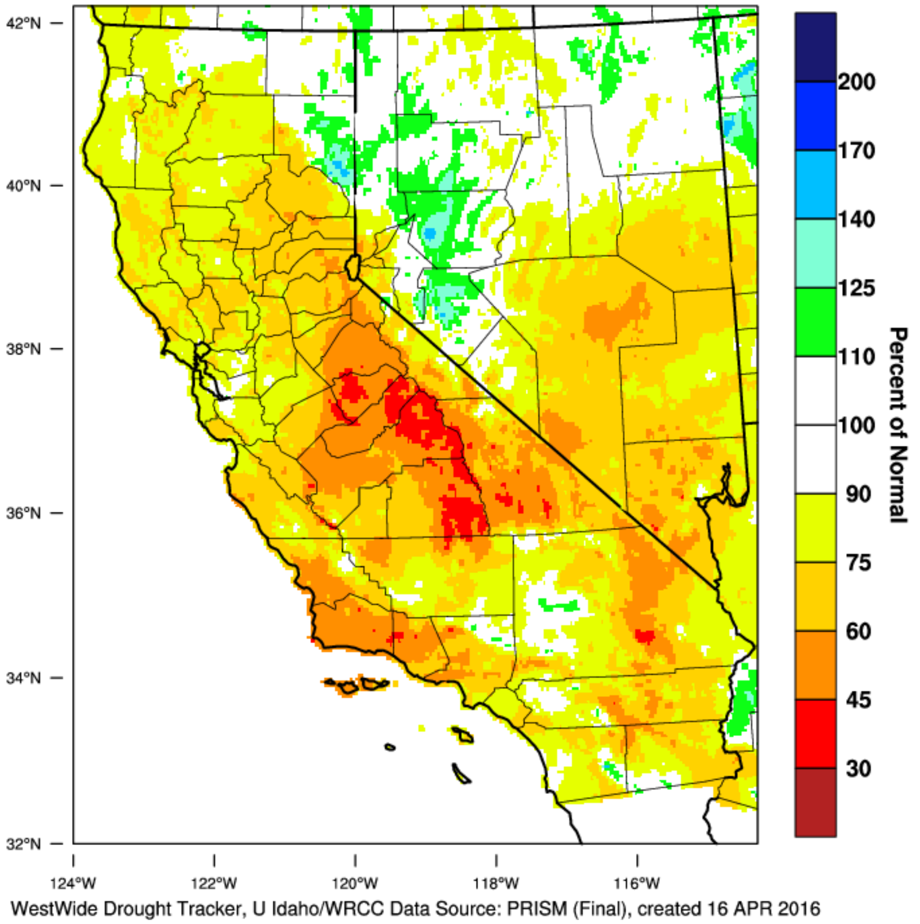
https://www.drought.gov/drought/california-no-stranger-dry-conditions-drought-2011-2017-was-exceptional

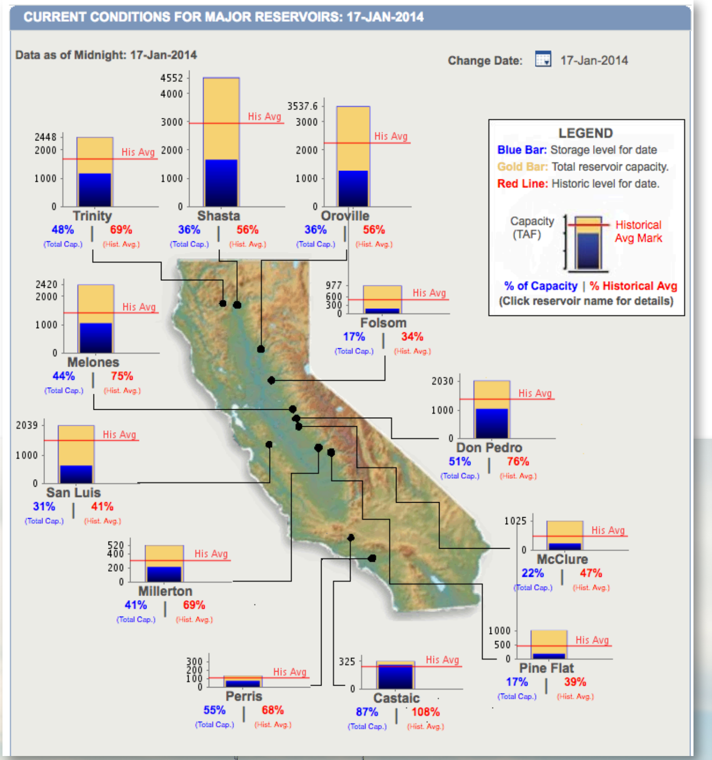


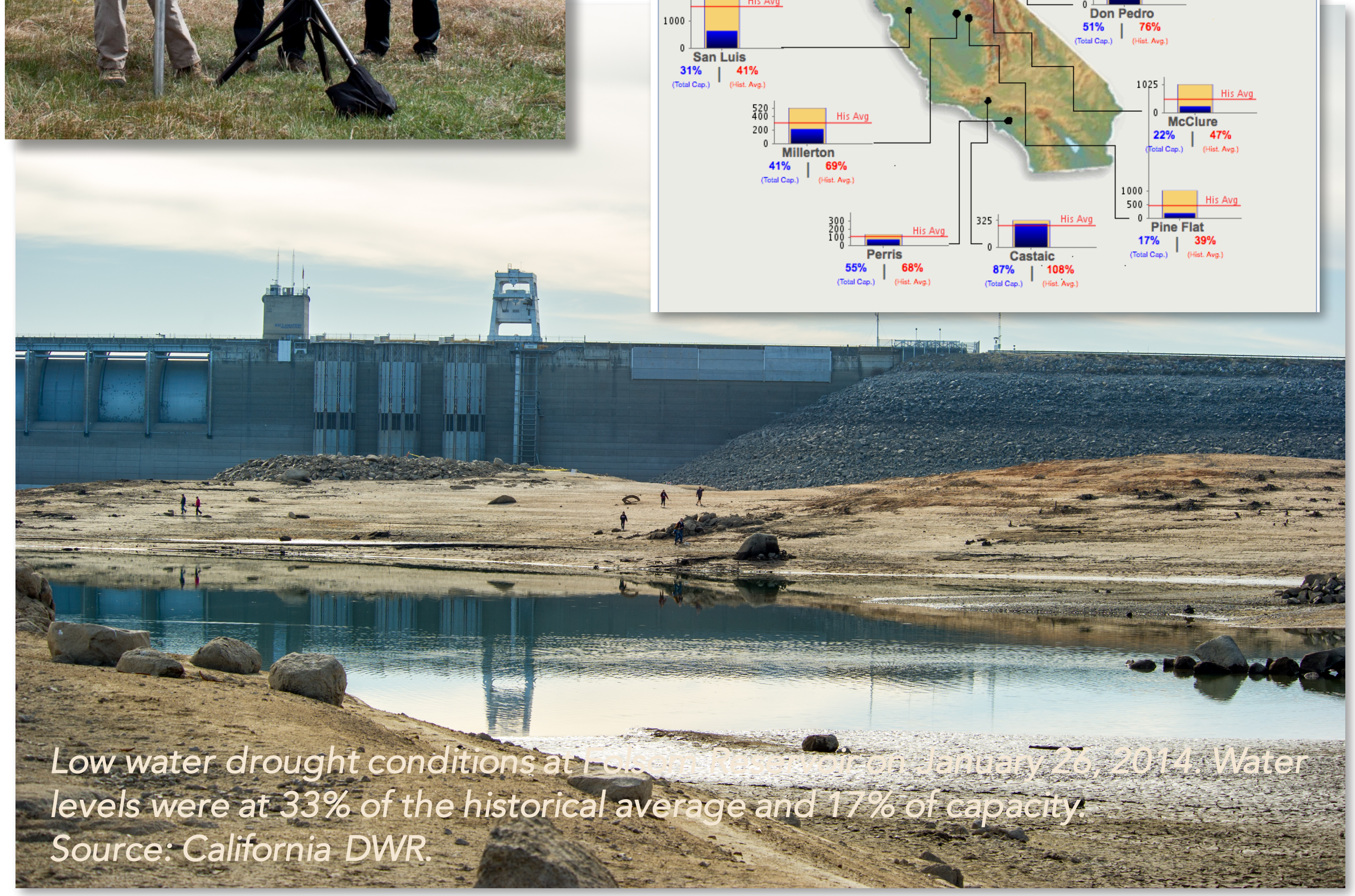
Water Year **2014**
Precipitation Percent of 1981 – 2010 Normal



