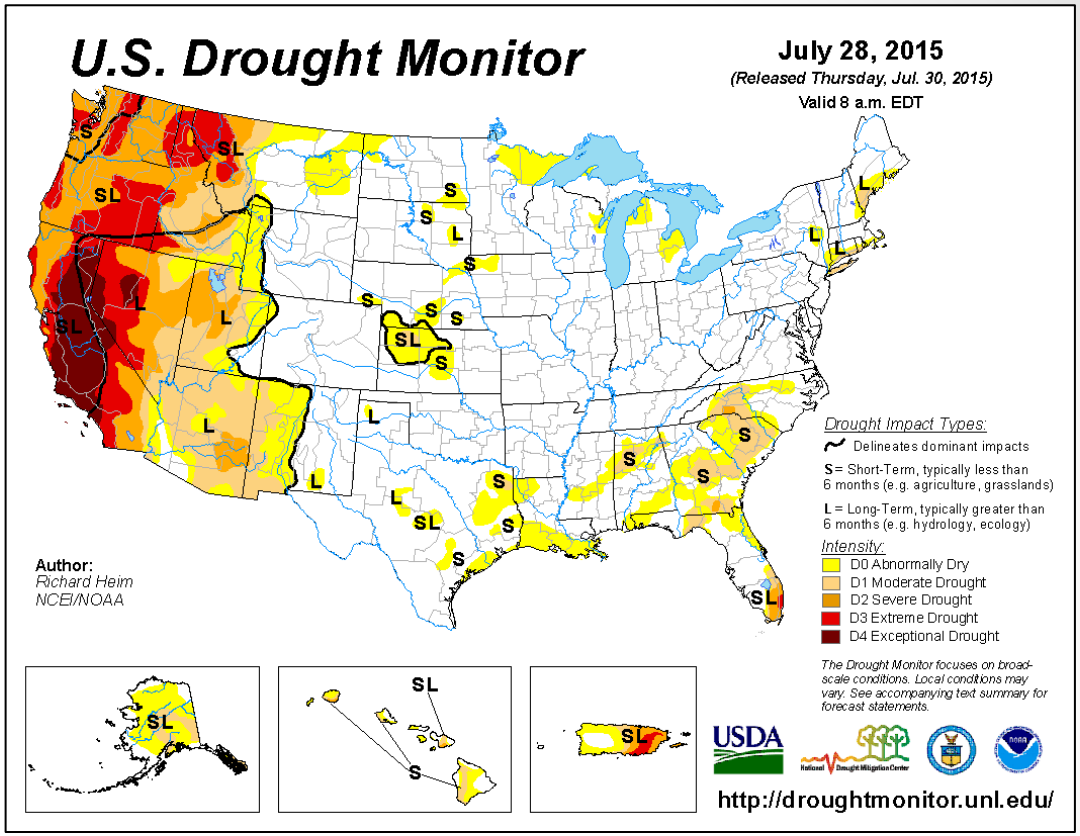
Coping with Drought in California



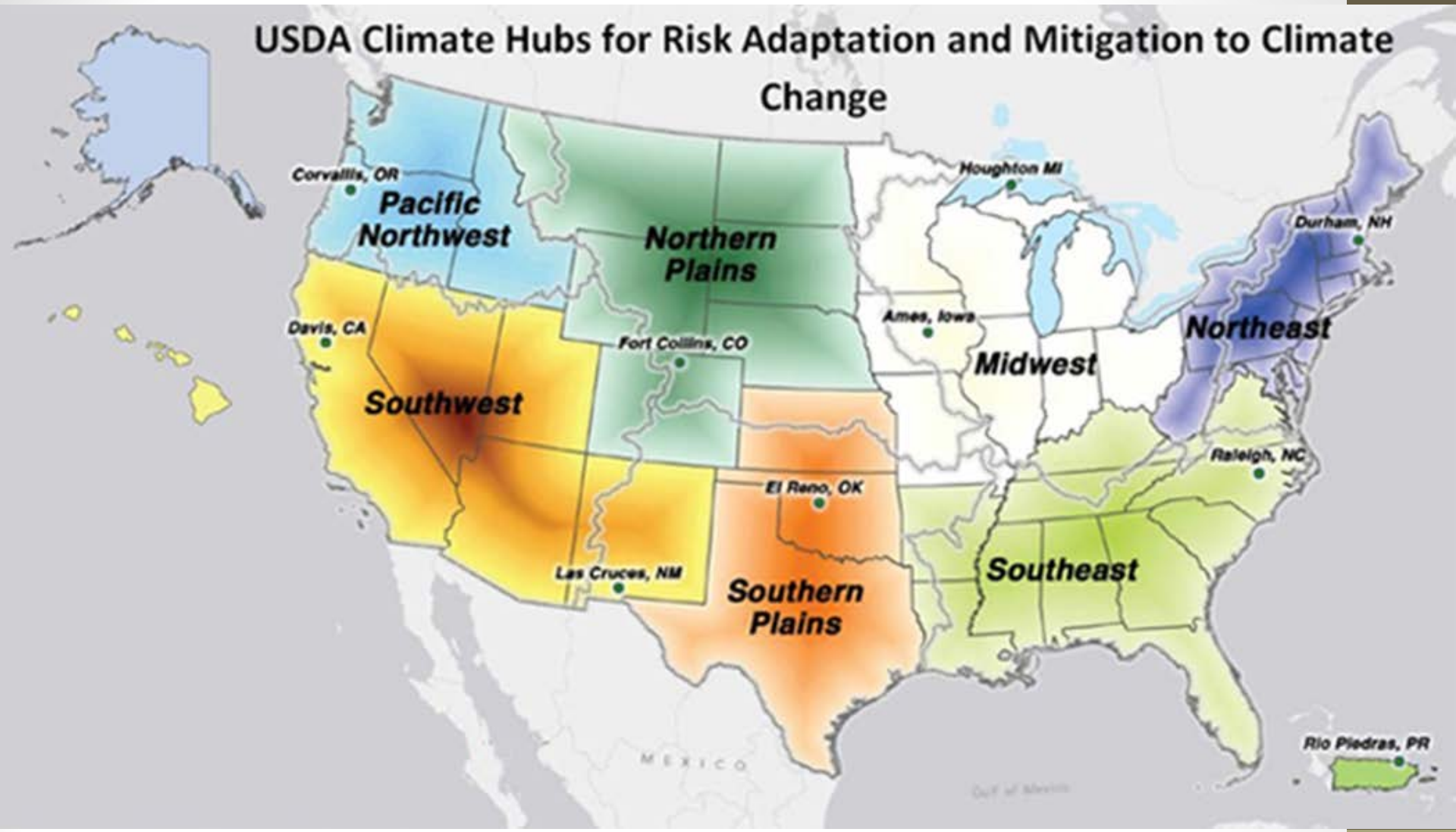
Peter A. Stine Ph.D.

