Background to the Reservoir Drought Status Product

The Reservoir Drought Status product was created in collaboration with the California State Climatologist and the Climate Focal Points of the Sacramento NWS Forecast Office and CNRFC. The goal was to generate objective analysis for classifying droughts with an historical perspective. Reservoirs form a crucial link in California's water supply strategy. While the lack of precipitation is the first link in California droughts, low reservoir storages ultimately determine reductions in water supply for both agriculture and urban usage.

California's water supply is ruled by two important discontinuities. First, the majority of the population of California (63%) lives in Southern California, the driest region of the State. As a result, the state relies heavily on the wet regions of northern California, in particular the Sacramento River basin, to meet water demands. As shown in Figure 1, greatest amount of precipitation falls over the northern two thirds of the State. The second discontinuity is seasonal. The majority (80-90%) of the rain and snow that falls each year is focused on 6 months of the year (November – April), while the greatest water demands are in the spring and summer months. Therefore, the state has made great efforts to store winter and spring runoff in reservoirs to meet year-long water supply demands. The majority of the State's water supply reservoirs are located in the Sacramento and San Joaquin River watersheds.

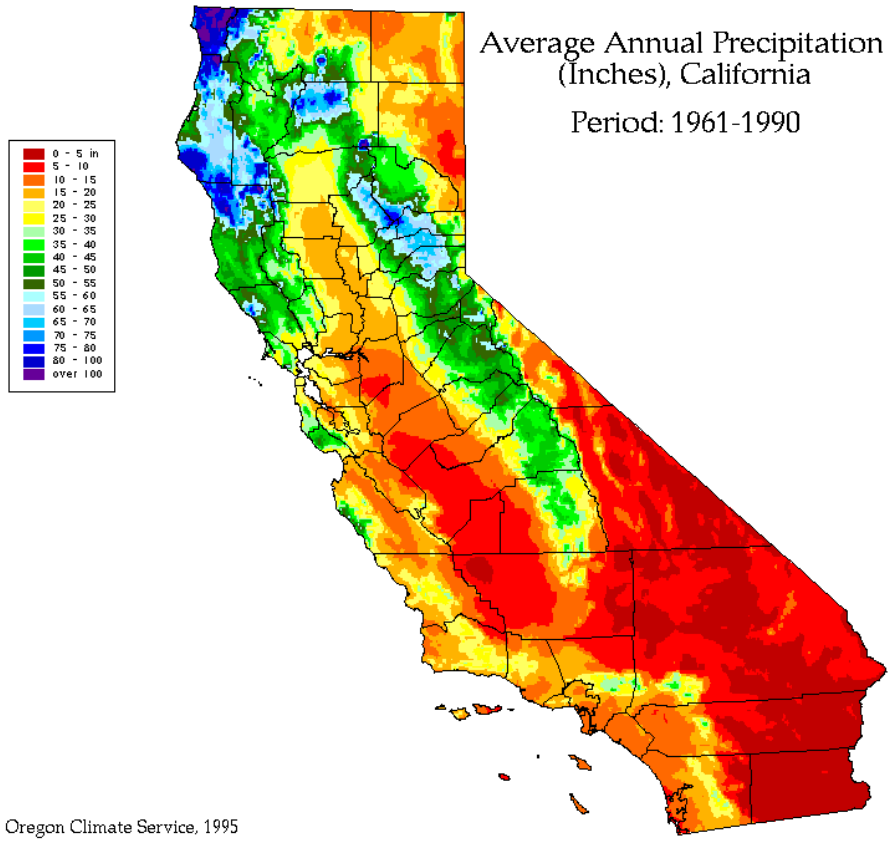

Figure 1

Map of annual rainfall generated using PRISM climate grids.

For more information, see: http://www.prism.oregonstate.edu/

Figure 2 shows the "statewide" end-of-month reservoir storage levels from 1974 -2008 using percentiles and the Drought Monitor's drought severity categories. The 1974-2008 time period was chosen as it includes most major reservoirs, accounting for approximately 64% of the total statewide storage. While individual reservoirs may have longer periods of record, the 1974 start date was determined by New Don Pedro reservoir which filled in 1974.