Water Year **2015**
Precipitation Percent of 1981 – 2010 Normal



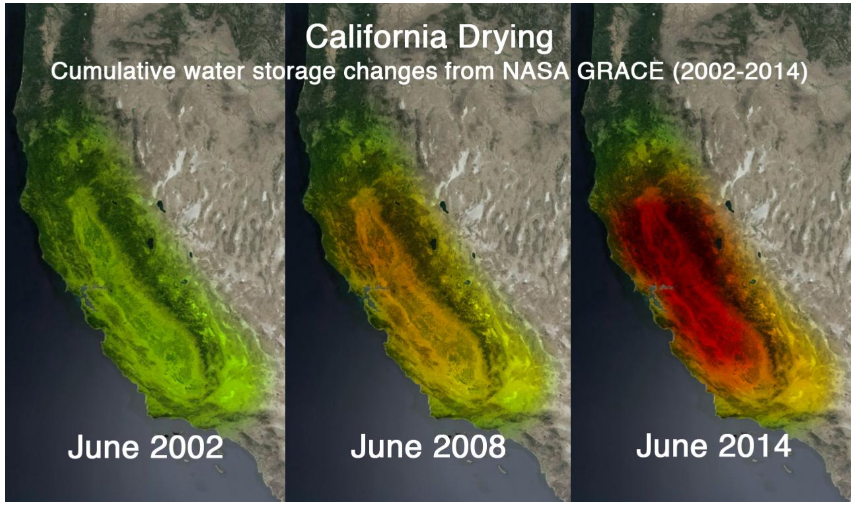




Low water drought conditions at Folsom Reservoir on January 28, 2014. Water levels were at 33% of the historical average and 17% of capacity. Source: California DWR.

Governor Brown Declares Drought State of Emergency January 17, 2014

Governor Brown Issues Executive Order to Redouble State Drought Actions April 25, 2014



Middle of Drought

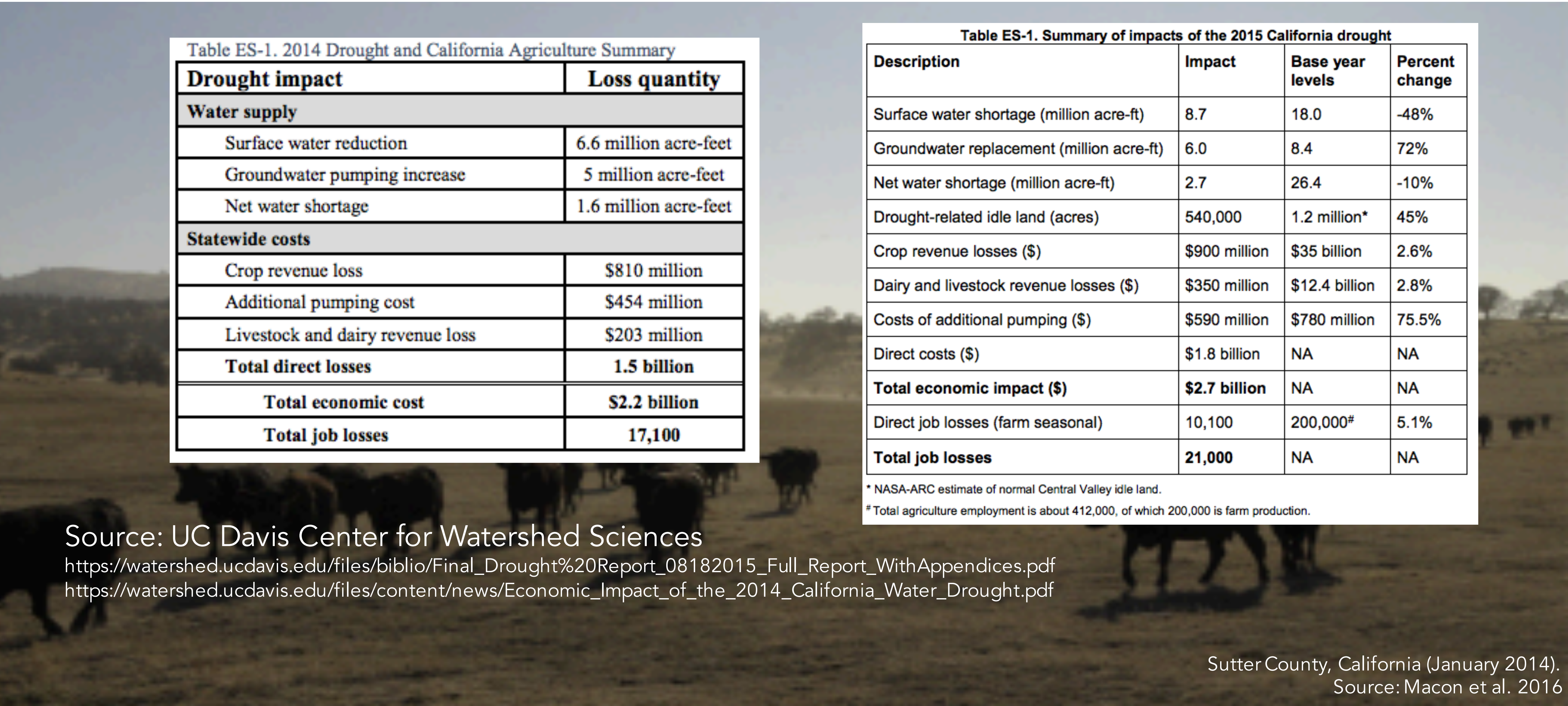


Table ES-1. 2014 Drought and California Agriculture Summary

Drought impact	Loss quantity
Water supply	
Surface water reduction	6.6 million acre-feet
Groundwater pumping increase	5 million acre-feet
Net water shortage	1.6 million acre-feet
Statewide costs	
Crop revenue loss	$810 million
Additional pumping cost	$454 million
Livestock and dairy revenue loss	$203 million
Total direct losses	**1.5 billion**
Total economic cost	**$2.2 billion**
Total job losses	**17,100**

Table ES-1. Summary of impacts of the 2015 California drought

Description	Impact	Base year levels	Percent change
Surface water shortage (million acre-ft)	8.7	18.0	-48%
Groundwater replacement (million acre-ft)	6.0	8.4	72%
Net water shortage (million acre-ft)	2.7	26.4	-10%
Drought-related idle land (acres)	540,000	1.2 million*	45%
Crop revenue losses ($)	$900 million	$35 billion	2.6%
Dairy and livestock revenue losses ($)	$350 million	$12.4 billion	2.8%
Costs of additional pumping ($)	$590 million	$780 million	75.5%
Direct costs ($)	$1.8 billion	NA	NA
Total economic impact ($)	**$2.7 billion**	NA	NA
Direct job losses (farm seasonal)	10,100	200,000#	5.1%
Total job losses	**21,000**	NA	NA

* NASA-ARC estimate of normal Central Valley idle land.

