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OVERSIGHT HEARING ON THE CALIFORNIA DROUGHT:
ACTIONS BY FEDERAL AND STATE AGENCIES TO ADDRESS IMPACTS ON LANDS, FISHERIES, AND WATER USERS

BEFORE THE
COMMITTEE ON NATURAL RESOURCES
U.S. HOUSE OF REPRESENTATIVES

March 31, 2009

Good morning Mr. Chairman and Members of the Committee. My name is Mary Glackin and I am the Deputy Undersecretary for Oceans and Atmosphere of the National Oceanic and Atmospheric Administration (NOAA). Thank you for the opportunity to testify at this oversight hearing about the actions being taken by NOAA to address the effects of drought in California, and in particular the effects on salmon fisheries.

Today I will specifically address the current hydrometeorological conditions and NOAA's weather and water supply predictions for northern California, as well as the actions being taken by NOAA's National Marine Fisheries Service related to the drought's effects on anadromous fisheries resources in California. I will also discuss the valuable climate services and information NOAA provides to the nation in an effort to help reduce or manage such impacts.

NOAA's National Weather Service (NWS) and its partners at the California Department of Water Resources and the U.S. Bureau of Reclamation, expect 2009 to be the third dry year (experiencing below-normal precipitation) in a row for California. Carry-over storage of water in major reservoirs, including Shasta Reservoir on the Sacramento River, Oroville Reservoir on the Feather River, and others, is well below normal. Human activities and natural resources, including fish populations, in these watersheds can be severely impacted during these drought periods. On Friday, February 27, 2009, the Governor of California declared a statewide drought emergency. This drought is a major concern for the salmon fishery resource because of the status of salmon populations and the state of the salmon fishery, for which a west-coast wide commercial fishery disaster was declared in 2008.

CURRENT CALIFORNIA HYDROMETEOROLOGICAL CONDITIONS, WATER SUPPLY FORECASTS, COMPARISONS TO NORMAL, AND CLIMATE TRENDS

In discussing the current conditions in California, I would like to highlight some of our data and information regarding precipitation, snowpack, and water supply forecast, as well as general trends.

PRECIPITATION

After a prolonged dry spell, recent heavy precipitation helped increase the water stored in the region's reservoirs and mountain snowpack. However, water supplies remain below the historical average levels after three drier than average years. During February, large sections of the Sierra Nevada and Coastal Mountain Ranges in Northern California received from 6 to over 20 inches of rainfall (Figure 1), with substantial additional precipitation in the northern sections of the state in early March. However, a retrospective examination of precipitation data for the state reveals a prolonged period of below-normal precipitation. The year-to-date totals for much of California range from only approximately 25 percent of normal, to near normal (Figure 2). The vast majority of the state experienced only 25 percent to 75 percent of normal precipitation during 2007 (Figure 3), and from 50 percent to 90 percent of normal precipitation during 2008 (Figure 4).

SNOWPACK

Although snow basins in central and northern sections of the state, including the Sacramento and San Joaquin basins, saw additional gains to snow water content from recent February and early March storm systems, snowpacks across the state still remain below normal and are less than those measured at the same time last year (Figure 5). The snow water content for basins in central California is approximately 80 percent of the April 1 normal level with slightly higher values, near 90 percent of normal, in northern basins.

RESERVOIR STORAGE

In spite of the recent heavy precipitation, reservoir storage continues to be below average for many of California's major reservoirs, particularly the largest reservoirs located in the northern part of the state (Figure 6). In fact, current observations at the Shasta, Lake Oroville, and Trinity Lake Reservoirs indicate they are currently at 72 percent, 66 percent, and 59 percent, respectively, of their historical average levels. The opportunity to further increase reservoir levels is diminishing as the wet season in the west, which typically extends to the end of April, is nearly over.

WATER SUPPLY FORECASTS

In many basins of the western United States, as much as 70 percent of the annual stream flow arises from the melting of the seasonal snowpack each spring. Current observed stream flow for the majority of locations in the state of California is below to near normal (Figure 7). Above-normal stream flow is occurring in the far northern part of the state in response to recent heavy precipitation.

The NWS and its California Nevada River Forecast Center (CNRFC), in collaboration with the Department of Agriculture's Natural Resources Conservation Service, generate water supply forecasts for California. These forecasts are then coordinated with the California Department of Water Resources, the Department of the Interior's U.S. Bureau of Reclamation, and local water district managers. The NWS issues water supply forecasts for seasonal snow melt stream flow volumes in the western United States. Forecasts are typically issued monthly, between January and July, and combine information from current mountain snowpack states with soil moisture and weather and water forecasts through a hydrologic and snow modeling system at NWS River

Forecast Centers. All NWS forecast volumes are based on natural flow, so the actual observed flow may be affected by upstream water management.

NWS water supply forecasts from the CNRFC indicate below-normal stream flow for the upcoming snowmelt season (Figure 7). Forecasts for nearly all locations in the state are in the 50 percent-90 percent of normal range. These forecasts are based on observed conditions as of March 1 and therefore do not account for recent March snowfall. In the Sacramento Basin, the April through July water supply runoff projections range from 85 percent of normal for the McCloud River at Shasta Lake, 78 percent for the Upper Sacramento River at Shasta Dam, 76 percent for the Yuba and American Rivers, and 65 percent for the Feather River at Oroville. In the San Joaquin Basin, April through July water supply forecasts call for runoff at the major river inflow points to be in the 78 percent to 82 percent range[1]. Updated CNRFC water supply forecasts for California are scheduled to be available by April 10[2]. Verification of water supply forecasts for the past 12 years (1997-2008) shows NWS forecasts demonstrate skill above the historical average value (climatology). In particular, general improvement over climatology begins with the March forecast, and continues to increase in April and into May, as most of the snowmelt will have already occurred by that time. In general, NWS water supply forecasts tend to be more accurate during years when the observed flows are less than the historical average.

