

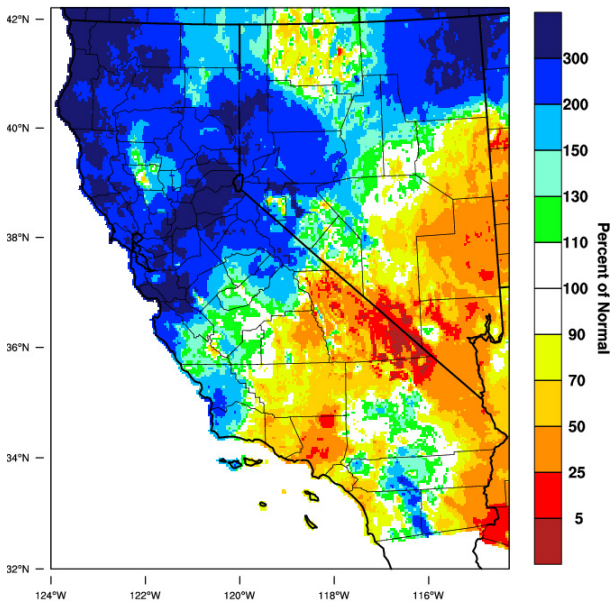


REGIONAL DROUGHT AND CLIMATE OUTLOOK SERIES

SEPTEMBER AND OCTOBER 2016

% OF NORMAL PRECIPITATION

September-October 2016 (normal includes 1981-2010)



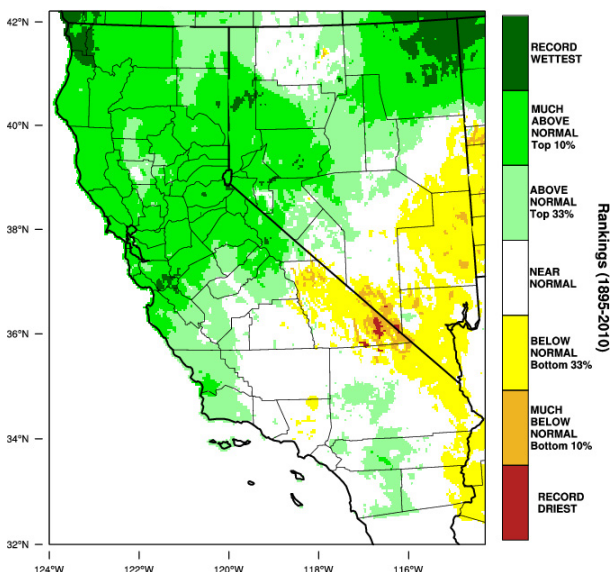
WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 7 NOV 2016

In September and October 2016 the National Integrated Drought Information System (NIDIS), the California Nevada Climate Applications Program (CNAP), the Desert Research Institute (DRI), the Western Regional Climate Center (WRCC) and other partners held a series of regional Drought and Climate Outlooks throughout California. These full-day meetings provided stakeholders and other interested parties with timely information on current drought status, as well as a preview of recent, current and developing climatic events (i.e. El Niño and La Niña) and ocean conditions. Presentations at each Outlook focused on regional topics such as water and land management, fisheries, forest health, groundwater, water quality and wildfire.

Participants also had the opportunity to discuss regional drought impacts and information needs, and provide input on the development of the strategic plan for the California-Nevada Drought Early Warning System (CA-NV DEWS). All of these Outlooks were CA-NV DEWS activities.

PRECIPITATION PERCENTILE

September-October 2016



WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 7 NOV 2016

CURRENT CONDITIONS

The end of water year 2015-2016 saw improvement in drought conditions in portions of California, but much of the state remained in drought with the largest deficits in the central coast and southern regions.

While portions of northern California received near average precipitation during last year's El Niño, below average precipitation in southern portions of the state and the statewide anomalously warm temperatures exacerbated historic and prolonged drought conditions. Despite improved precipitation compared to 2015, the region as a whole continues to experience a large precipitation deficit. Large areas of Southern California and the Central Coast received only 45-75% of normal precipitation throughout water year 2016. As a result, frequent and intense **wildfires** were seen this year, with the fire season essentially extending to a year-round threat.