\# Total agriculture employment is about 412,000, of which 200,000 is farm production.

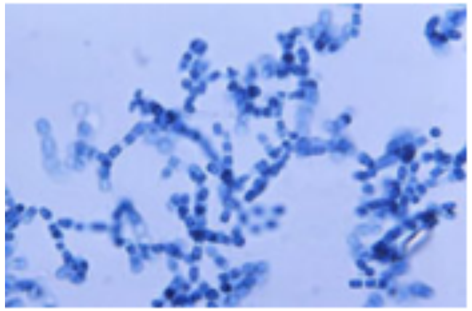
Source: UC Davis Center for Watershed Sciences

https://watershed.ucdavis.edu/files/biblio/Final_Drought%20Report_08182015_Full_Report_WithAppendices.pdf

https://watershed.ucdavis.edu/files/content/news/Economic_Impact_of_the_2014_California_Water_Drought.pdf

Sutter County, California (January 2014).
Source: Macon et al. 2016

Middle of Drought



Photomicrograph showing arthroconidia of *Coccidioides* (Valley Fever) (environmental form)

<u>Community Assessment for Public Health Emergency Response (CASPER) addressing the California Drought</u>

Tulare County, Mariposa County October 2015

"Extent of health effects associated with this natural disaster depends not only on the drought severity and duration, but also on the **underlying population vulnerability and resources** available to mitigated the effects as they occur."

(quality/quantity of potable water, diminished living conditions, adverse mental and behavioral outcomes, increased disease incidence, including infectious diseases, job loss/poverty)

Figure 1. Tulare County CASPER sampling frames for the North Tulare and the South Tulare CASPERs.

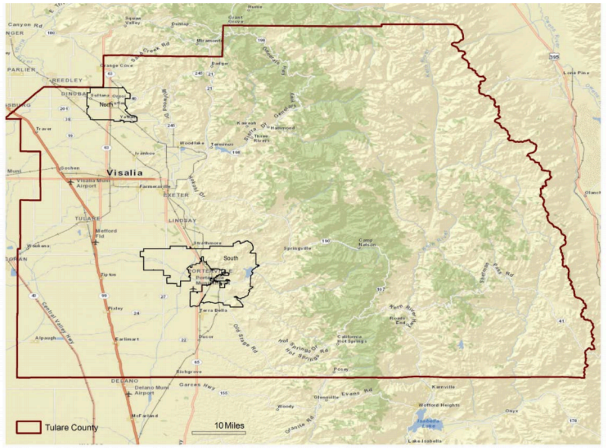
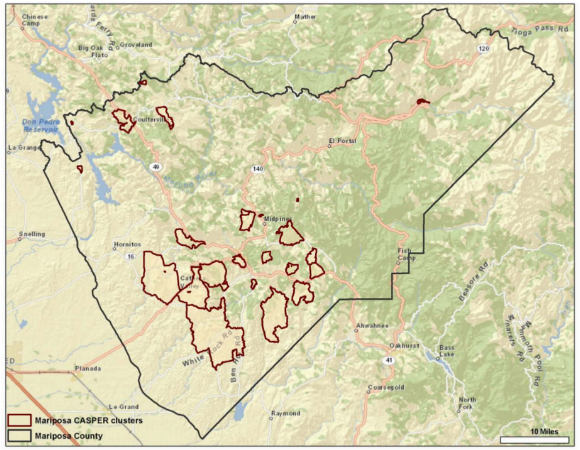


Figure 1. Mariposa County CASPER sampling frame.