DROUGHT BACKGROUND

Drought refers to a deficiency in long-term average precipitation over a period of time resulting in a water supply shortage that has an adverse effect on the environment, agriculture, industry, recreation or domestic consumption. In the west, droughts can be exacerbated due to impact of warming temperatures on snowpack, increasing envirotranspiration (absorption of atmospheric moisture by plants), and decreasing soil moisture resulting in reduced available water supply. Although they are normal recurrent features of climate that vary from region to region, droughts can have profound societal and environmental effects. Droughts stand apart from other natural hazards. Drought can last for a season, for multiple years, or even decades with cumulative effects carried on from year to year. Being slow to onset, drought does not tend to directly affect infrastructure. The secondary effects of drought, however, such as on tourism, commodity markets, transportation, wildfires, insect epidemics, soil erosion, and hydropower, are frequently larger and longer lasting. Each year drought is estimated to result in average annual losses to all sectors of the economy of between $6 and 8 billion (in 2002 dollars[3]).

Although drought has not threatened the overall viability of U.S. fisheries, it is an additional stress on ecosystems and can impact recovery efforts for stream-dependent fish, such as west coast salmon, exacerbating the costs to regional and local coastal communities.

[1] http://www.wrh.noaa.gov/total_forecast/getprod.php?wfo=sto&sid=STO&pil=ESF
[2] http://www.nwrfc.noaa.gov/westernwater/index.php?page=map&id=
[3] Economic Statistics for NOAA, April 2008, 6th edition

FORECAST FOR THE NEXT 12 MONTHS

Current drought conditions are depicted in the U.S. Drought Monitor (Figure 8), which shows most of California experiencing moderate to severe long-term drought. The U.S. Seasonal Drought Outlook, valid through May 2009 (Figure 9), shows some reduction in the severity of the drought is expected, due to recent precipitation. However, the drought is not over. For the longer term, drier than normal conditions for Northern California are more likely from April through September. After that period, current data does not support a trend either way — i.e., the chances are equal for above, below, or normal precipitation.

LONG-TERM TRENDS IN TEMPERATURE AND PRECIPITATION

Recent climate studies[4] incorporating observations from 1941-present reveal long-term trends in average temperature and precipitation over the conterminous United States, which indicate warmer winters and springs and drier falls in the western United States, drier winters and summers in the northwest to northern plains, drier springs in the southwest, southern plains, and southeast, and wetter conditions for other areas and other seasons. The western United States, including California, has experienced warming trends in every season, though these are most prominent in the spring and summer. Northern California has also experienced wetter conditions during the spring, summer, and fall seasons, with some indication of wetter winters, though these trends are weak. However, the recent dry years in California deviate from this trend. Observed increases in average temperature are projected to continue throughout the United States during the 21st century. Interior and more northern regions are projected to warm more than coastal and more southern regions. The magnitude of the projected temperature increases depends upon the amount of greenhouse gases emitted globally. Projected changes in precipitation depict a continuation of recent trends, in which dry areas will generally become drier and wet regions will become wetter. For most regions, especially those that become wetter, the character of precipitation is projected to continue an observed trend of more frequent heavy precipitation events, with relatively little change in light and moderate events. Precipitation projections show a continued decrease of precipitation and runoff in the southwestern United States, including southern California. For the western U.S., the projected increase in temperatures will result in more rain and less snowfall, higher snow elevation levels, earlier runoff, and consequently less spring and summer snowmelt for water supply. In general, the degree of confidence for temperature projections is higher than that for precipitation projections.

NOAA'S ROLE IN IMPROVING SOCIETY'S CAPACITY TO RESPOND AND ADAPT TO DROUGHT

NOAA's Office of Oceanic and Atmospheric Research (OAR) provides a number of services to help predict and respond to the effects of drought. NOAA's services include assessments and predictions of climate change and variability on timescales ranging from weeks to decades for a variety of phenomena, including drought. These services provide observations, analyses and predictions, decision support tools, and sustained user interaction. NOAA's National Marine Fisheries Service (NMFS), as well as coastal and land-based communities, use these services and

[4] Livezey, R.E., Vinnikov, K.Y., Timofeyeva, M.M., Tinker, R., and H.M. van den Dool. 2007. Estimation and Extrapolation of Climate Normals and Climate Trends. Journal of Applied Meteorology and Climatology. 46:1759-1776.

information to improve management of climate sensitive sectors (such as fisheries and other living marine resources, energy, agriculture, and water).

I will briefly describe some of these services and then focus the remainder of my testimony on the effects of drought conditions on California salmon populations.

NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

The *National Integrated Drought Information System(NIDIS) Act of 2006* (*NIDIS Act*; 15 U.S.C. § 313d and § 313d note) prescribes a multi-agency and multi-state approach, led by NOAA, for coordinating drought monitoring, forecasting, and early warning at watershed, state and county levels across the United States. The goals of NIDIS are to improve and expand upon reliable data and indicators of droughts (both hydrological data as well as information on societal effects), and to integrate and interpret the data with easily accessible and understandable tools to provide timely information to both the public and policymakers.

NIDIS links multi-disciplinary observations from a number of federal and state sources to 'on-the-ground' conditions through its U.S. Drought Portal. The Drought Portal provides comprehensive information on emerging and ongoing droughts. NIDIS engages partners in agricultural, recreational, environmental, commercial, water management, and other sectors and tailors Drought Portal information to enhance the nation's drought preparedness at relevant scales (watershed, state, county). The NIDIS framework offers a dynamic and accessible drought risk information system that provides users with the capacity to determine the potential impacts of drought, and the decision support tools needed to better prepare for and mitigate the effects of drought. NIDIS is beginning to work with the Western Regional Climate Center, the University of Nebraska Drought Mitigation Center and the State of California to assess relevant drought information. For instance, salmon fishery managers will benefit from NIDIS activities by being better positioned to make decisions regarding preparation for low water flow conditions and riparian impacts and the need to provide water resources in a particular stream or alter hatchery release operations at critical times.