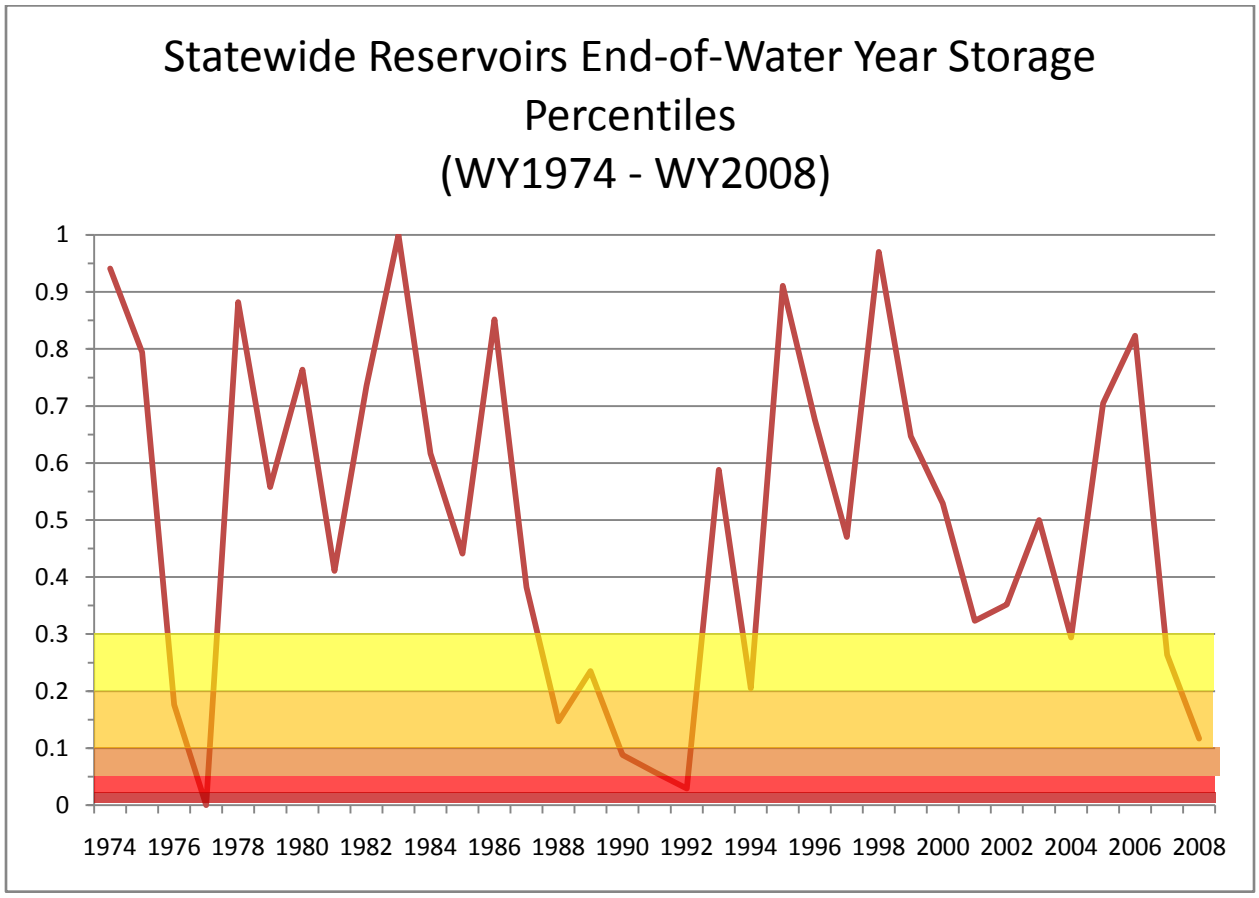

Figure 2

September 30th values of major reservoir storages . These reservoirs represent 64% of the total state capacity. Color scheme based on Drought Monitor (see http://www.drought.unl.edu/dm/drmon.gif