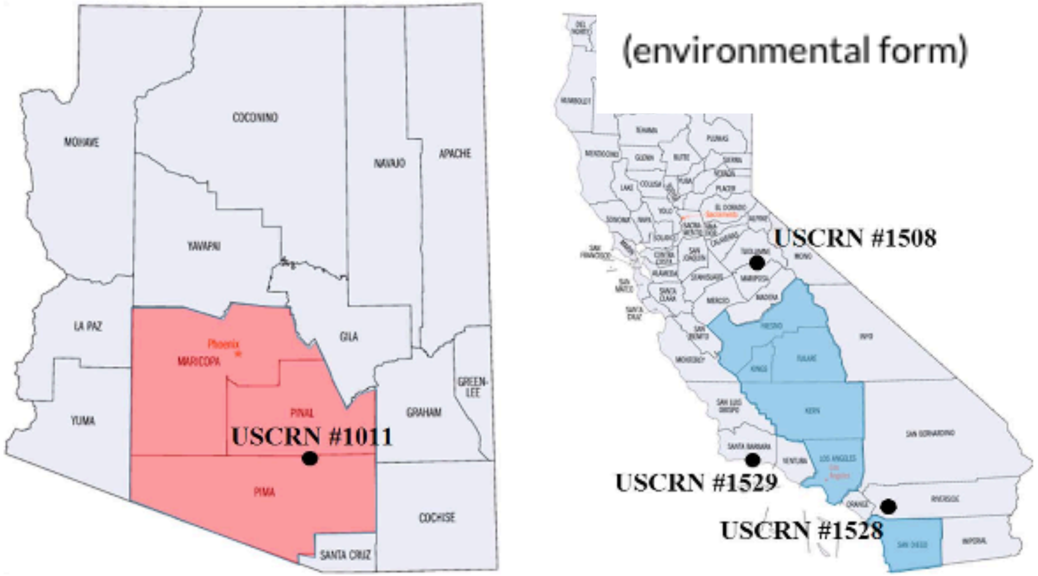
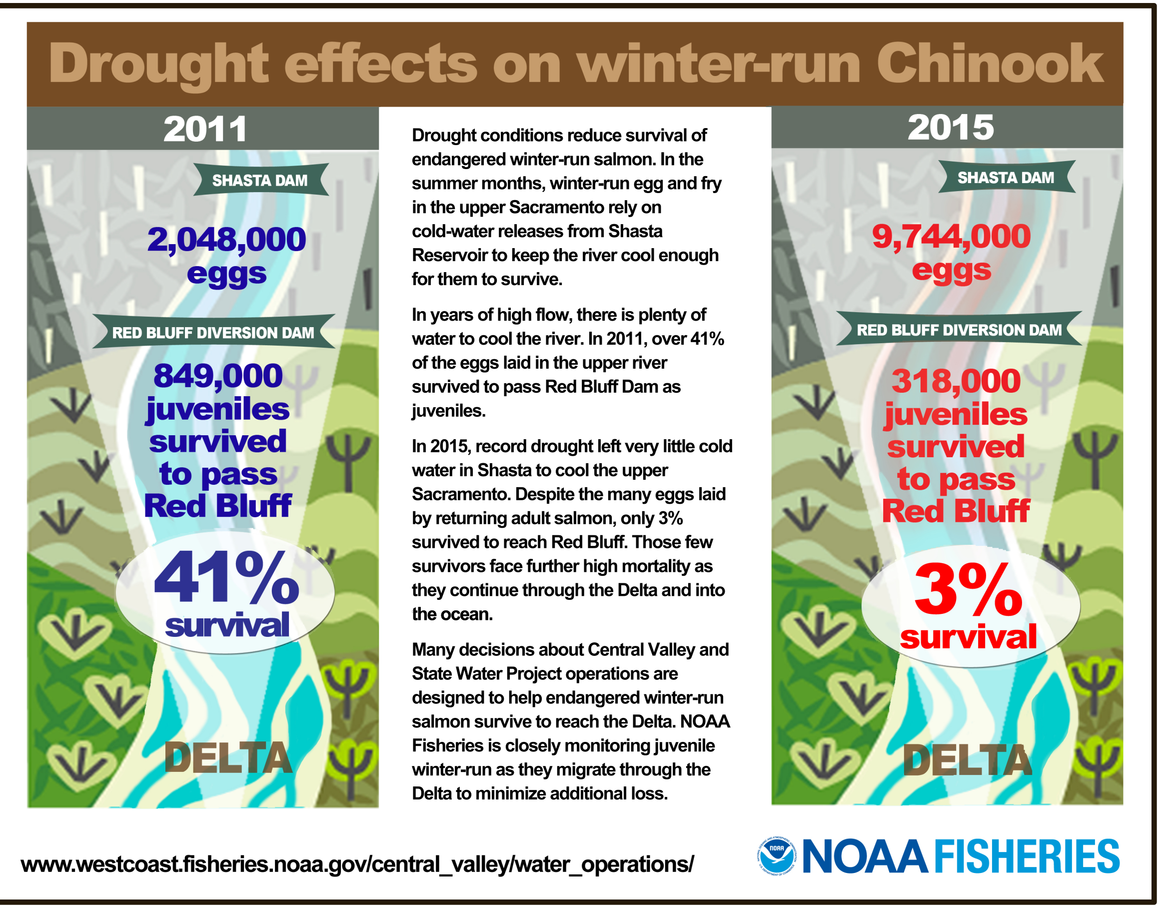
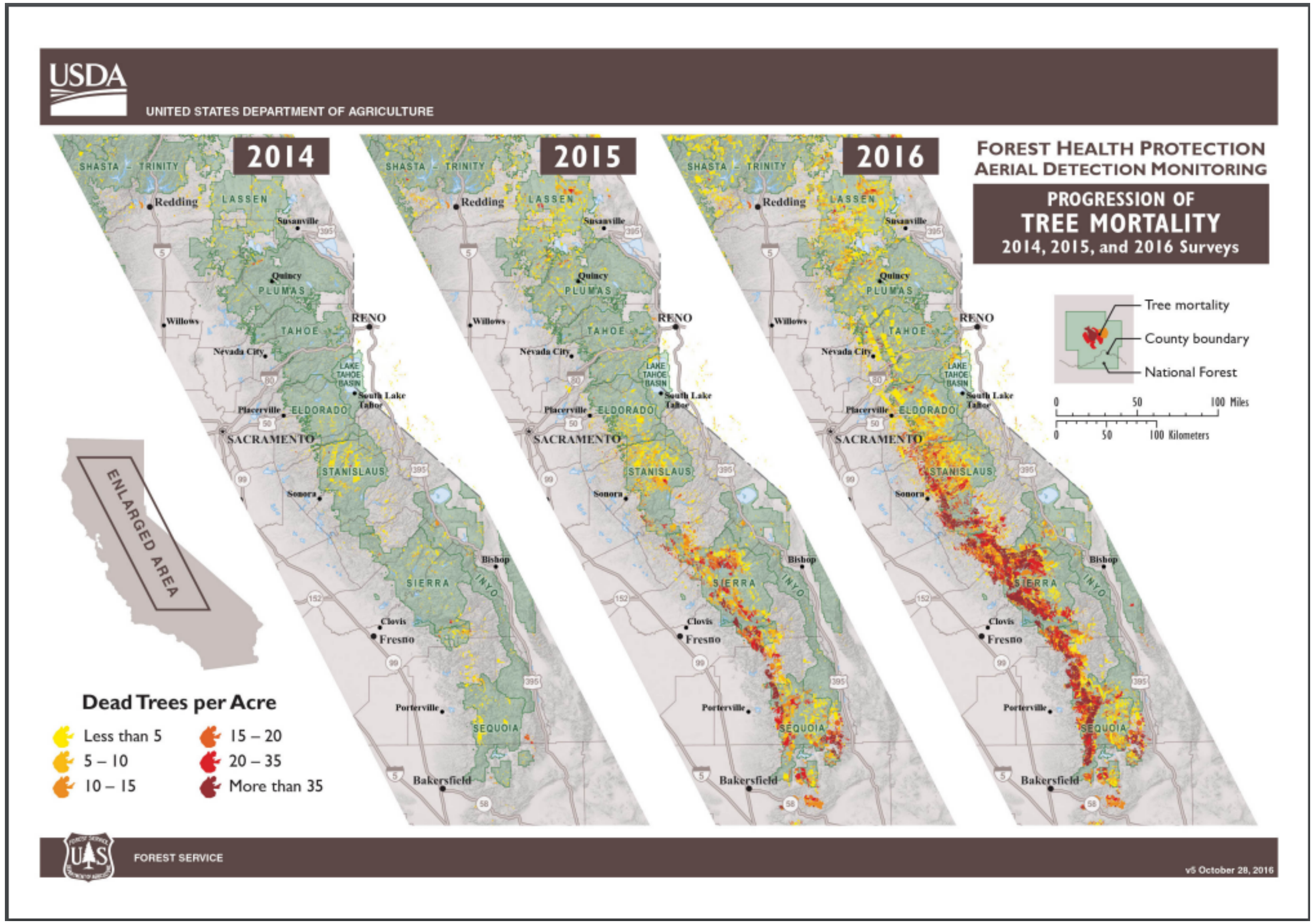


Figure 1. (U.S. Climate Reference Network) USCRN soil moisture gauges within county maps of (left) Arizona and (right) California. Counties with sufficient reported coccidioidomycosis cases in Arizona and California are shaded red and blue.