Co-Director of the USDA Climate Sub Hub in California

Pacific Southwest Research Station, Forest Service

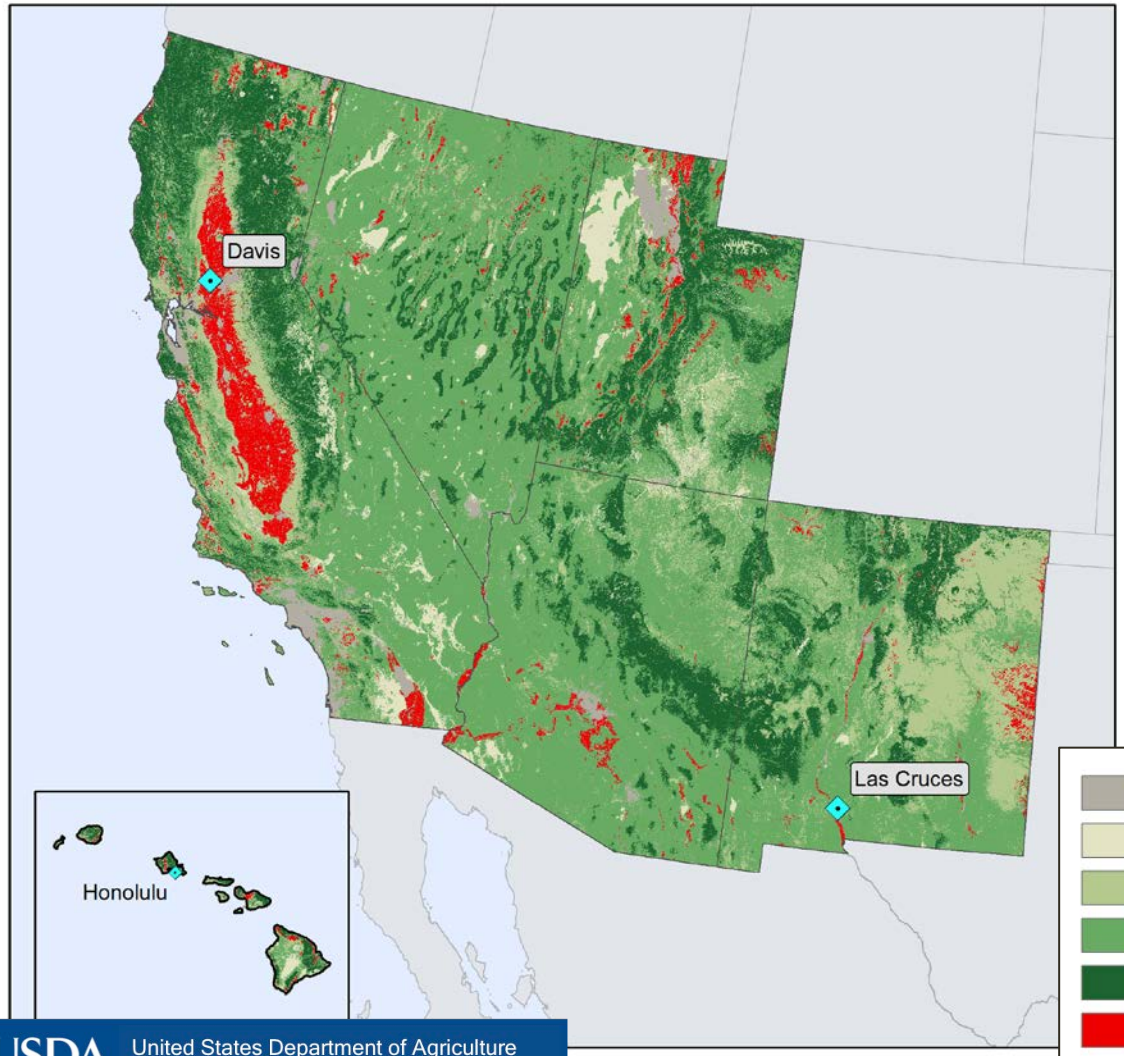
USDA United States Department of Agriculture
CALIFORNIA SUB HUB OF THE SOUTHWEST REGIONAL CLIMATE HUB

FOREST SERVICE US DEPARTMENT OF AGRICULTURE



Seven regional climate hubs established in early 2014
To support smart decision making

The Southwest Climate Hub



Changing weather conditions

- Longer growing seasons
- Plant water stress
- Heat stress
- Warmer night temperatures affect blossom and fruit set for a number of important crops

Current as of August 6, 2015

Organizational chart for the California Sub Hub of the USDA Southwest Regional Climate Hub

Key to abbreviations:

ARS = Agricultural Research Service (USDA)
CA NRA = California Natural Resources Agency
CDFA = California Department of Food and Agriculture
FS = Forest Service (USDA)
FSA = Farm Service Agency (USDA)
NMSU = New Mexico State University
NRCS = Natural Resources Conservation Service (USDA)
OCE = Office of the Chief Economist (USDA)
RD = Rural Development (USDA)
RMA = Risk Management Agency (USDA)
UC ANR = University of California Division of Agriculture and Natural Resources (Cooperative Extension)

Secretary of Agriculture
Tom Vilsack

Executive Committee for Climate Hubs
Chair, Randy Johnson (USDA/FS)
National Coordinator, Rachel Steele (OCE)

Southwest Hub director
Al Rango, USDA/ARS

Southwest Hub deputy directors
Emile Elias, NMSU
Caiti Steele, NMSU

California Sub Hub co-directors
Kerri Steenwerth, USDA/ARS
Peter Stine, USDA/FS

California Sub Hub core members

UC ANR	UCD	USDA/FS	USDA/NRCS	USDA/FSA	USDA/RD	CDFA	CA NRA
Tapan Pathak	Mark Schwartz	Chris Fischer	Luana Kiger	Oscar Gonzales	Robert Tse	Ami Gunasekara	Russ Henly
Mark Battany	Ron Tjeerdema	Jeanne Chambers	Tom Hedt	USDA/RMA	Allison Tse		JR DeLaRosa
Doug Parker	Amber Kerr			Jeff Yasui			

What's special about California?

- **#1 agricultural** state in the nation ($43 billion in 2012); produces more than half of US specialty crops
- Economically and ecologically important **rangelands**; #1 biggest sheep state, beef cattle industry produced $3.03 billion (2012 data)
- California is the nation's highest producing **dairy** state

Vast amount and diversity of **forest**
33 million acres

Specialty and field crops in California

- California produces over **400 specialty crops**, including 90% of US wine grapes and 100% of US almonds, walnuts, olives, and artichokes.
- Specialty crops make up **87% of the total value** of California's crop production.
- **7 of the top 10** agricultural commodities in CA are specialty crops; only one (hay) is a field crop.
- CA also relies on international trade of key commodities and exports almonds, walnuts, short-grain rice, and process tomatoes

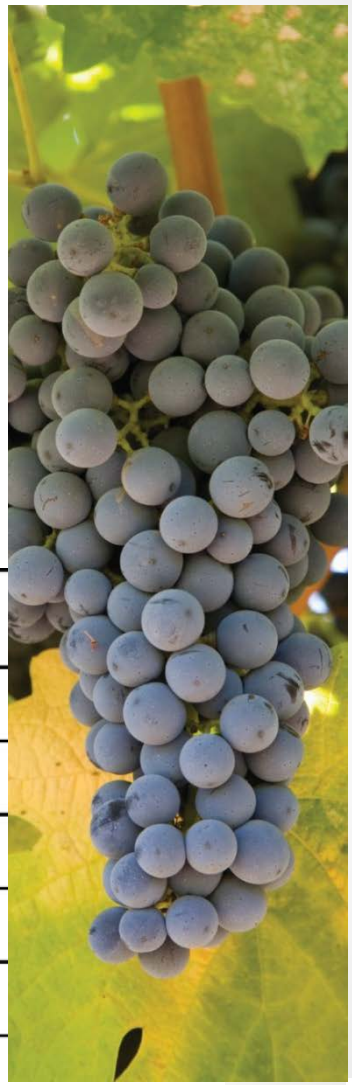
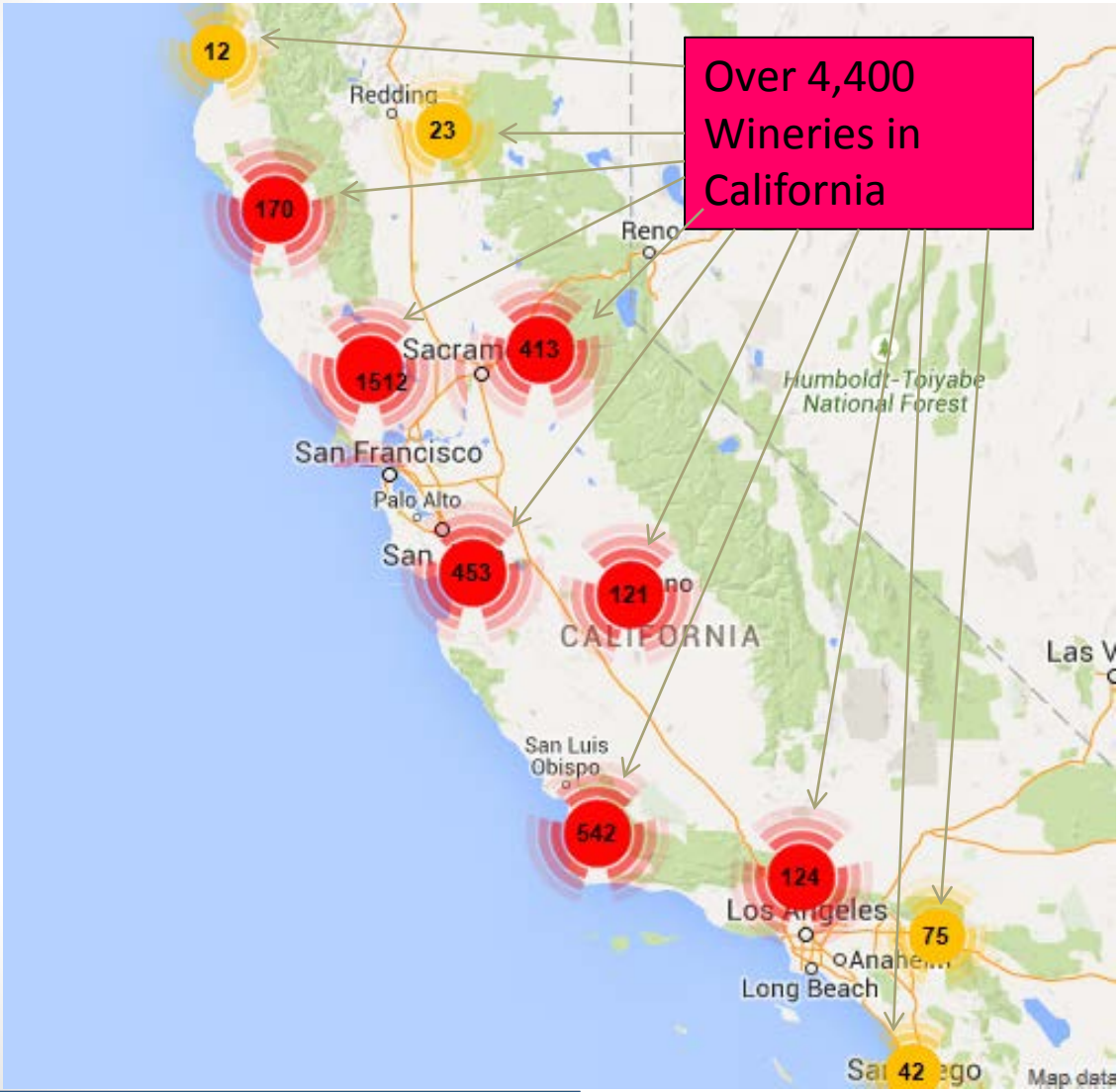