This year's Sierra **snowpack** was improved compared to 2014-2015, but was still below normal especially in the Southern Sierra. Higher temperatures resulted in earlier melting of Sierra snowpack in the spring, and continued snow drought conditions were observed at the SNOTEL



sites throughout the region due to high freezing levels and rain instead of snow. Although the region did experience much-needed March storms, they did little to boost spring snowpack.

Statewide **reservoir conditions** are highly variable, reflecting both the improved precipitation conditions but also complex reservoir operations. Carmel River, for example, had **streamflows** that supported threatened steelhead return in 2016 compared to previous years.

Warm **temperatures** and **evaporative demand** are greatly intensifying drought severity. For example, Fresno County has seen 14 years of anomalously warm temperatures since the year 2000. The impacts of the drought, insects, and other factors have been felt through large numbers of **tree mortality** in the Sierra, including tens of thousands of dead trees in Fresno County alone that pose hazards near infrastructure and other structures such

as roads, power lines, private homes and water quality in the upcoming year (see map on page 3).

The start of the **2017 water year** has been encouragingly wet for Northern California. Several atmospheric rivers in October have provided precipitation from the coast to the northern Sierra. Atmospheric rivers (ARs) are narrow corridors of high water vapor transport in the lowest two km of the atmosphere. They primarily occur over the west coast of the U.S. in the cool season (Oct-Mar) and can bring much-needed rain and snow but can also result in hazards such as flooding, landslides and post-fire debris flows.

While precipitation in California and Nevada fell as rain rather than snow in October 2016, it will improve some water resources but more importantly improve soil moisture that may aid in ameliorating the drought later this winter.

THE 2014-2016 MARINE HEAT WAVE AND ITS IMPACTS ON WEST COAST MARINE LIFE

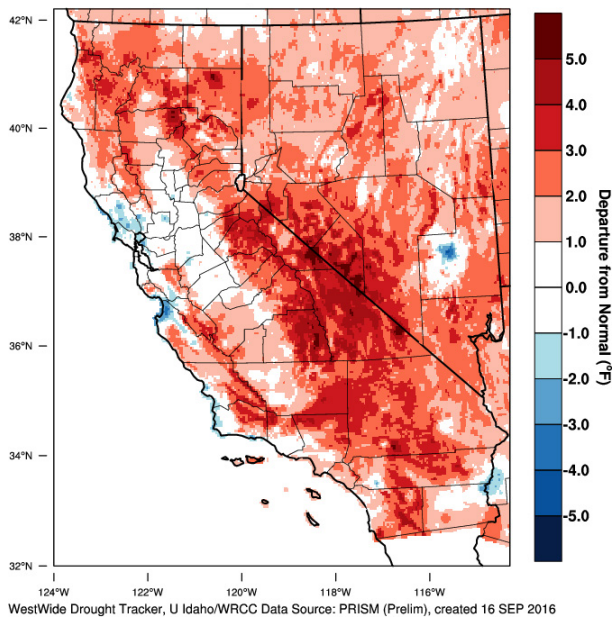
As California and Nevada have been experiencing record drought, the northeast Pacific has been experiencing a record marine heatwave. A large warm sea surface temperature anomaly developed in 2013, spreading over the Gulf of Alaska during the following winter with record breaking sea surface temperatures. This intensifying marine heatwave in 2013-2014 in the northeast Pacific is attributed to the same persistent atmospheric ridge pattern that has tended to divert Pacific storms away from California, and is linked with the North Pacific Oscillation (NPO), which is also a precursor for El Niño ocean conditions. The marine heatwave persisted through 2014-2015 extending to Baja and extreme southern California, and may be the most ecologically and economically significant marine heatwave on record.

Recent work by NOAA's Southwest Fisheries Science Center (Di Lorenzo and Mantua 2016) examined this marine heat wave, and found that ocean internal processes may not have played as key of a role as the direct atmospheric forcing in the persistence of the sea surface temperature anomaly through 2015. Instead, this study found evidence that the northeast Pacific marine heatwave (and atmospheric response to this ocean warming) in 2013-2014 led to tropical sea surface temperature changes through large-scale climate mechanisms that favored the development of El Niño in 2014-2015. The atmospheric response to El Niño and extratropical teleconnections then fed back on the persistence of the marine heatwave through 2015.