Source: https://www.cdc.gov/nceh/hsb/disaster/casper/states/ca.htm

Coopersmith et al. 2017



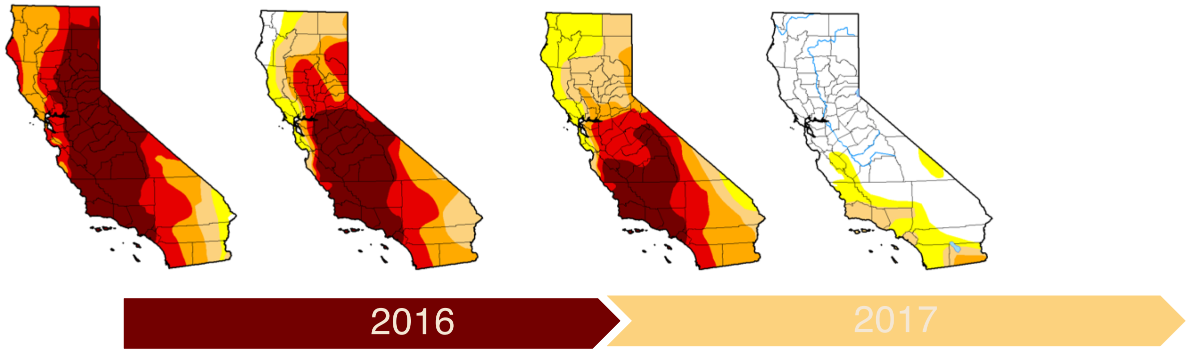


2010-2017: 129 million dead trees

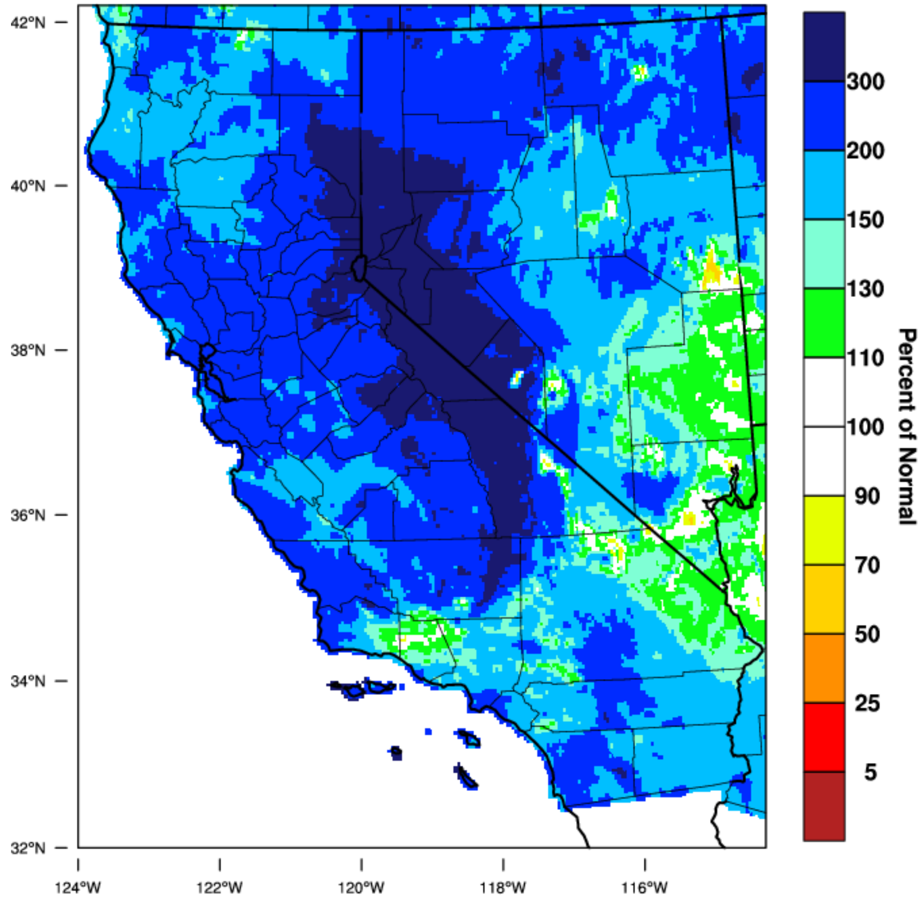

WILDFIRE AND DROUGHT:
IMPACTS ON WILDFIRE PLANNING, BEHAVIOR, AND EFFECTS
NIDIS
CNA
CALIFORNIA DROUGHT
2014 SERVICE ASS
ASSESSMENT REPORT
Causes and Predictability of the 2011-14 California Drought
RICHARD SEAGER
Lamont Doherty Earth Observatory of Columbia University
MARTIN HOERLING
NOAA Earth System Research Laboratory
SIEGFRIED SCHUBERT
HAILAN WANG
NASA Goddard Space Flight Center
BRADFIELD LYON,
International Research Institute for Climate and Society
ARUN KUMAR
NOAA Climate Prediction Center
JENNIFER NAKAMURA
NAOMI HENDERSON
Lamont Doherty Earth Observatory of Columbia University


NEVADA DROUGHT FORUM

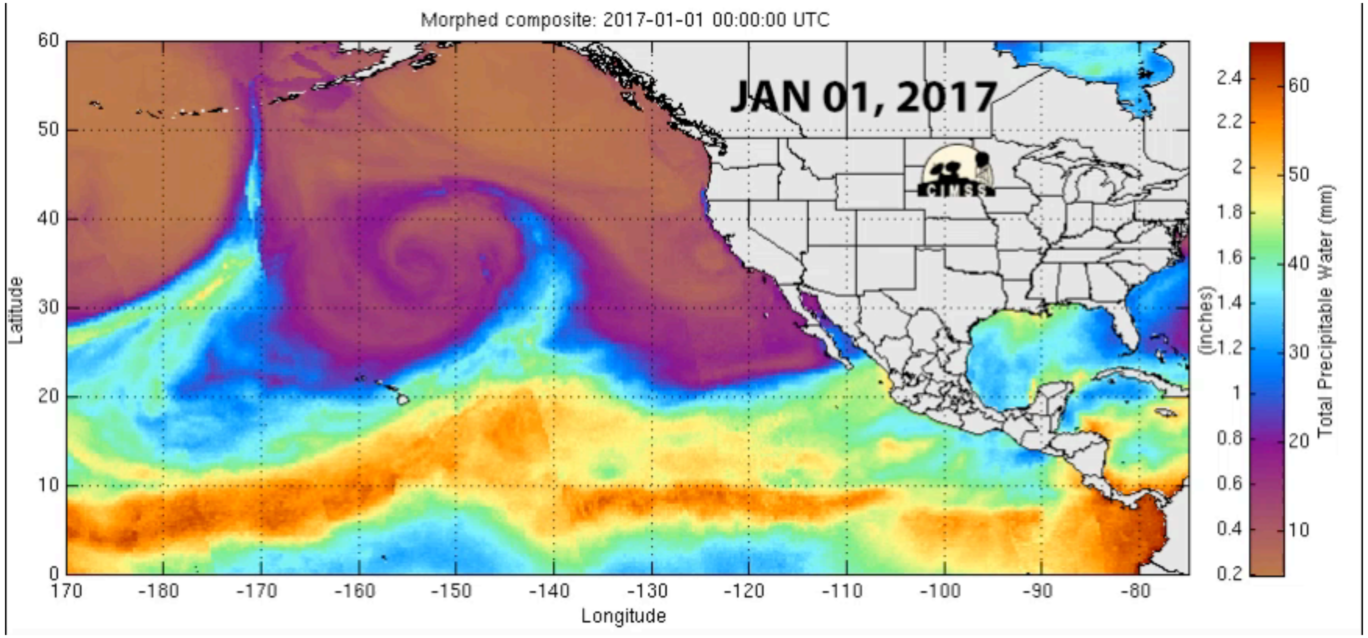
Flooding During Drought



January-February **2017**
Precipitation Percent of 1981 – 2010 Normal



WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Final), created 16 SEP 2017