Table 1. California's top agricultural commodities (by market value) in 2012.

1. Milk ($6.90 billion)	6. Strawberries ($1.94 billion)
2. Grapes ($4.45 billion)	7. Lettuce ($1.45 billion)
3. Almonds ($4.35 billion)	8. Walnuts ($1.35 billion)
4. Nursery plants ($3.54 billion)	9. Hay ($1.23 billion)
5. Cattle and calves ($3.30 billion)	10. Tomatoes ($1.17 billion)

Source: http://www.cdfa.ca.gov/statistics/

Grape Production in California



Over 4,400 Wineries in California

California grows more than 90% of the nation's wine grapes and 99% of raisin grapes. Approximately 1 million acres are in grape production that yields almost $60 billion in total state economic impact, over $120 billion in national economic impact (wineinstitute.org).

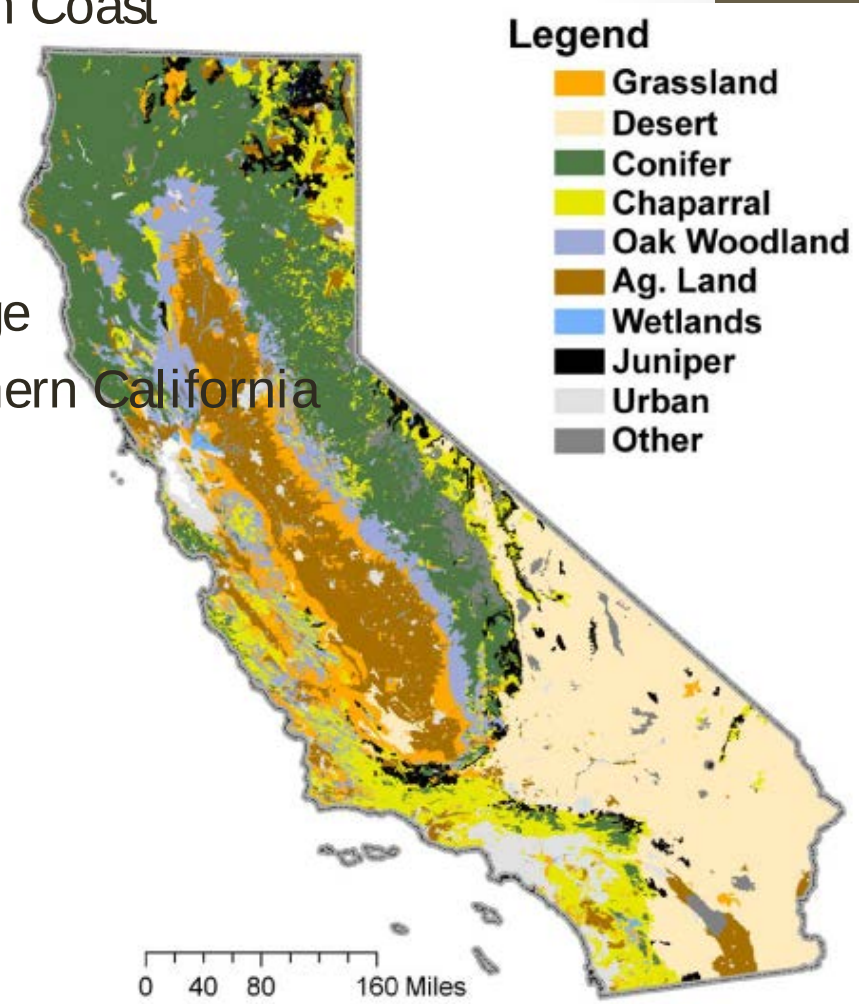
Types of exposure and resulting sensitivities of animal agriculture

Exposure	Sensitivity	Adaptive Measures
Elevated maximum temperature	Reduced grazing capacity	Cooperative Extension Service and USDA programs on climate effective management
Elevated minimum temperature	Reduced air/water qualities	Reduced stocking rates
Temperature rise will be higher in summer than other seasons in most of the region	Persistent land degradation	Conservation practices for erosion controls
Heat waves will increase in frequency, intensity, duration and spatial extent.	Reduced forage / pasture quantity / quality	Heat and/or drought tolerant feeds and forages and livestock breeds
More intense and longer-lasting drought.	Increased heat stress with expansion of arid zone	Diversification of ranch scale production systems
	Inconsistent preparedness for prolonged dry periods	Intensification of water re-use for irrigation

Forests in California

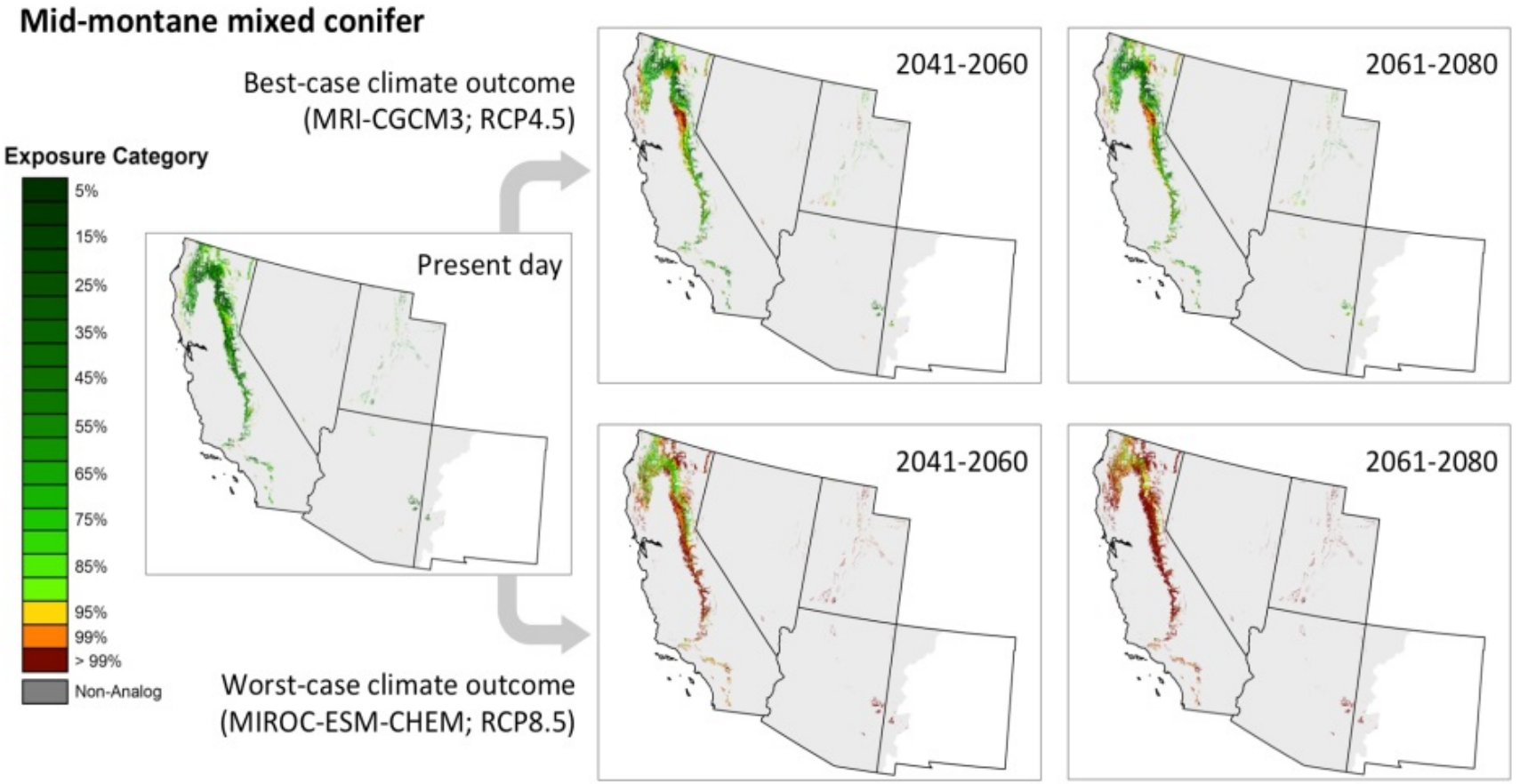
One-third of California (33 million acres) is forested. There is a great diversity of forest types:

- Redwoods along the North Coast
- Mixed conifer forests in the Sierra Nevada
- Oak woodlands in the Sierra foothills/Coast Range
- Chaparral in coastal Southern California

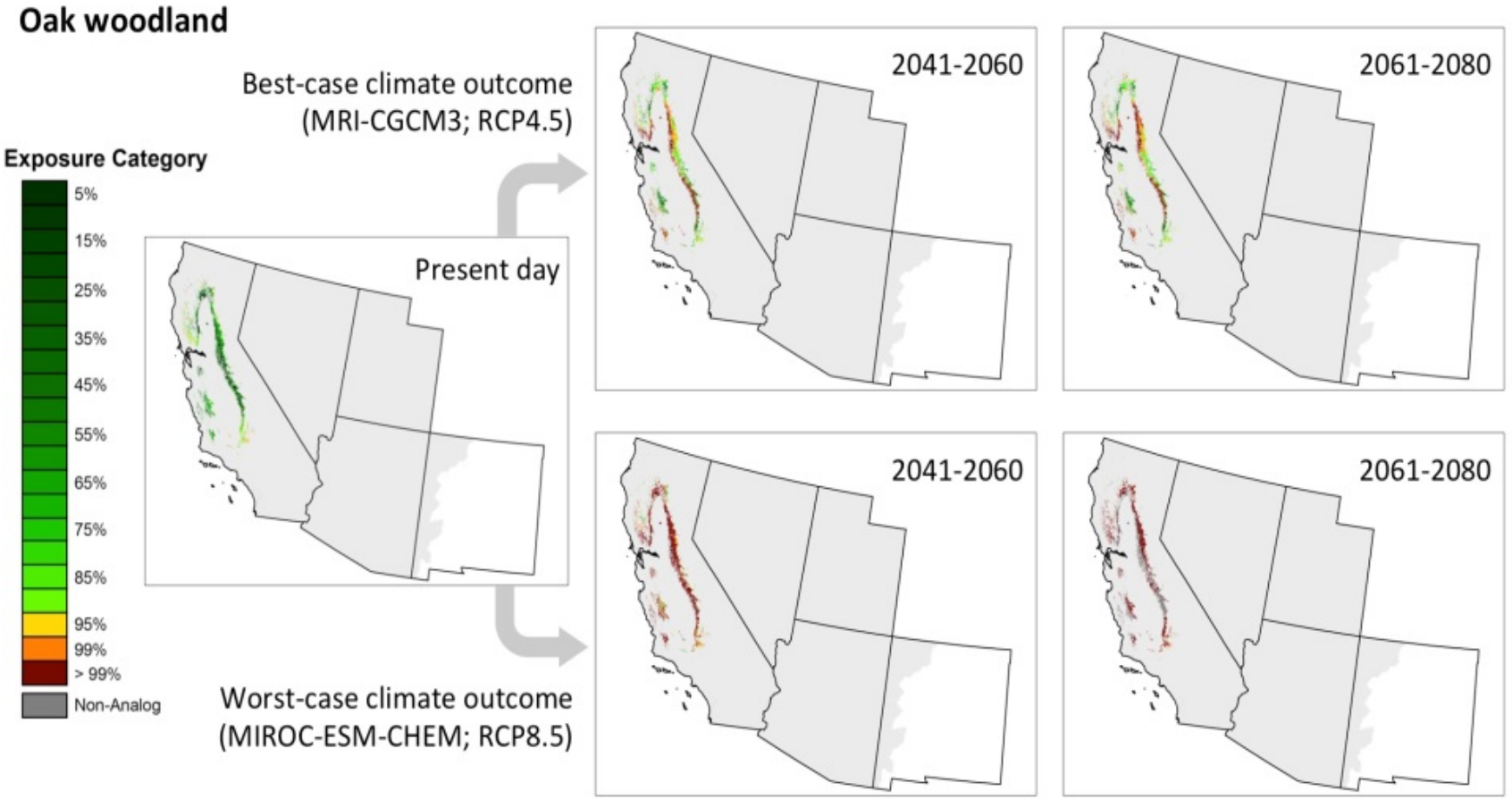


- California's forests
  - **60% public**
  - **40% private**

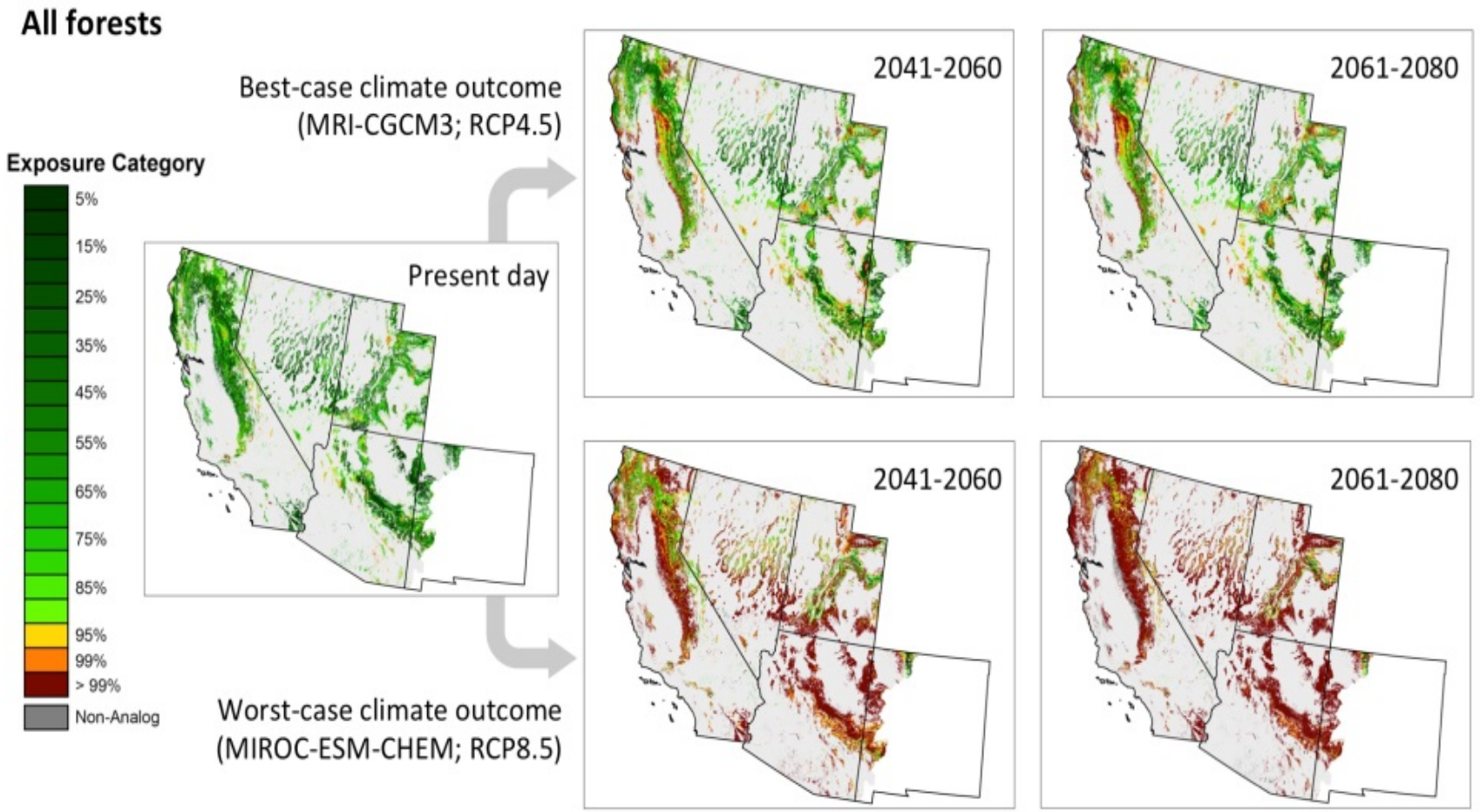
Vulnerability of Major SW Forest Types



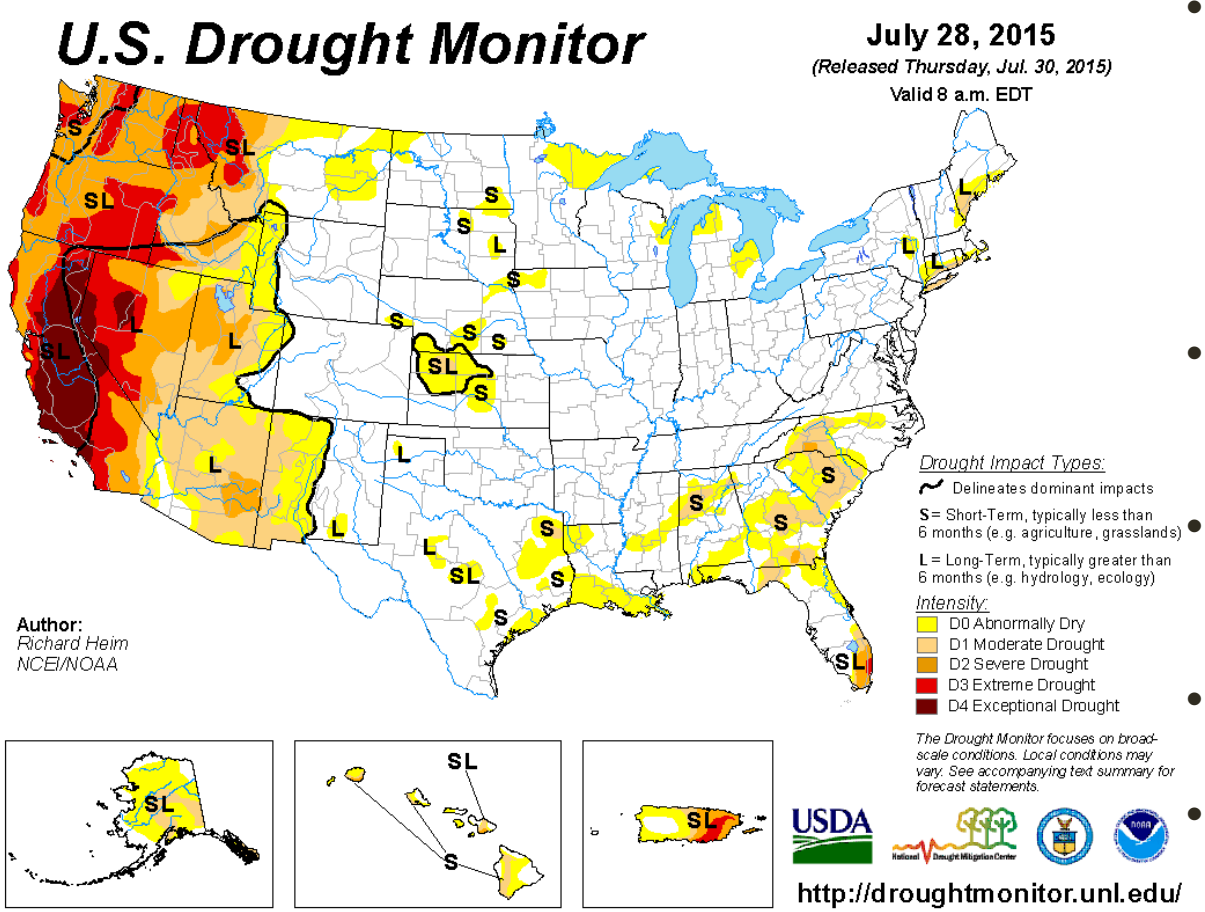
Vulnerability of Major SW Forest Types



Vulnerability of Major SW Forest Types



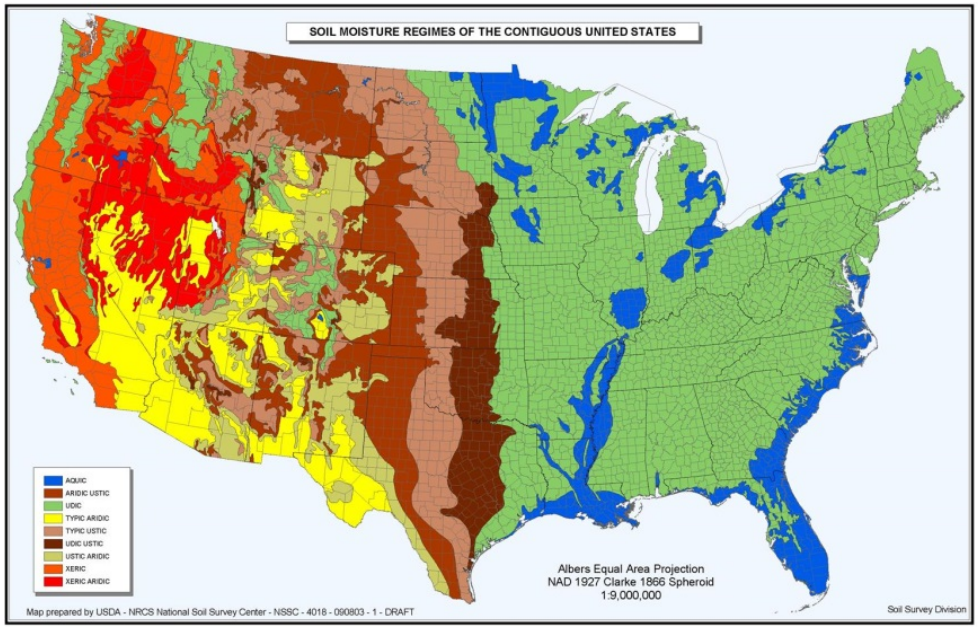
Current Drought 2011-2015



- Four-year period between fall 2011 and the present has been the driest since recordkeeping began in 1895.
- Effects of the drought are being felt differently around the state.
- The drought has been particularly hard on the agricultural sector.
- Forests and rangelands are highly vulnerable.
- Wildlife and fish are also being hit hard.