HYDROMETEOROLOGICAL TESTBED

NOAA's Hydrometeorological Testbed (HMT) project operates a sophisticated network of weather and river hydrology instruments that enhance the regional observations available to the NWS Weather Forecast Offices and River Forecast Centers. The HMT is designed to inform forecasters, hydrologists, and water resource managers of watershed changes related to floods. NOAA's research has shown that improved monitoring in a testbed setting improves lead times for flood forecasts and warnings.

Drought-specific applications:

(1) The HMT helps enable forecast-based reservoir operations that will decrease the risk of reduced summer water supply while maintaining adequate flood control capability. The ability to optimize both flood control and water supply has major benefits to fisheries by enabling more effective use of the naturally available water resources.
(2) The HMT is helping to design and deploy state-of-the-art soil moisture monitoring networks, which are critical for both drought monitoring and flood prediction.

(3) The HMT has led the development of new methods for monitoring and predicting atmospheric rivers, which are narrow regions (300-400 km wide) of water vapor that are responsible for more than 90 percent of the world's transport of atmospheric water vapor. Atmospheric rivers provide a key source of moisture to Western states from Pacific evaporation that falls as rain and snow in the Western states. For example, atmospheric rivers provide approximately 50 percent of Northern California's water supply, and are associated with most, if not all, the major floods in the west coast states.

REGIONAL INTEGRATED SCIENCES AND ASSESSMENTS

There are nine NOAA-supported Regional Integrated Sciences and Assessments (RISA) teams that focus on climate impacts and adaptation issues. Four of these university-based RISAs are located in the western United States. These multidisciplinary teams of experts in climate, water, law, ecology, and economics work to identify and characterize regional vulnerabilities associated with climate variability and change, such as drought, and to develop information products and processes to inform water resource decision-making throughout the Intermountain West. By gathering, analyzing, and presenting data about the state of the climate and hydrology issues, and producing forecast products, the RISAs are providing decision support to state governments, water managers, industry interests such as energy, skiing, tourism, natural resources, and fisheries in the western United States. Research at the Climate Impacts Group, University of Washington, focuses on the impacts of climate variability and change on salmon populations, and led to the development of a forecast tool for use in managing salmon stocks. A complementary team of NOAA-supported regional climate impacts experts are located at the California Applications Program (CAP) housed at the Scripps Institution of Oceanography in California, and works with partners in Nevada. This RISA team is supported by NOAA, the U.S. Geological Survey, and the state of California, and analyzes the effects of climate, and in particular drought, on water resources, fire, and health issues in California.

DROUGHT EFFECTS ON FISHERIES IN CALIFORNIA AND ACTIONS TO ADDRESS AILING SALMON POPULATIONS

MANAGING THREATENED AND ENDANGERED SALMON IN LOW WATER CONDITIONS

While the weather and climate predictive capabilities within NOAA provide an essential service to resource managers, the agency continues to struggle with the restoration and recovery of threatened and endangered salmonid populations, as well as salmon fisheries, as a result of drought and other environmental and human-induced impacts. Both NOAA and the state of California have listed numerous species of anadromous fish as threatened or endangered in California. Anadromous fish start their lives in streams and then migrate to the ocean before returning to the streams to spawn the next generation. These fish populations are distributed throughout the entire length of the state. Pursuant to the *Endangered Species Act*, NOAA consults with federal agencies and works closely with the state and many other non-federal entities to protect and recover endangered and threatened species. NOAA issues formal biological opinions and incidental take statements in response to proposed federal and non-federal activities that affect anadromous fish, and in the process, does its best to ensure water of sufficient quantity, quality and temperature will be delivered to rivers and streams at the appropriate times for the fish to complete their life-cycles.

Drought conditions pose the most challenging conditions for ensuring sufficient water remains in the rivers and streams for salmon. In this third dry year, NOAA confers frequently with the state and federal water managers to most effectively use the water available for the protection of fish, while recognizing the health and safety needs of the public. At this time of year, water delivery plans are updated monthly based on forecasts of inflow to the reservoirs.

This real-time management is possible in large-scale watersheds with significant storage capacity. However, smaller watersheds without significant storage generally have little flexibility in water management for fish and thus rely on snowpack, which, as mentioned above, has been below the long-term average in recent years. In cases where fish are threatened by lethal warm water temperatures or become stranded in drying streams, moving those fish may be the only feasible alternative. This may be a particularly important strategy for fish that are listed as threatened or endangered.

MANAGEMENT ACTIONS IN CALIFORNIA

Although many of these salmonid species have adapted over time to periods of drought and changing ocean conditions, additional stresses induced by predation, invasive species, sanitation discharges, water diversions and other human development activities have increased their susceptibility to the negative effects of those natural events. On February 17, 2009, representatives from NMFS, the California Department of Water Resources, and the U.S. Bureau of Reclamation, along with researchers from University of California at Davis and Humboldt State University, held a teleconference to discuss the potential need and process for rescuing salmon and steelhead that may become stranded due to low flows. This call was organized in anticipation of immediate short-term problems for salmon and steelhead throughout California as a result of low snowpack and projected low flows in rivers and streams.

The agencies determined it was prudent to develop technically sound strategies to approach the fish rescue situation this year, and to ensure the responsible state and federal agencies were approaching the challenge in a coordinated and consistent manner. An interagency strategy was subsequently developed to address potential fish rescues for 2009. The four key objectives of the strategy are:

1. To ameliorate short-term survival bottlenecks (water temperature, flow, etc.) and boost chances for survival;
2. In view of longer-term recovery efforts, to perpetuate those species at the greatest risk of extinction;
3. To learn more about the effectiveness of various rescue approaches; and
4. To educate the public and be responsive to high priority stakeholder inquiries. Because most rescues are requested by stakeholder groups and members of the public, it will be important to clearly communicate the fish rescue strategy and objectives so the public understands when and why we choose to act.