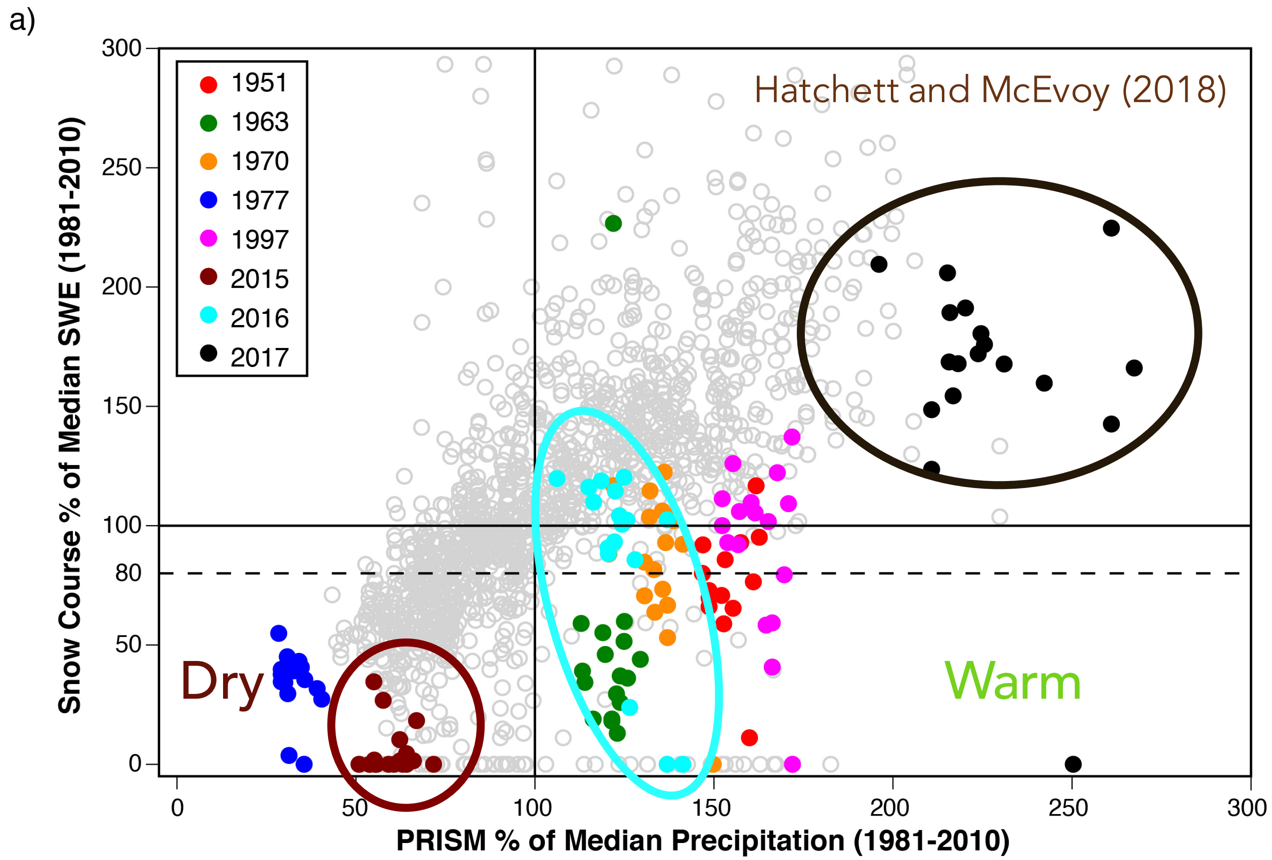


April 7, 2017: Governor Jerry Brown lifted the statewide proclamation of emergency due to drought, but kept in place state-designated conditions of emergency for certain Central California counties still experiencing drought impacts.

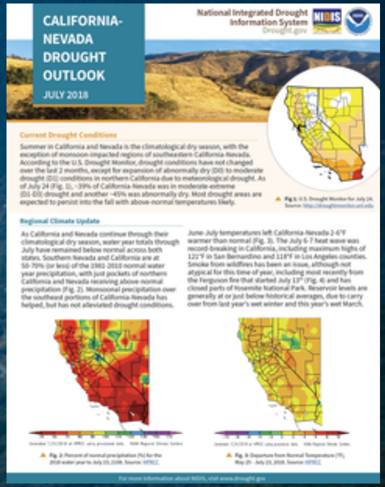
Defining Snow Drought

Dry snow drought:
Below average precipitation,
below average snow water equivalent

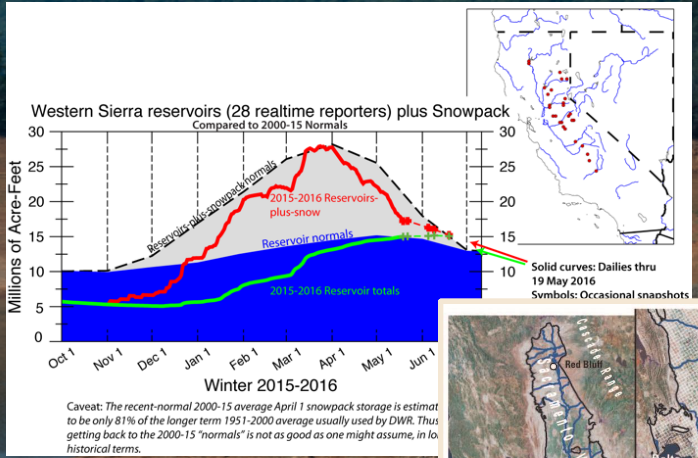
Warm snow drought:
Above average precipitation,
below average snow water equivalent



THE CALIFORNIA-NEVADA DROUGHT EARLY WARNING SYSTEM



The CA-NV DEWS utilizes new and existing partner networks to optimize the expertise of partners in order to make climate and drought science readily available, easily understandable and usable for decision makers; and to improve the capacity of stakeholders to better monitor, forecast, plan for and cope with the impacts of drought.



- *Optimize the collaborative DEWS network*
- *Development of Drought Monitoring Metrics & Research*
- *Develop Forecast & Decision Support Tools for Resource Managers*
- *Improve Drought Early Warning Communication & Outreach*

https://drought.gov/drought/dews/california-nevada

Climate Engine

Source: CA DWR

Climate Engine

Drought Monitoring

Agriculture & Ecosystems

Wildfire

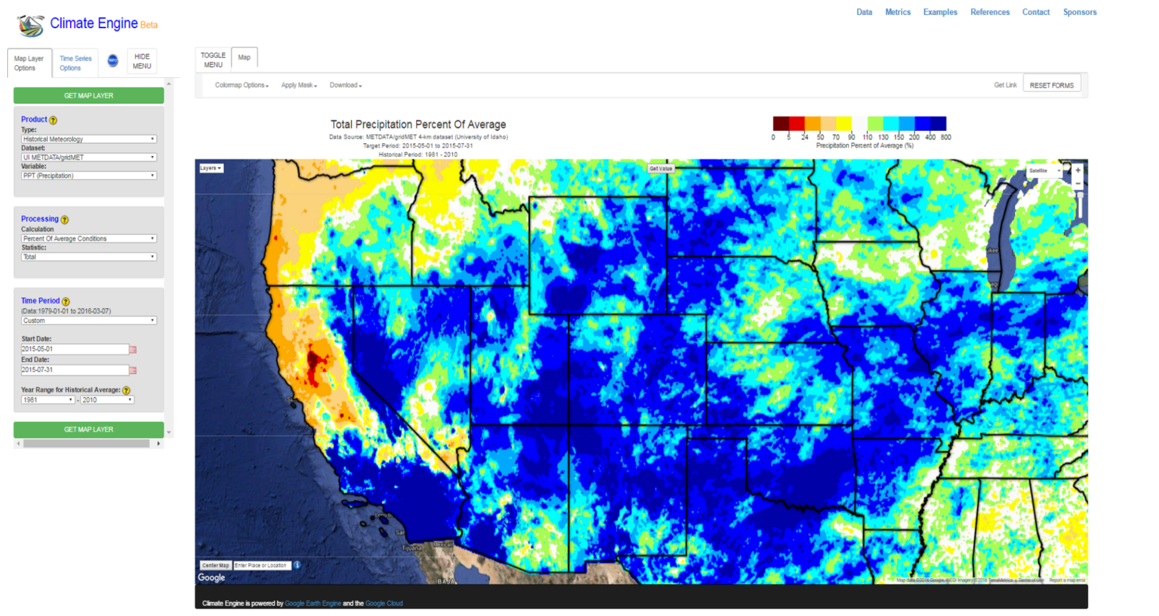
University of Idaho

DRI Desert Research Institute

Google

2015 West Coast Drought and West - Central U.S. Wet Summer

METDATA percent of average precipitation, illustrating anomalously low May - July precipitation in California, and high precipitation over the intermountain and central U.S.