Drought: Precipitation and Temperature

- During this drought statewide and regional temperatures have dramatically exceeded historic highs going back to the late 1800's.
- Warm temperatures:
  - increase the length of the growing season
  - reduce soil moisture due to evaporation.



"The picture's pretty bleak, gentlemen. ... The world's climates are changing, the mammals are taking over, and we all have a brain about the size of a walnut."

Go to: ca.gov/drought/

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California's Watersheds

Where it falls is not where it stays

Central Valley Project
State Water Project

Local Control
Federal Control

USDA United States Department of Agriculture
CALIFORNIA SUB HUB OF THE
SOUTHWEST REGIONAL CLIMATE HUB

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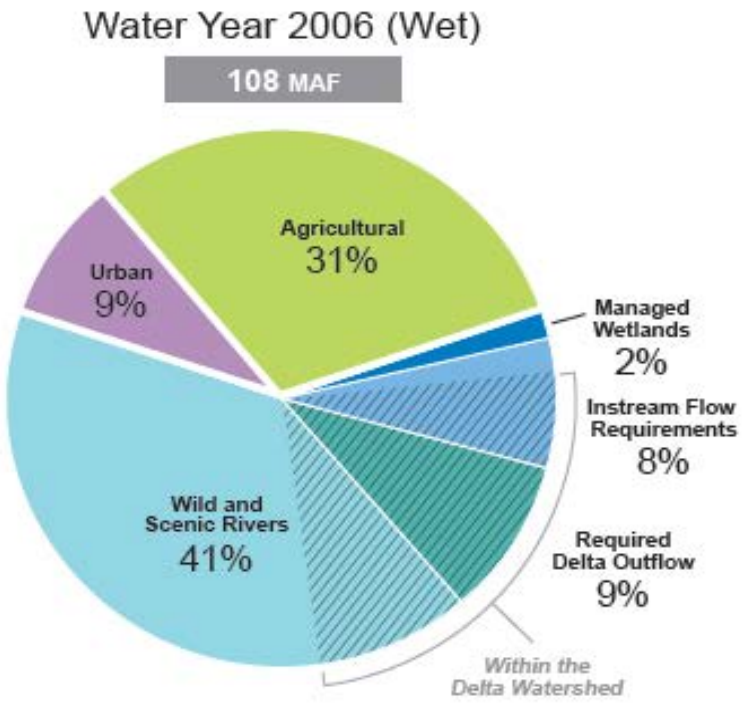
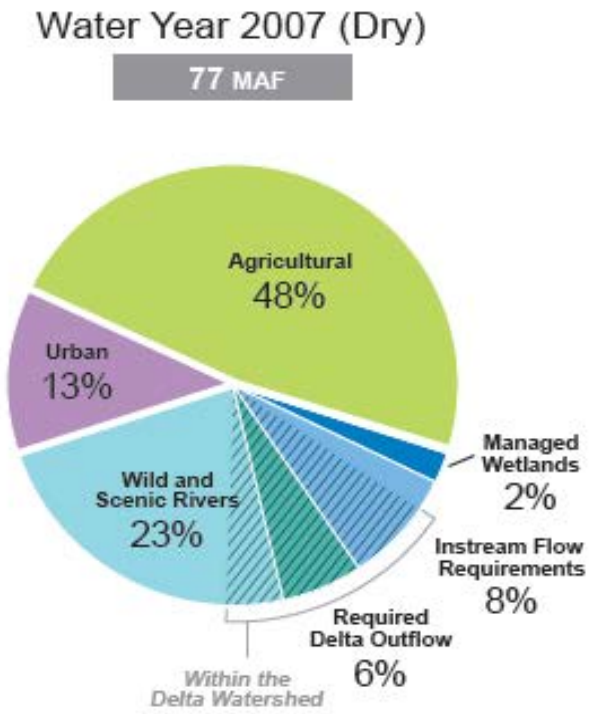
How Water Is Used in California