Ecologically, there have been far-reaching impacts on the

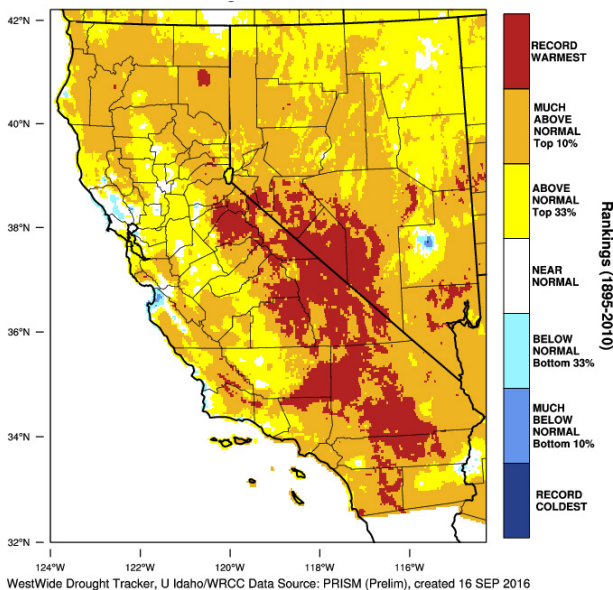
MEAN TEMPERATURE

June-August 2016 departure from 1981-2010 normal



MEAN TEMPERATURE PERCENTILE

June-August 2016



OUTLOOK MEETING DETAILS

You will find agendas, and presentations from each Outlook event at these URLs.

Southern California Drought & Climate Outlook

September 15, 2016 Riverside, CA

<https://www.drought.gov/drought/calendar/events/ca-nv-drought-early-warning-system-southern-california-drought-outlook>

North Central Coast Drought & Climate Outlook

October 11, 2016 Seaside, CA

<https://www.drought.gov/drought/calendar/events/north-central-coast-drought-climate-outlook-oct-11>

Central Valley Drought & Climate Outlook

October 12, 2016 Fresno, CA

<https://www.drought.gov/drought/calendar/events/central-valley-drought-climate-outlook-oct-12>

marine ecosystem and socio-economically important fisheries, including the largest ever recorded harmful algal bloom that extended from southern California to southeast Alaska. Important industries such as dungeness crab were affected.

Large scale climate mechanisms are linked to both the marine heatwave and drought in California. Examples of ecological links between the two include West Coast salmon. Multiyear intensification of the California drought with impacts on reservoir storage and stream temperatures at a time of multiyear ocean marine heatwave may have complex impacts on multiyear salmon life cycles.