NIDIS

Landsat Program

NASA Earth Science

U.S. Department of the Interior Bureau of Land Management

FEWS NET Famine Early Warning Systems Network

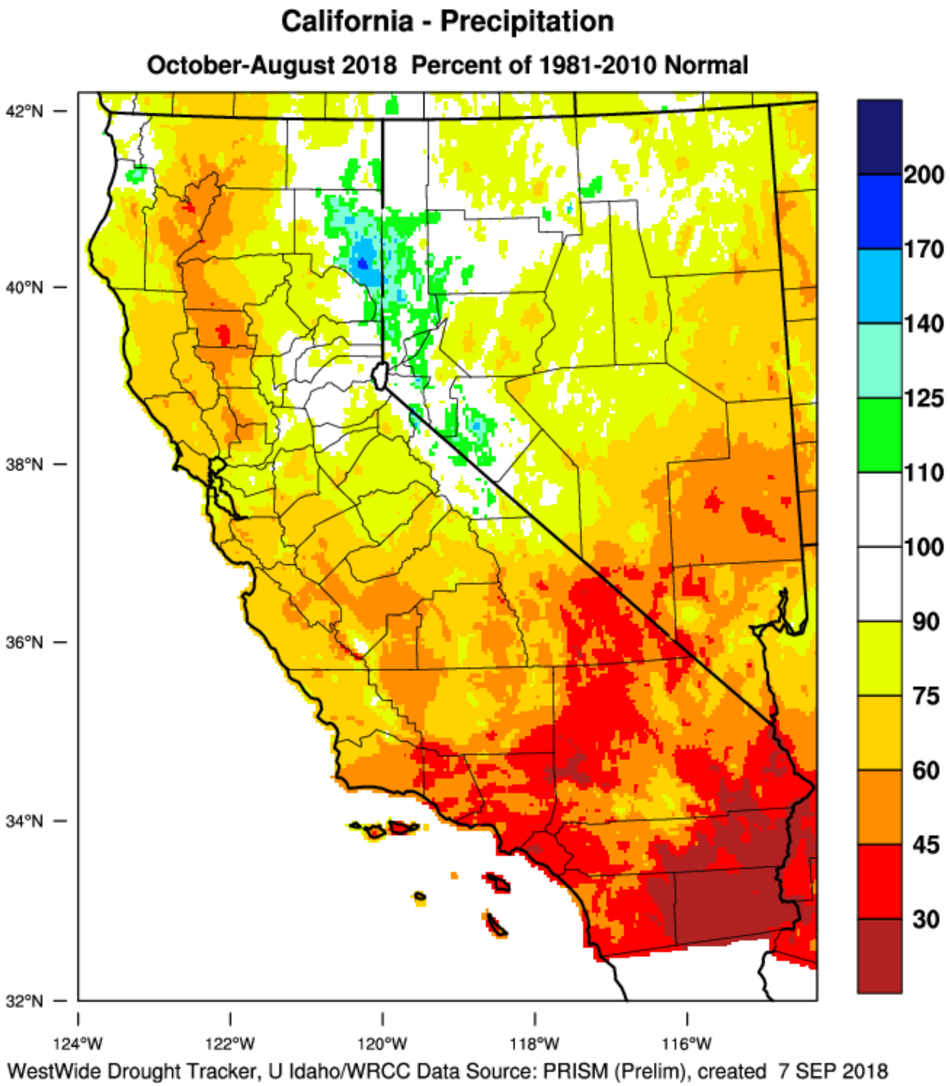
USGS science for a changing world

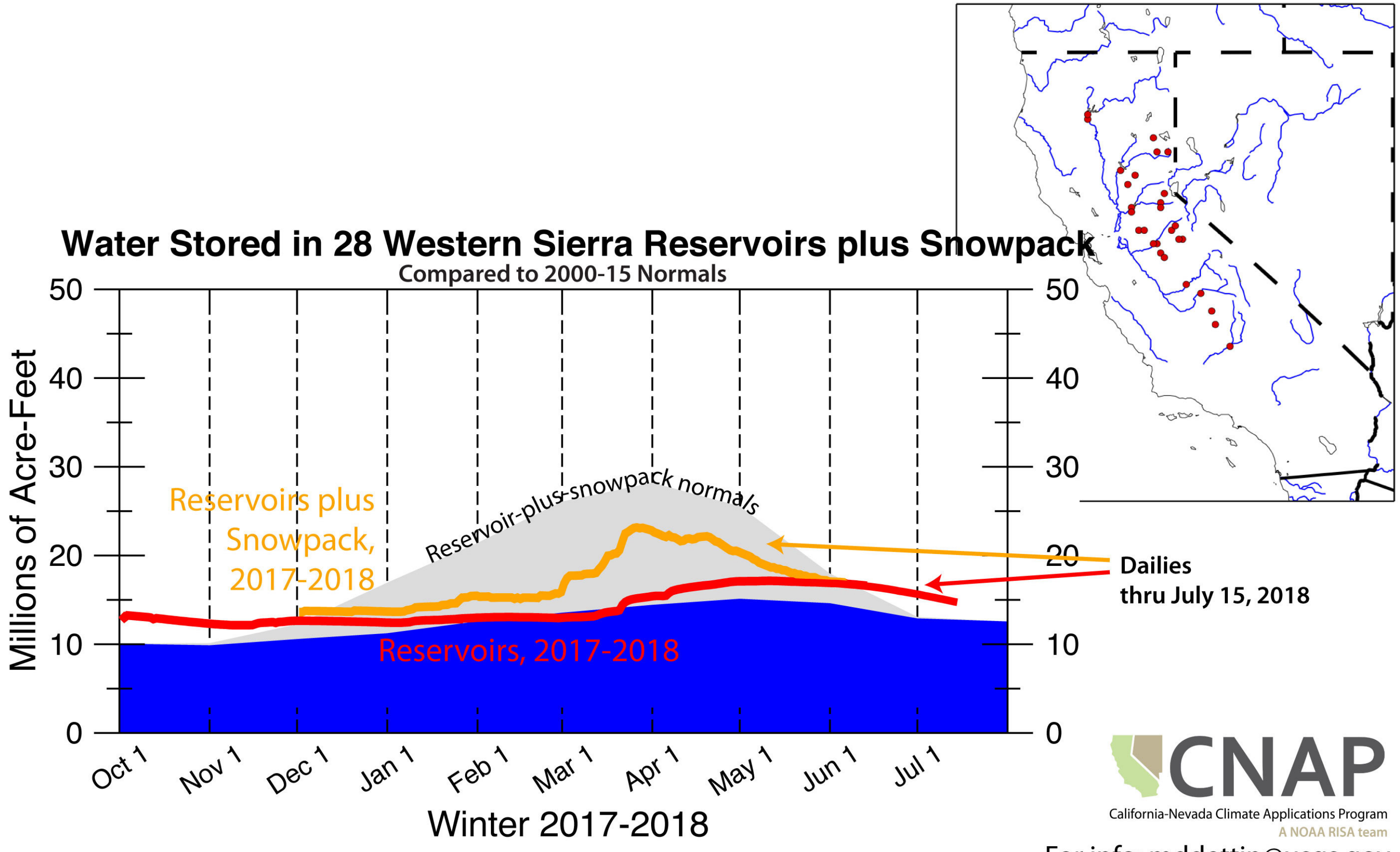
CIRC A NOAA RISA Team

Western Regional Climate Center Providing climate services since 1986

REACCH Regional Approaches to Climate Change – Pacific Northwest Agriculture

Water Year 2018

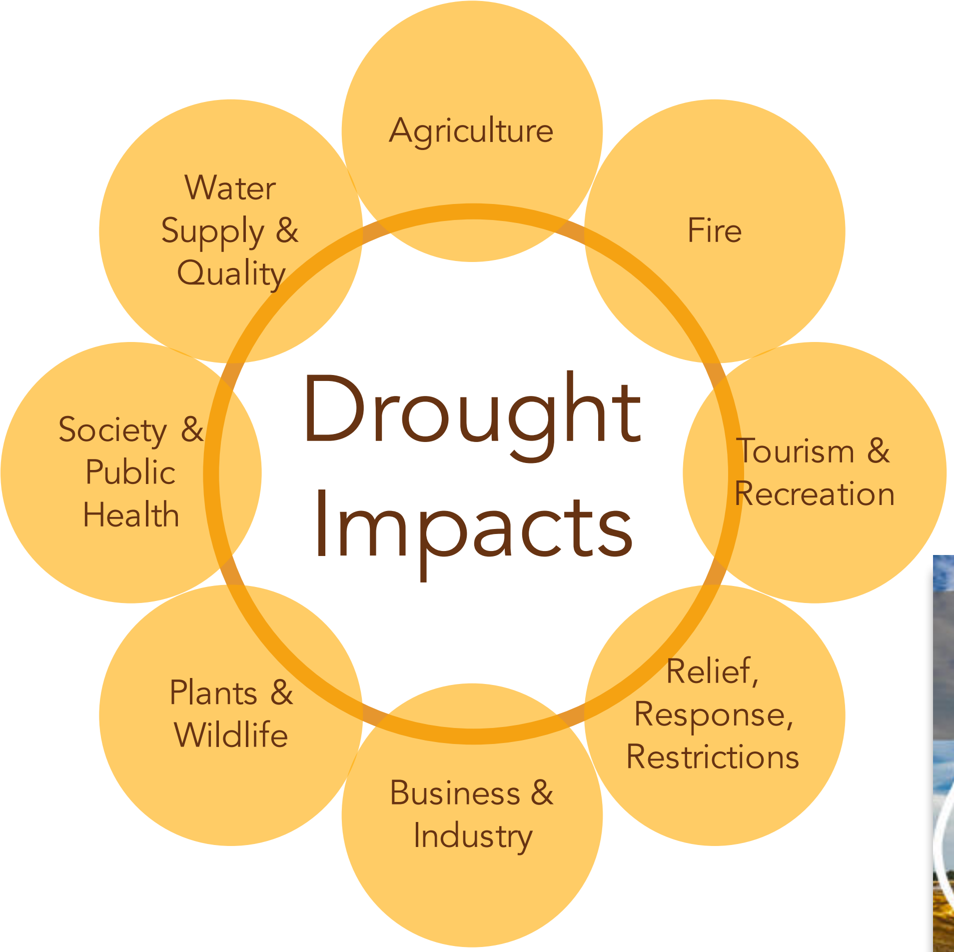