		Applied Water Use			
		2006 (Wet)		2007 (Dry)	
Water Use	Definition	%	MAF	%	MAF
Urban	*Water for urban purposes, including residential, commercial, institutional, and industrial.*	9%	9.5	13%	9.6
Agriculture	*Water for irrigated agriculture including multi-cropping.*	31%	33.3	48%	36.9
Managed Wetlands	*Water for managed wetland areas.*	2%	1.6	2%	1.6
Minimum Instream Flow Req'ts	*Water within natural waterways as specified in an agreement, water rights permit, court order, FERC license, etc.*	8%	8.5	8%	6.5
Minimum Required Delta Outflow*	*Freshwater outflow from the Sacramento-San Joaquin Delta required by law to protect the beneficial uses within the Delta from the incursion of saline water.*	9%	10.1	6%	4.5
Wild and Scenic Rivers	*Over 2,000 miles of river systems are designated wild, scenic, and recreational under the 1968 National Wild and Scenic Rivers Act and the 1972 California Wild and Scenic Rivers Act.*	41%	44.8	23%	18.1

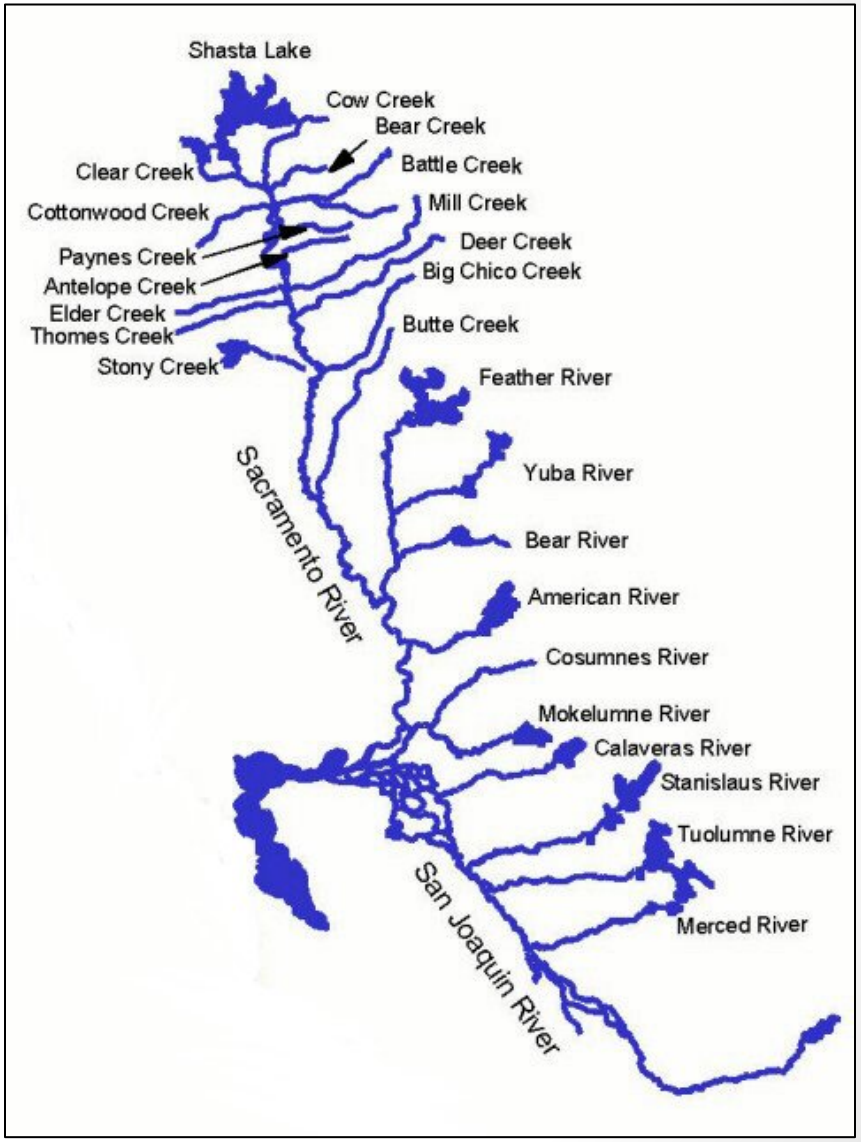
Source: CA Department of Water Resources; California Water Plan 2013

Major Water Projects in CA

- Central Valley Project (federal). 7 million acre-feet (MAF) per year.
- State Water Project (state). 2.3 MAF / year.
- All-American Canal (local). 3 MAF / year. Constructed in 1930s
- Colorado River Aqueduct (local). 1.2 MAF / year.
- Los Angeles Aqueduct (local). 200,000 AF / year.
- Mokelumne Aqueduct (local). 364,000 AF / year. Completed in 1929.
- San Francisco Hetch Hetchy Project (local). 330,000 AF / year.

Environmental Uses

- Wild and scenic rivers (north coast)
- Habitat for fish within rivers and streams (one quarter of California's native freshwater fish species are listed as endangered or threatened)
- Water that supports wetlands for migratory birds, and
- Water needed to maintain water quality (e.g. salinity in the Delta).



Environmental Uses

Chinook Salmon (UC Davis)

Delta Smelt (USFWS)

San Francisco Bay Delta (Bureau of Reclamation)

Where Does Water Devoted to Agriculture Go?

- California's unique geography and climate enables the state to be among the most productive agricultural regions in the world.
- The value of California's farm output leads the nation.
- Most of this production would not be possible without irrigation. In an average year, California agriculture irrigates more than 9 million acres.

Source: CA Dept. of Water Resources

California is the second leading rice producing state in the U.S.

Residential efforts to Save Water

April 1, 2015 Executive Order, Governor Brown mandated water restrictions on residents, businesses and farms; a 25 percent water use reduction for cities and towns.

- From 1967–2005, statewide per capita water use declined by half, real state GDP doubled, and the economic value of each unit of water increased fourfold.
- Daily per capita urban use fell from a peak of 247 gallons in 1995 to 199 gallons in 2010, now we are aiming for 35-50 daily per capita use.
- California's large urban water suppliers increased savings from 13.6 percent in April to approximately 28.9 percent in May 2015, and 27% in June compared to 2013.
- Between June 2014 and May 2015, approximately 237.3 billion gallons (728,136 acre-feet) of water were saved, as compared to the same time period for the year prior, enough water to supply approximately 2.38 million Californians for one year.