The agencies agreed that the California Department of Fish and Game will serve as the lead fishery agency for all fish rescue actions. The California Department of Fish and Game will

coordinate with NMFS and the U.S. Fish and Wildlife Service before making a final decision about whether to pursue a rescue effort in any particular watershed or at any particular site.

All rescued fish will be relocated to the nearest suitable upstream or downstream habitat within the same stream or river to the maximum extent possible, with effectiveness monitoring and management plans implemented to gauge the success. If suitable habitat is unavailable, the California Department of Fish and Game, in consultation with the federal agencies, will make a determination about whether to relocate the rescued fish to a different stream or river, or to a recovery facility. In some cases, the agencies might need to consider relocation of fish above major reservoirs. These cases would be considered experimental and additional tagging and related monitoring and studies would need to be implemented.

There is little capacity to accommodate rescued fish at hatcheries within California. If necessary, the Livingstone National Fish Hatchery could accommodate up to 250 more adult, endangered winter-run Chinook and some threatened spring-run Chinook salmon.

As I mentioned earlier, 2008 was a difficult year for salmon fisheries and those who depend on them. It was, in fact, the worst salmon fishery collapse on record for California and led to the complete closure of the ocean salmon fishery off the California coast. Subsequently, on May 1, 2008, the Secretary of Commerce declared a commercial fishery failure for the West Coast salmon fishery and Congress appropriated $170 million for disaster relief. This year is looking equally problematic. In a report released last week, NMFS, in conjunction with several other scientific agencies (e.g., California Department of Fish and Game, Oregon Department of Fish and Wildlife, Washington Department of Fish and Game), reported that poor ocean upwelling conditions in 2005 and 2006 were most directly responsible for the 2008 salmon fishery collapse. Nonetheless, freshwater factors and the availability of freshwater were implicated indirectly. Loss of freshwater habitat is a chronic problem and has made salmon populations more susceptible to poor ocean conditions, limiting the benefits of recovery programs when ocean conditions return to normal. An array of factors including land and water development and diversions in the Sacramento-San Joaquin watershed have degraded the once-diverse habitats that historically supported highly diverse Chinook populations, which drive the ocean salmon fishery. Drought conditions amplify these factors, causing them to have a much more severe impact on remaining fall Chinook populations, which lack the diversity necessary to allow the population to be resilient during periods of nutrient poor ocean conditions or other factors.

An improved multi-year Fish Rescue Strategic Plan is needed to address the increasing demands on water resources in California. NOAA will continue to work with its fish management partners on such a plan. If drought conditions persist beyond 2009, these agencies recognize the likelihood that additional intervention and conservation efforts might be needed in 2010, and perhaps beyond.

CONCLUSION

Information services for adaptation to short-term (seasonal) or longer-term (multi-year) droughts will be important in coping with current climate vulnerabilities and effects in the near-term, and

will also help support resilient economies as climate changes. Water managers in some states are already considering explicitly how to incorporate the potential effects of climate change into specific designs and multi-stakeholder settings. For example, in California and Nevada, adaptive management measures such as water conservation, reclamation, riparian protection, conjunctive use of surface and groundwater, and desalination of brackish water have been advocated as a means of proactively responding to climate change threats on water supply. Integrated water resources and coastal zone management are based around the concepts of flexibility and adaptability and using measures that are resilient to changing conditions. NOAA is actively involved with its federal and state partners in these efforts. Nonetheless, unmitigated anthropogenic climate change could, in the long-term, exceed the capacity of some natural, managed and human systems to adapt, especially in drought-prone, rapidly developing regions. For this reason, and for the health of local and regional economies, we must continue to anticipate and develop systems to respond rapidly to the effects of drought on both our human communities and natural and protected resources.

Thank you again for this opportunity to present NOAA's views on these matters. I would be happy to answer any questions that you may have.

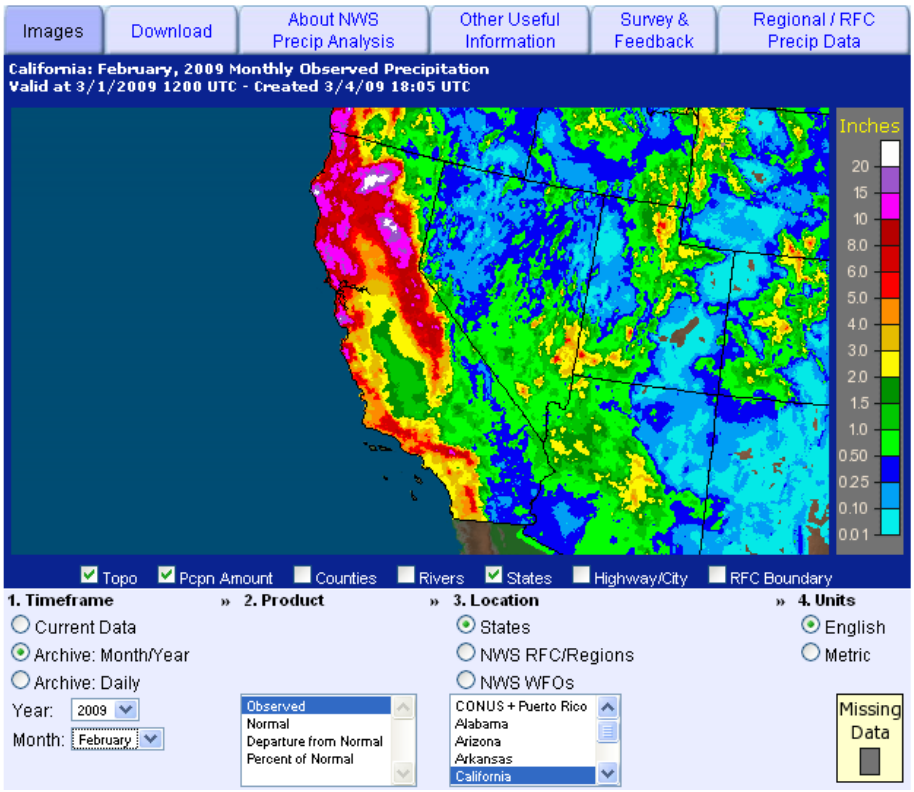

Figure 1: Observed precipitation in inches for February 2009.