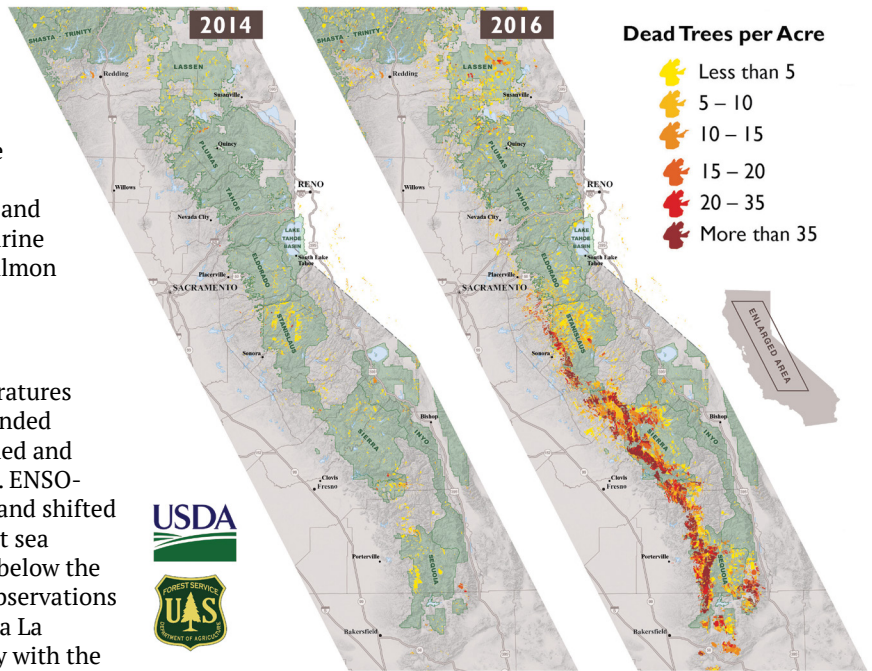
CLIMATE OUTLOOK

Last year's warmer than normal sea surface temperatures in the tropical Pacific Ocean, or El Niño conditions, ended earlier this summer when the trade winds strengthened and the tropical Pacific upper ocean temperatures cooled. ENSO-Neutral conditions were observed during September and shifted to weak La Niña conditions in October, with the latest sea surface temperatures in the Niño-3.4 region slightly below the La Niña threshold. The coupled ocean-atmosphere observations are moving towards conditions typically seen during a La Niña, and the Climate Prediction Center (CPC) jointly with the National Center for Environmental Prediction (NCEP), National Weather Service (NWS) and International Research Institute for Climate and Society (IRI) have released a La Niña advisory as of November 10, 2016 (http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensodisc.shtml).

As of November 2016, La Niña conditions are present and slightly favored to persist (~55% chance) during winter (December-January-February) 2016-2017. La Niña conditions are currently weaker than observed after the El Niño in 1997-1998. Each La Niña is different, but on average result in a drier

PROGRESSION OF TREE MORTALITY

From Forest Health Protection Aerial Detection Monitoring



ABOUT EL NIÑO AND LA NIÑA

Want to learn more about monitoring and forecasting El Niño, La Niña and their impacts? Check out NOAA's ENSO blog on <https://www.climate.gov/> for the most up-to-date discussions and observations.

<https://www.climate.gov/news-features/blogs/ens/november-2016-la-ni%C3%B1a-update-hello-lady>

PARTICIPATING AGENCIES

CAL FIRE

California Department of Fish and Wildlife
California Nevada Climate Applications Program
California State University Fresno
California State University Monterey Bay
Center for Ocean Solutions, Stanford University
City of San Diego
City of Upland
Desert Research Institute (DRI)
Eagle Rock Analytics
Fresno County Office of Emergency Services
Golden Gate Weather Services
Inland Empire Utilities Agency
Kings River Conservation District
Kings River Water District
Los Angeles Department of Water and Power
Mariposa County Health Department
Metropolitan Water District for Southern California
Monterey County Agricultural Commissioner
Monterey County Water Resources Agency
National Aeronautics and Space Administration (NASA) Ames Research

Center

Natina Integrated Drought Information System (NIDIS)
National Oceanic and Atmospheric Administration (NOAA)
National Center for Environmental Information (NCEI)
National Marine Fisheries Service Southwest Fisheries Science Center
National Weather Service - Hanford Weather Forecast Office
National Weather Service - San Francisco Bay Area/Monterey Weather Forecast Office
National Weather Service - San Diego Weather Forecast Office
Western Regional Climate Center
North Fork Rancheria of Mono Indians of California
Operation Unite
Pala Band of Mission Indians
Ramona Band of Cahuilla
Riverside County Department of Environmental Health
Riverside County Emergency Management Department

San Bernardino County Fire Office of Emergency Services
San Joaquin Valley Air Pollution Control District
San Manuel Band of Mission Indians
Southern California Association of Governments
University of California Cooperative Extension
University of California Davis
University of California Merced
University of California San Diego
Scripps Institution of Oceanography
University of Washington
U.S. Department of Agriculture (USDA)
USDA California Regional Climate Hub
Natural Resources Conservation Service (NRCS)
U.S. Forest Service (USFS)
USFS Sequoia National Forest
U.S. Department of Interior
Bureau of Indian Affairs
Bureau of Land Management
Bureau of Reclamation
Western Municipal Water District

California as do average neutral ENSO conditions, but to a lesser magnitude.

Historically, La Niña years have mostly produced drier than normal to normal precipitation (15-20% on average drier) in Southern California, while neutral ENSO years have produced both wet or dry years. There is not a consistent signal in other regions of the state such as the central coast, central valley, and northern California where most of the state's water resources originate. Both wet and dry years have been found during phases of ENSO in these regions. This speaks to the complexity of the climate system, and associated uncertainty for seasonal forecasts for the region and the associated impacts on water resources for the state as a whole.