Residential efforts to Save Water

Lawns are pretty

But so are Xeriscapes

Agricultural efforts to Save Water

Regulated Deficit Irrigation

Full potential of limited water use is the goal in wine grape production

- Use soil moisture monitoring methods
- Quality grapes result from periods of water stress; desirable irrigation involves a scheduling method that regulates the amount and timing of water deficits
- New tools such as **Surface Renewal: reliable & automated ET measurement system**
- Water use is a combination of
  - In-season rain
  - Soil-stored water
  - Timed irrigation

Developing surface renewal as a real time technology to measure actual evapotranspiration and crop stress

Andrew McElrone USDA ARS/UC Davis

Agricultural efforts to Save Water

Drought Management for California Almonds

- Age of orchard
- Avoid canopy reduction
- Monitor soil salinity
- Variety matters
- Micro-irrigation and timing
- Reduction of evaporation
- Reduce nitrogen inputs

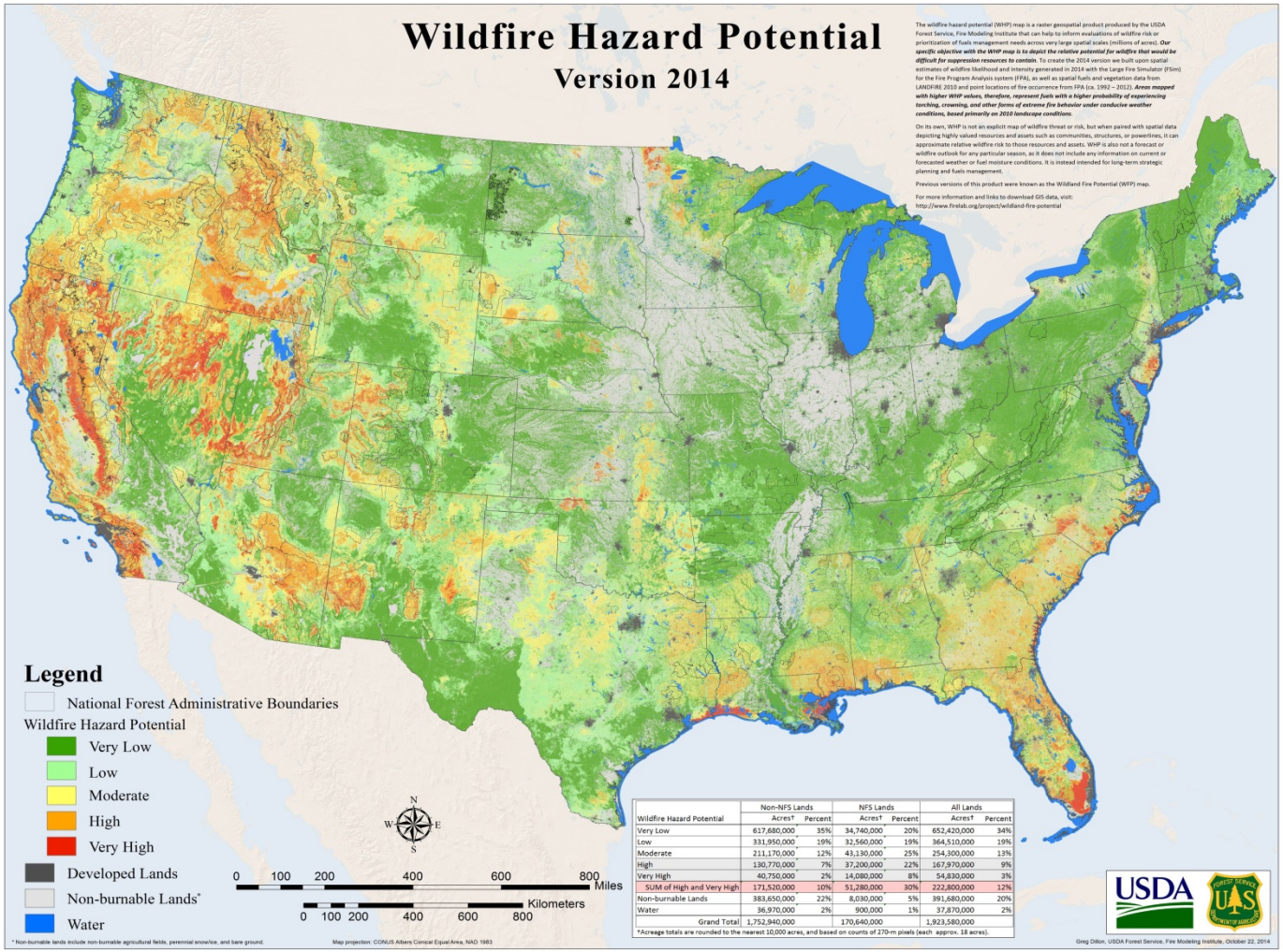
(Doll and Shackel 2015)

Jack Kelly Clark, UC Statewide IPM Program

There are more than 6,000 almond growers in California and 615,000 bearing acres. *Above,* an almond orchard in bloom at Nickels Soil Laboratory in Colusa County.

University of California Agriculture and Natural Resources

Wildfire Hazard Potential for the conterminous United States



Wildfire Hazard Potential	Non-NFS Lands		NFS Lands		All Lands	
	Acres†	Percent	Acres†	Percent	Acres†	Percent
Very Low	617,680,000	35%	34,740,000	20%	652,420,000	34%
Low	331,950,000	19%	32,560,000	19%	364,510,000	19%
Moderate	211,170,000	12%	43,130,000	25%	254,300,000	13%
High	130,770,000	7%	37,200,000	22%	167,970,000	9%
Very High	40,750,000	2%	14,080,000	8%	54,830,000	3%
SUM of High and Very High	171,520,000	10%	51,280,000	30%	222,800,000	12%
Non-burnable Lands	383,650,000	22%	8,030,000	5%	391,680,000	20%
Water	36,970,000	2%	900,000	1%	37,870,000	2%
Grand Total	1,752,940,000		170,640,000		1,923,580,000	

*Acreage totals are rounded to the nearest 10,000 acres, and based on counts of 270-m pixels (each approx. 18 acres).


Current Large Incidents
August 05, 2015
Wildfire - IMT1
Wildfire - IMT2
Wildfire - Other
Wildfire - NIMO
1 ROCK
2 CARLSON LAKE
3 HAMLIN CREEK
4 ROUTE COMPLEX
5 GASQUET COMPLEX
6 HUMBOLDT COMPLEX
7 SOUTH COMPLEX
8 RIVER COMPLEX
9 STOUTS CREEK
10 CABLE CROSSING
11 FORK COMPLEX
12 ROCKY
13 NATIONAL CREEK COMPLEX
14 WRAGG
15 MAD RIVER COMPLEX
16 FROG
17 LOWELL
18 WOLVERINE
19 HWY 8
20 DODGE
21 WILLOW
22 153 WEST FORK
23 CHORRO
24 CABIN
25 NORTH BOULDER 2
26 BLUE CREEK
27 PHILLIPS CREEK
28 BALDY
29 REYNOLDS
30 SA HILL
31 SHEEP CREEK
32 FT. CRAIG
33 FORT MCKAVETT COMPLEX
34 ROCKY POINT FIRE
35 HICKMAN CEMETERY ROAD FIRE
36 WOLF CREEK

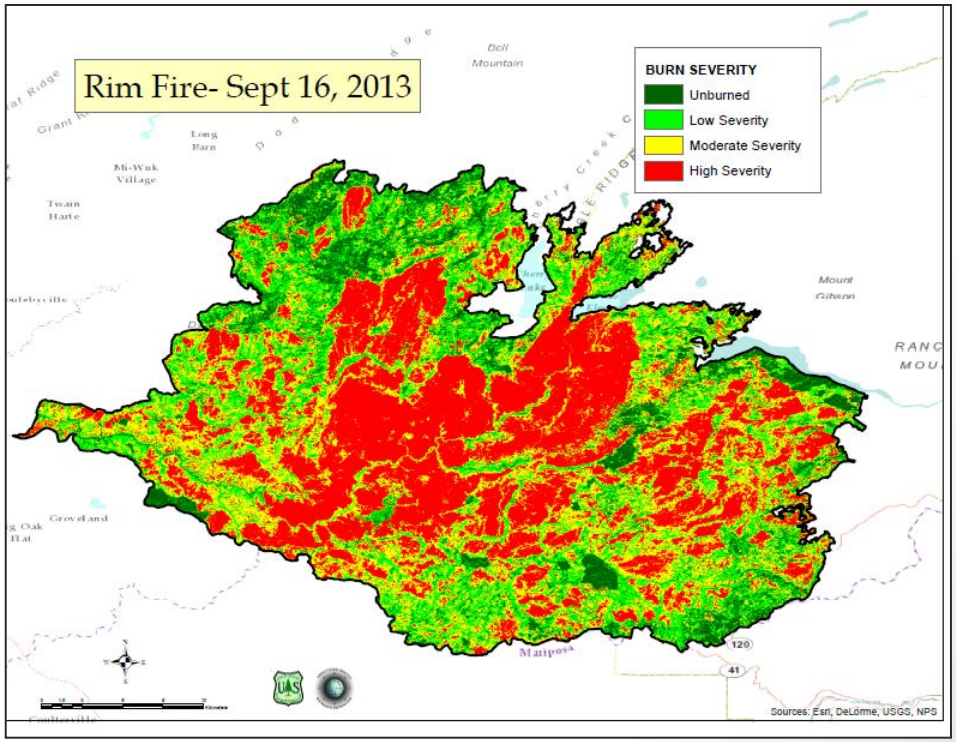
Rocky Fire in Lake County, CA

Burnt Area: 69,600 Acres
Location: Lake County, California
Cause: Undetermined
Incident Team Type: IMT Type 1
Containment Status: 40% contained
Expected Containment: 2015-08-10T17:00:00.000

Photos: Davis Press Democrat

Rim Fire of 2013

"Mega-fires" are extraordinarily large, complex, and resistant to control. Such fires may become more common as climate changes and fuels accumulate following decades of fire suppression.