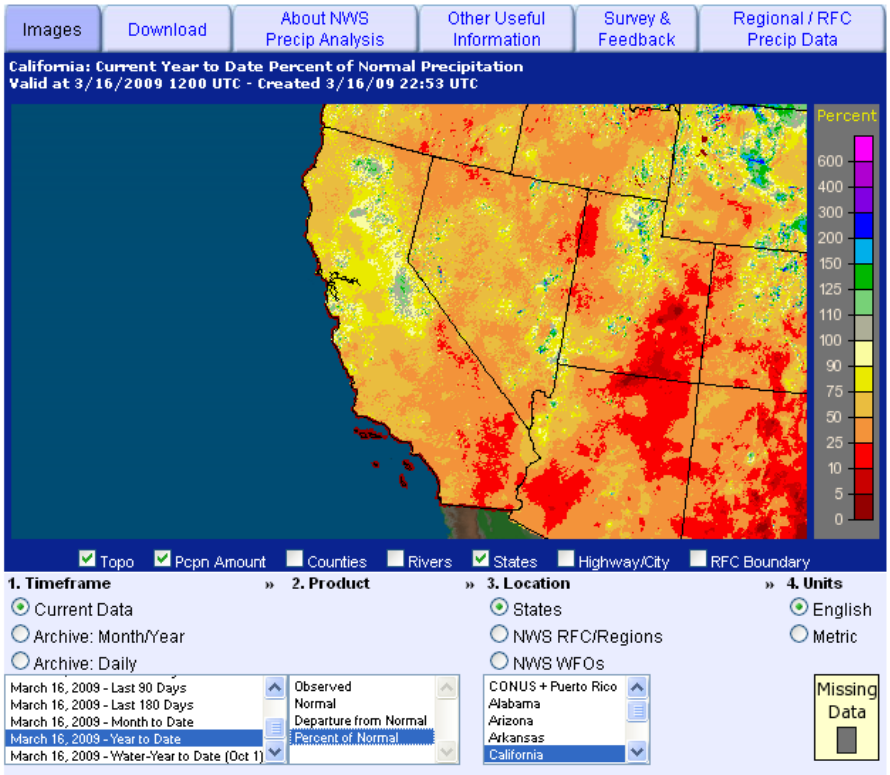

Figure 2: Percent of normal precipitation January 1-March 16, 2009.

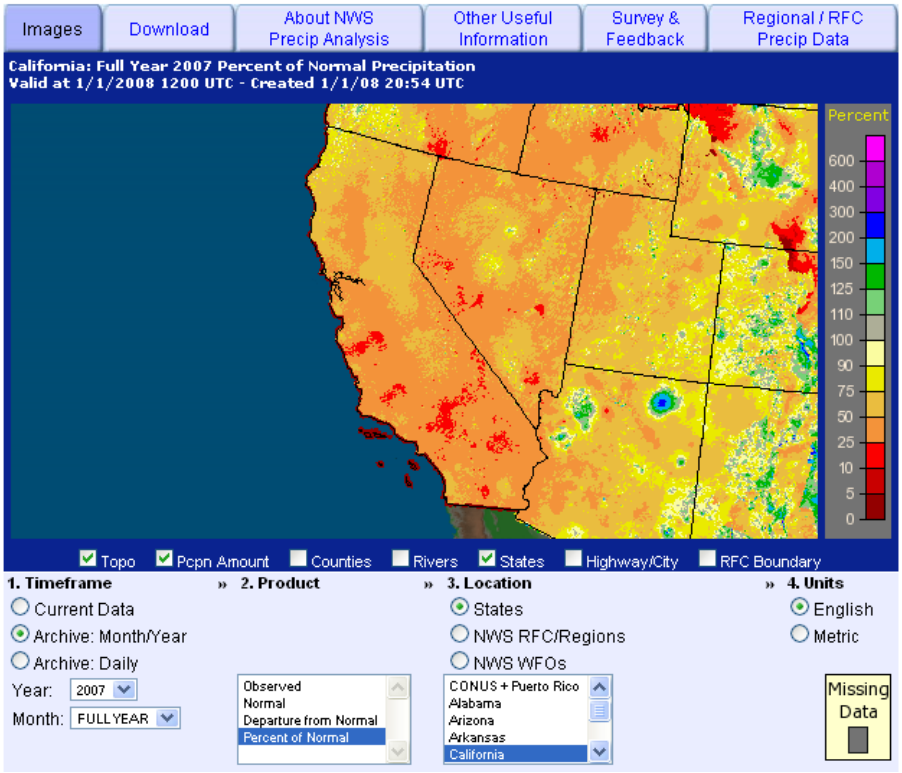

Figure 3: Percent of normal precipitation for January 1-December 31, 2007.