Percentile	Drought Monitor Category	
0.00 - 0.02	D4	Drought - Exceptional
0.02 - 0.05	D3	Drought - Extreme
0.05 - 0.10	D2	Drought - Severe
0.10 - 0.20	D1	Drought - Moderate
0.20 - 0.30	D0	Abnormally Dry
0.30 +		Normal

Looking at reservoir storages statewide in historical perspective is somewhat difficult due to several factors. Reservoir storage levels are affected not only by runoff from the watershed, but also by outflow, which is influenced by varying factors over time. Demand for water from State reservoirs is constantly changing. Simply from the fact that the State population is growing over time translates to a greater demand for the stored water supply in reservoirs. Another major factor is changing legal requirements to meet environmental standards. Current standards for water quality and species protection equate to even greater demands on State reservoirs. This means that current reservoir levels, when compared to the past, may be skewed toward a lower rank, not because of reduced inflow from dry conditions, but due to increased demand.

To illustrate this, Figure 3 compares the combined storage of three major reservoirs on the Sacramento River during two similar drought years, 1991 and 2008. When conditions require additional water in the Sacramento River to meet water quality standards, Shasta, Oroville and Folsom reservoirs are often called upon to increase releases and provide more fresh water to the Sacramento Delta. As Figure 3 shows, despite having 3 inches more precipitation during the 2008 water-year (as measured by the 8 Station Index), the combined storage for these three major reservoirs lost 1,000,000 ac-ft in comparison to WY1991 storages. The contrast is even more striking if you look at inflows. The full natural inflow for the three watersheds for WY2008 was 7.36 million ac-ft (MAF), but only 5.76 MAF in WY1991. Thus, for the entire year, these three reservoirs ended up about 2,600,000 ac-ft lower than they would have been in WY1991, much of that storage spent on water quality standards in the summer months (note the sharp decline in June-August, 2008).