Current Conditions

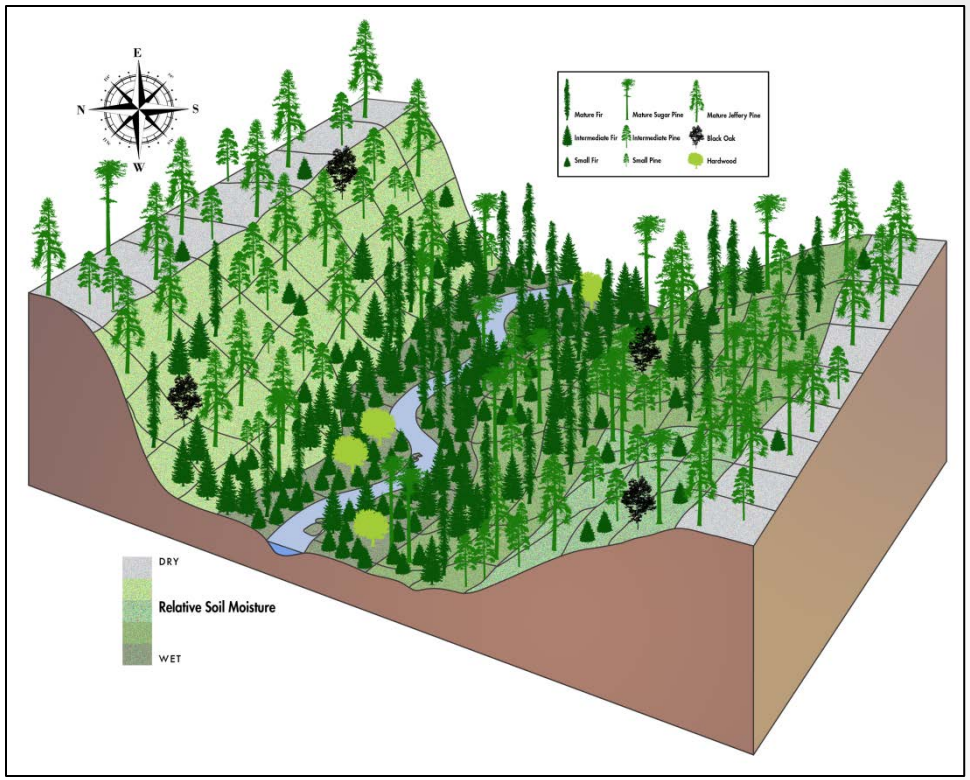
Contemporary western conifer forests are a result of:

- highly effective fire exclusion,
- Selection and clear cutting,
- invasions of alien plant species,
- expanding disease and insect infestations, and
- high severity fires
- other disturbances
- changing climates

Today's forests are denser, have more small trees and fewer large trees, and are dominated by more shade tolerant and fire intolerant tree species.

Forest Restoration

Restoration should aim to re-establish the self-organizing, self-maintaining, and adaptive capacities of ecosystems. This is done by restoring ecological patterns and processes.



Promote Heterogeneity

Landscape Heterogeneity is a function of:

- Topography
- Soils
- Precipitation
- Geomorphic processes
- Fire history

Federal Assistance to California

- USDA is providing $9.7 million in emergency water assistance to 73,000 residents in 11 California counties.
- Designated 57 counties as disaster areas, making farmers and ranchers eligible for emergency loans.
- Targeted $25 million from the Environmental Quality Incentives Program to help farmers and ranchers implement conservation practices.
- Invested $5 million in emergency watershed protection.
- Provided $7.6 million to livestock producers.
- Invested $750,000 to reduce aquatic weeds clogging irrigation screens, pumps and canals.
- Set aside $3.3 million of a $30 million national investment to mitigate wildfire threats.
- Continuing research investments in water conservation and use efficiency.

CA Climate Sub Hub Drought Fact Sheets (in prep)

These fact sheets are intended to increase knowledge about drought impacts and responses; the target audience for these fact sheets includes farmers, ranchers, foresters and the public.

- **The causes, consequences, and outlook for the 2011-2015 California drought;**
- **Impacts of drought in California rangelands;**
- **How drought affects forests and forest fires in California;**
- **Drought, water policy, and agricultural water supply in California;**
- **Impacts of drought on California's specialty crop production.**
- **What happens when the near term drought "ends"?**

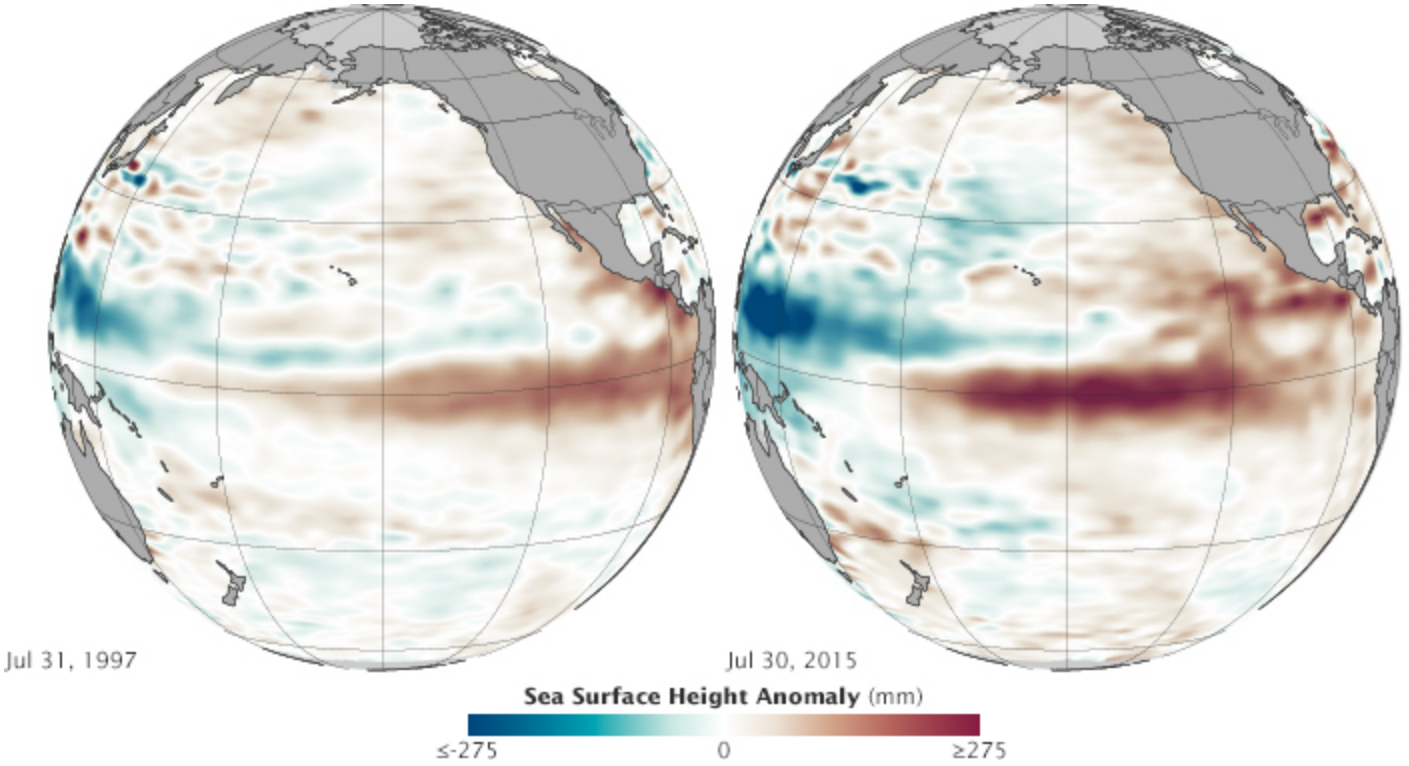
Beyond Conservation …

- Urban and agricultural water use is governed by the state's seniority-based water-rights system, established soon after statehood.
- The drought has brought considerable attention to water management practices and policies.
- There are abundant calls for reforms and for the construction of new water supply infrastructure.

- California Legislature passed (2014) the most comprehensive groundwater legislation in state history.
- Voters passed a $7.5 billion bond for expanding water supplies, promoting conservation, and improving ecosystems.

- What's next?

Precipitation in our Future?



This El Niño is getting billed as the 'great wet hope.' Many people in the American West are looking to El Niño to save them from drought, however, 1997 was mayhem, and drenching rains on a parched landscape are just as hazardous as a drought.

NASA Earth Observatory Program