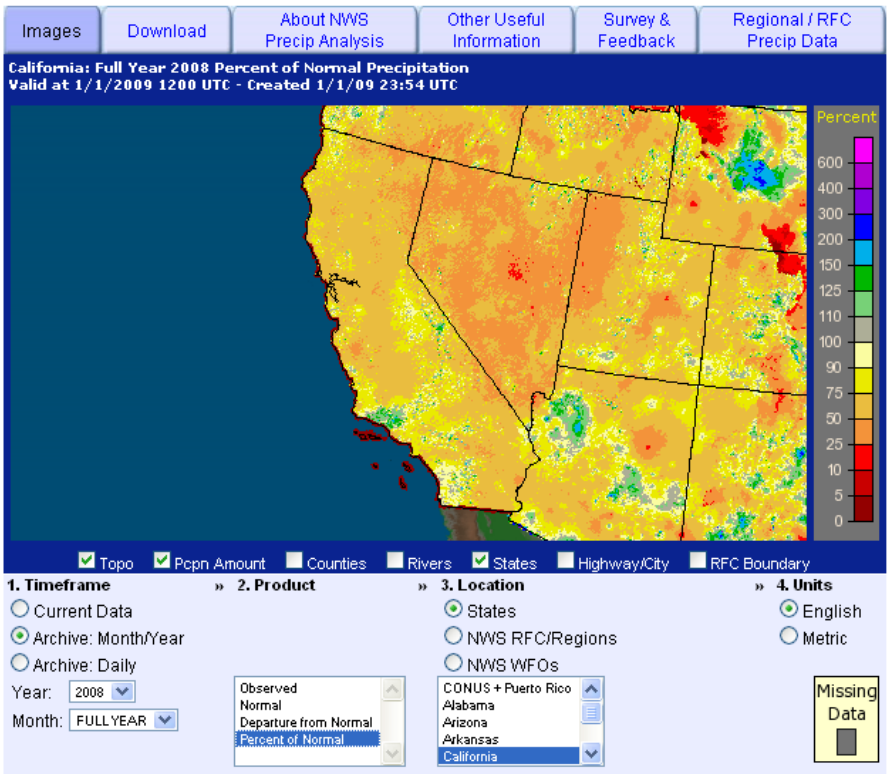

Figure 4: Percent of normal precipitation for January 1-December 31, 2008.

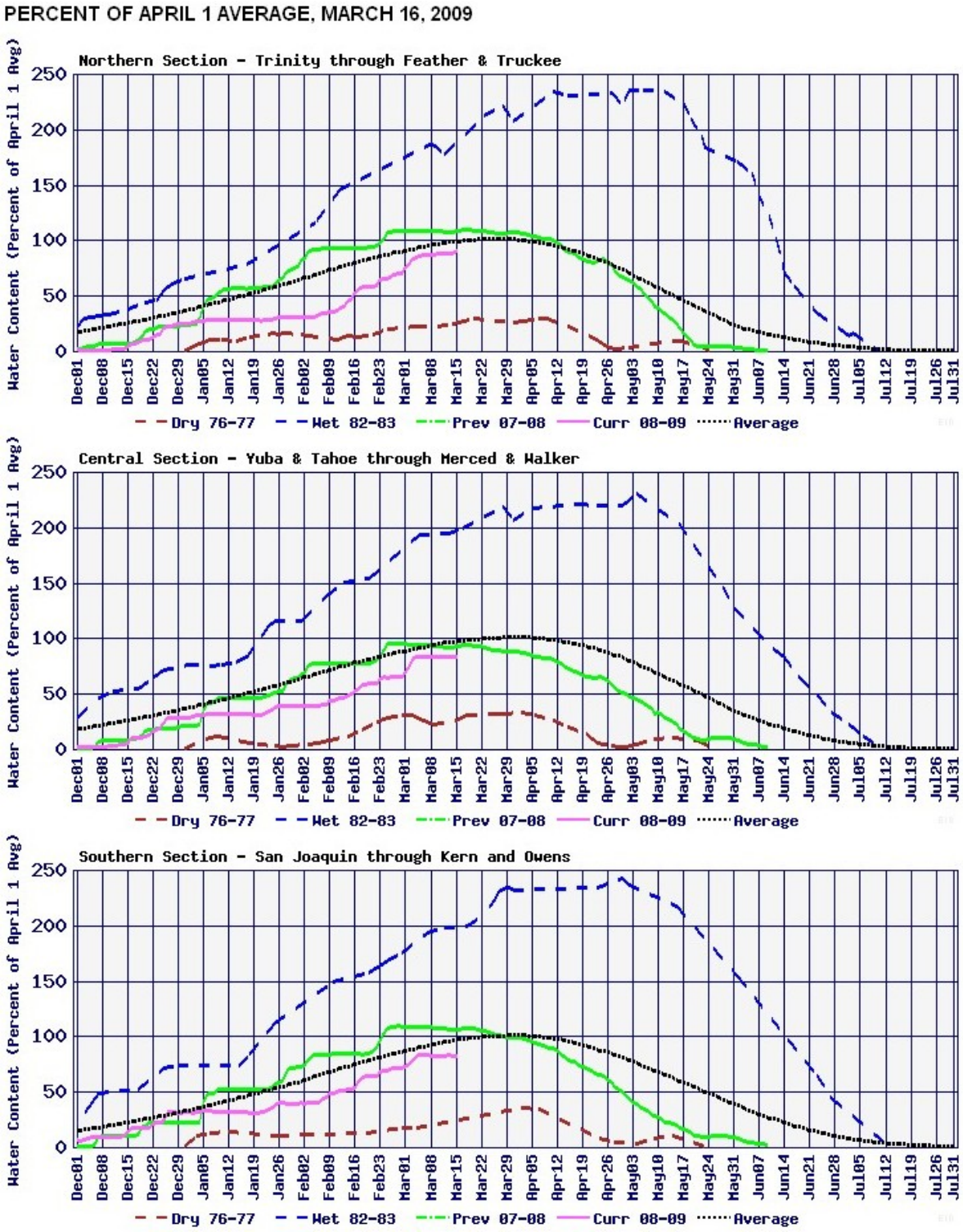

Figure 5: Snow Water Content in California Basins as of March 17, 2009 (from CA Department of Water Resources – http://cdec.water.ca.gov/cgi-progs/snow/PLOT_SWC)