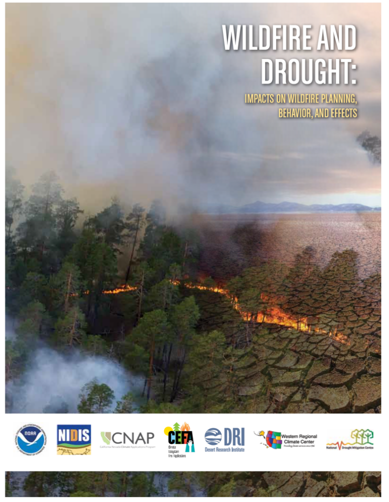


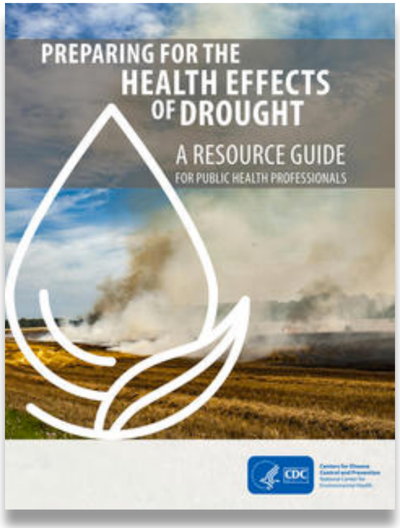
CNAP
California-Nevada Climate Applications Program
A NOAA RISA team

For info: mddettin@usgs.gov

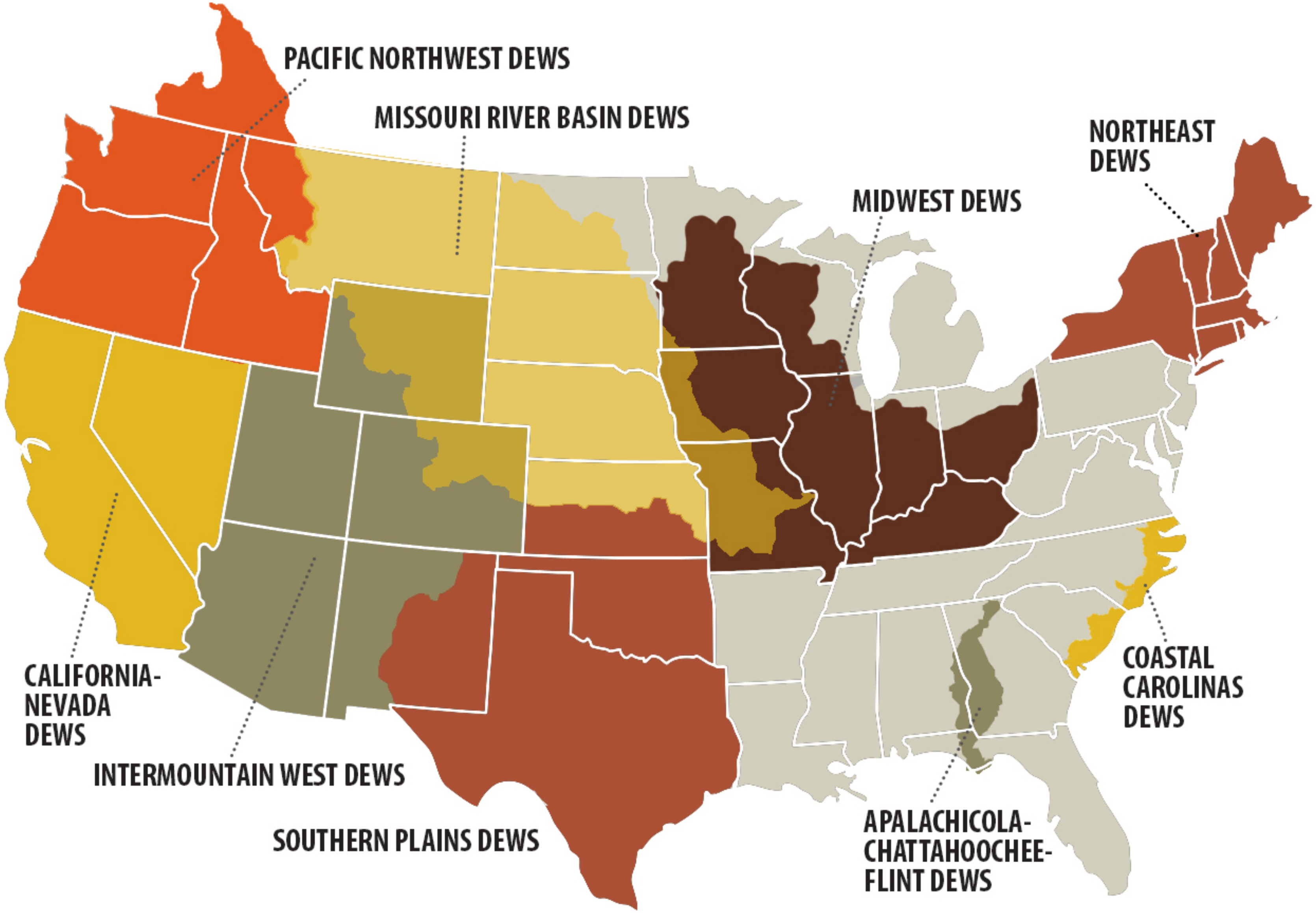
Drought Early Warning Across S2S Timescales







RISA
Regional Integrated Sciences and Assessments



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SCRIPPS INSTITUTION OF OCEANOGRAPHY
UC San Diego

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National Integrated Drought Information System