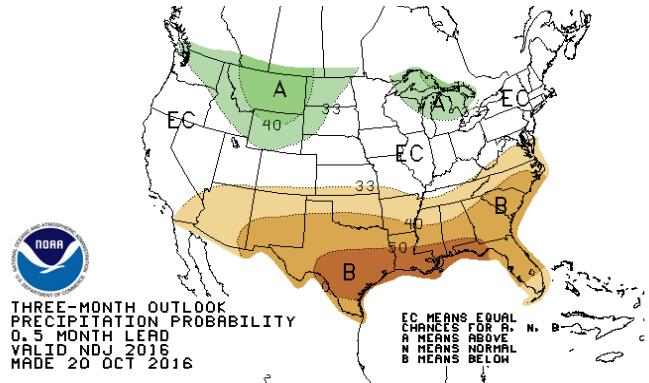
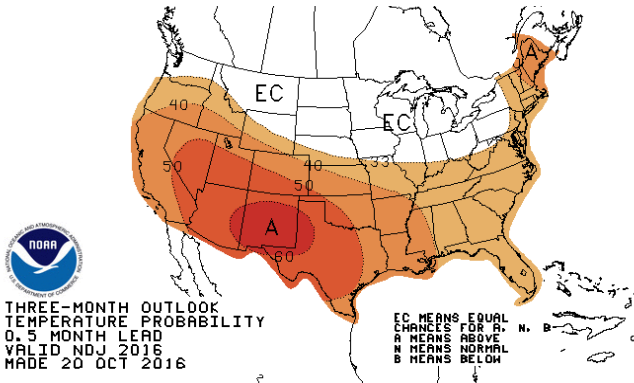
Temperature forecasts have been found to be less uncertain, and the CPC is forecasting above normal temperatures for

much of California this winter. This has implications on Sierra snowpack and other drought conditions with or without precipitation.

While driven by different factors, it is interesting to note that the last four years of drought in the region have been drier than an average La Niña, especially for northern portions of California, and have also been a time of record breaking average temperature.

There are many pathways that the climate system can follow after a large El Niño event. What's yet to be determined is where and when, or if, precipitation events will occur this water year as the atmosphere responds to the climate.

For more information contact Amanda Sheffield (amsheffield@ucsd.edu) or Alicia Marrs (alicia.marrs@noaa.gov).



RESEARCH & TOOLS

Each regional Drought & Climate Outlook featured presentations on innovative research and decision making tools stakeholders can use to monitor and/or mitigate drought impacts.

Evaporative Demand Drought Index (EDDI)

EDDI is a drought index that can serve as an indicator of both rapidly evolving "flash" droughts (developing over a few weeks) and sustained droughts (developing over months but lasting up to years).

https://www.drought.gov/drought/sites/drought.gov.drought/files/media/regions/rdews/UCRB/documents/rpt_EDDI_2-pager_2015.pdf

Southern California Predictive Services (USFS)

Current conditions and outlooks related to fire potential including weather discussions, fuels and drought outlook. Highlights at the meeting included the Santa Ana Wildfire Threat Index (SAWTI) and monthly & seasonal outlooks.

<http://sawti.fs.fed.us/#8/33.993/-119.193>

<http://gacc.nifc.gov/oscc/predictive/weather/>

NOAA Drought Amelioration Project

<https://www.ncdc.noaa.gov/temp-and-precip/drought/recovery/current>

Observing Fallowed Lands

https://nex.nasa.gov/nex/static/media/other/Central_Valley_Fallowing_Data_Report_14Oct2015.pdf

Satellite Irrigation Management Support (SIMS)

<http://ec2-54-197-48-121.compute-1.amazonaws.com/dgw/sims/>

NWS/USGS Debris Flow Forecasting

Experimental Post Wildfire Debris Flow and Flash Flood Web Page
<http://www.wrh.noaa.gov/wrh/postwildfire/?wfo=mtr>



USDA California Regional Climate Hub

<http://www.climatehubs.oce.usda.gov/california>

The California Regional Climate Hub's (CA Hub) mission is to bridge the gap between producers of climate science and research and producers of agricultural products.

The CA Hub strives to help California land users (farmers, ranchers, forest landowners, and tribes) and land managers maintain sustainable communities and ecosystems by adapting to climate variability and change.

The CA Hub recently published a series of two-page fact sheets on drought in California as part of their most recent regional assessment. Find out more here: <http://www.climatehubs.oce.usda.gov/california/california-regional-assessments>