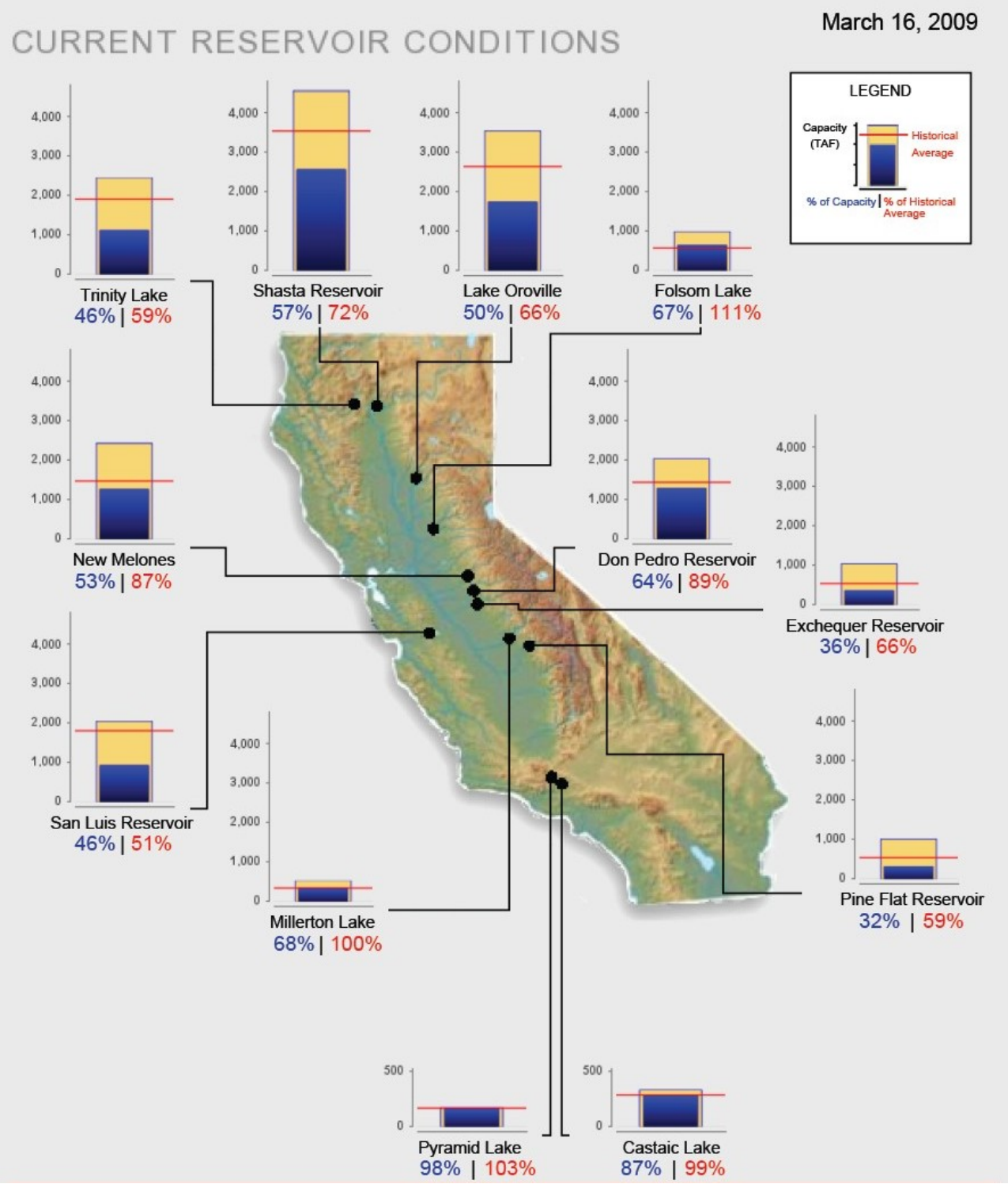

Figure 6: California Reservoir Storage Conditions as of March 16, 2009 (from CA Department of Water Resources http://cdec.water.ca.gov/cgi-progs/products/rescond.pdf)

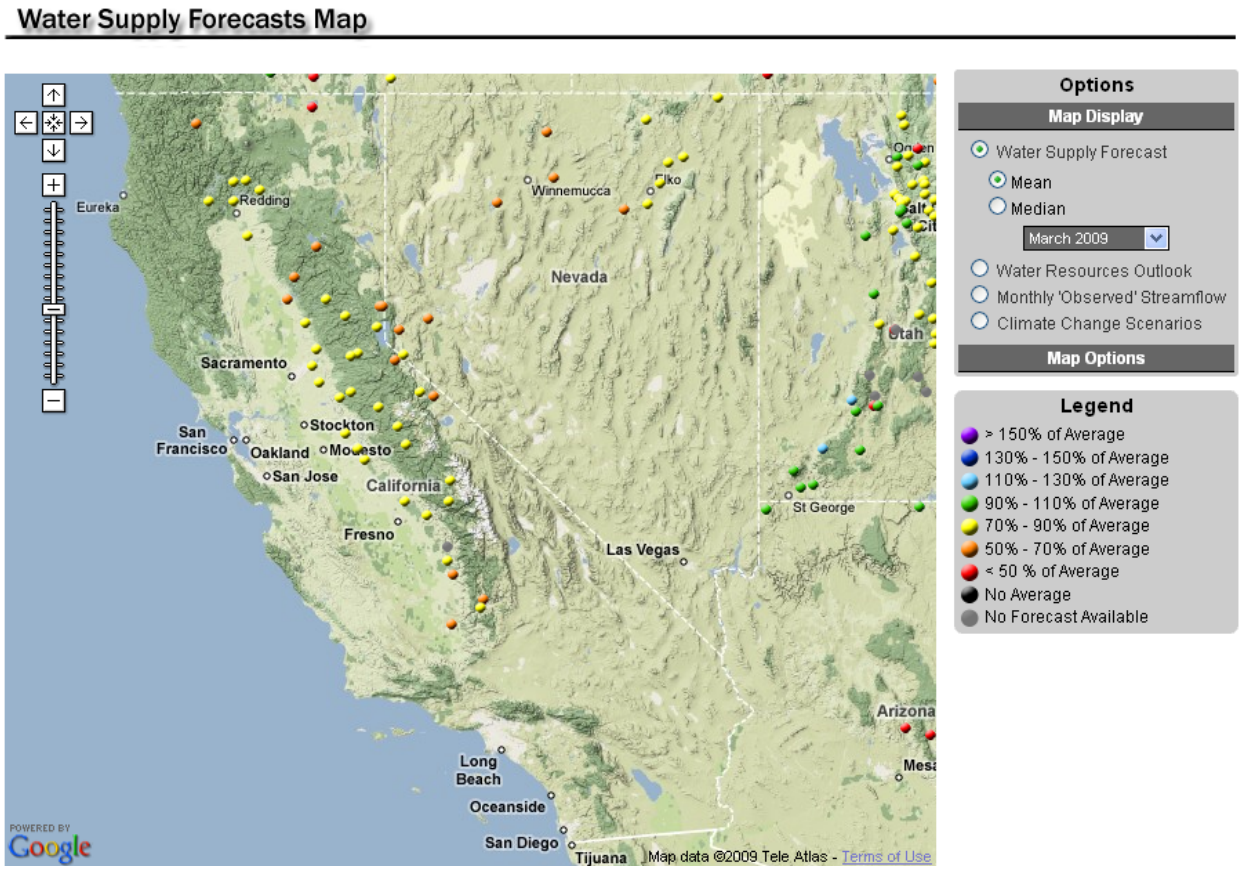

Figure 7: Water supply forecasts compared to mean flows at NWS service locations for the forthcoming snow melt season - http://www.nwrfc.noaa.gov/westernwater/index.php?page=map&id=

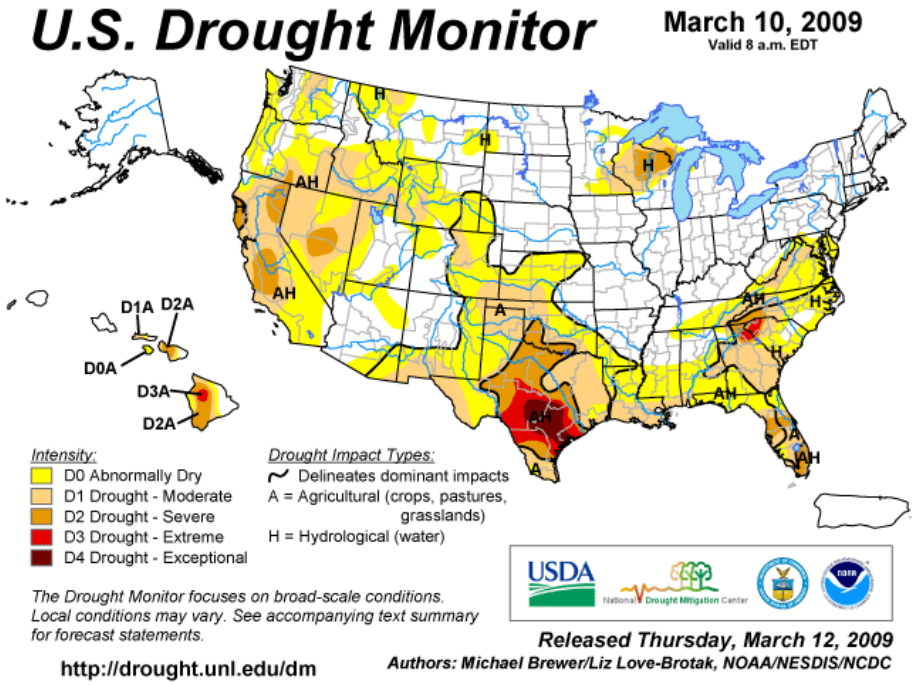

Figure 8: U.S. Drought Monitor focusing on broad scale conditions. Most of northern California is under moderate to severe drought conditions.

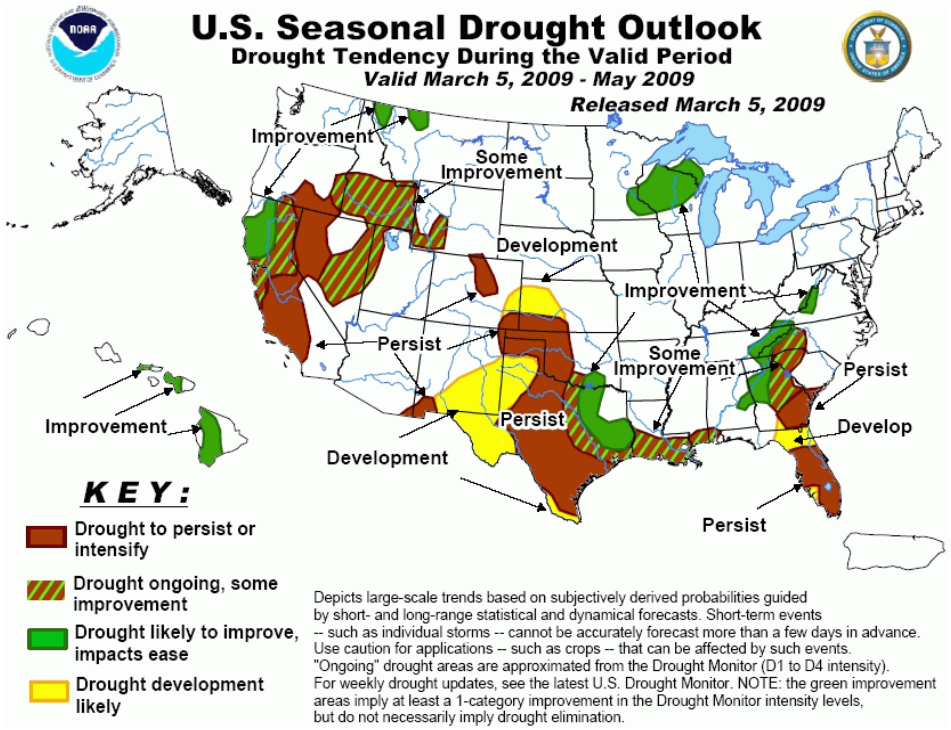

Figure 9: U.S. Seasonal Drought Outlook Monitor focusing on broad scale conditions. Most of northern California is under moderate to severe drought conditions.