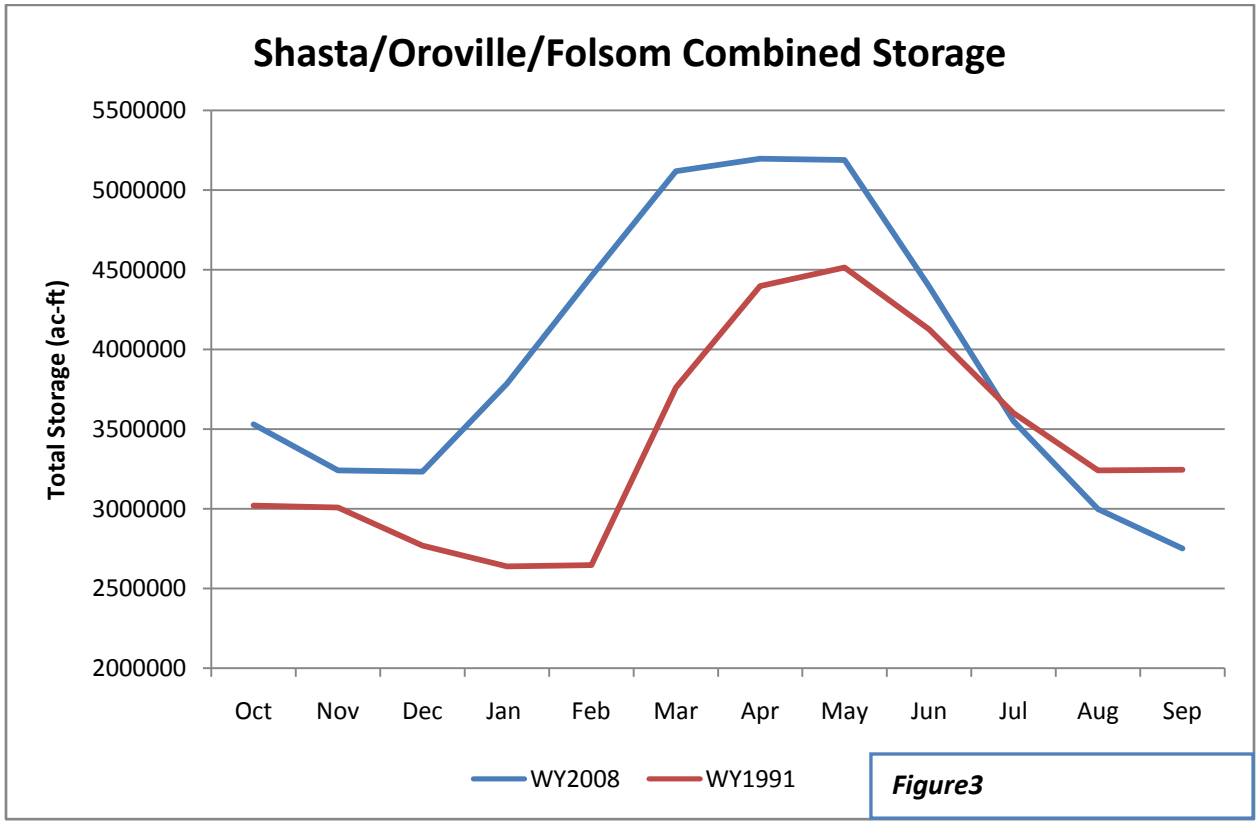

Figure3

Another difficulty in using reservoirs as a gauge of drought severity is the short period of record of some reservoirs. For example, New Melones Dam is major source of water supply. With a reservoir capacity of over 2.4 million acre-feet, New Melones is the fourth largest reservoir in the State. However, construction of New Melones dam was completed in 1978, and the reservoir did not reach full capacity until 1982. Therefore, the historic storage levels for New Melones would not include the 1976-1977 drought, leading the New Melones percentiles to be lower in comparison to surrounding reservoirs with longer periods of record.

Product Details

All the data behind this product was collected from the California Department of Water Resources website (http://cdec.water.ca.gov). The calculation of percentiles for each individual reservoir was based on the longest period of record available after the reservoir was filled. The listing of the period of records is as follows:

Reservoir	Period of Record (POR)		
Trinity	1/1/1963	-	Present
Shasta	1/1/1954	-	Present
Almanor	1/1/1965	-	Present
Oroville	1/1/1969	-	Present
New Bullards Bar	1/1/1970	-	Present
Tahoe	1/1/1959	-	Present
Folsom	1/1/1956	-	Present
Berryessa	1/1/1963	-	Present
Camanche/Pardee	1/1/1967	-	Present
New Don Pedro	1/1/1974	-	Present
New Exchequer	1/1/1968	-	Present
Friant	1/1/1954	-	Present
Pine Flat	1/1/1956	-	Present
Isabella	1/1/1968	-	Present
San Luis	1/1/1969	-	Present
Cachuma	1/1/1960	-	Present
Casitas	1/1/1970	-	Present
"Statewide"	**1/1/1974**	**-**	**Present**

There are two primary sections in the Drought Status Product. First is a map of the major State reservoirs and their Drought Status as defined by the Drought Monitor (See Figure 4). The major reservoirs included in this product are a mixture of different types. While most are primarily water supply reservoirs, others have large recreation concerns (Lake Tahoe, Lake Almanor, and Lake Berryessa) which play a role in storage levels. Efforts were made to include a couple Southern California reservoirs which are filled from local supplies (i.e, Lake Cachuma and Casitas). Knowing who operates a reservoir can also help explain why their particular storage level is high or low. For example, local agencies

operate New Bullards Bar and Lake Almanor, which often means these reservoirs will store more water in dry years, while Shasta, Oroville and Folsom may be forced to release more water to meet statewide water demands. San Luis reservoir is primarily a storage facility that receives and delivers water from the State Water Project.

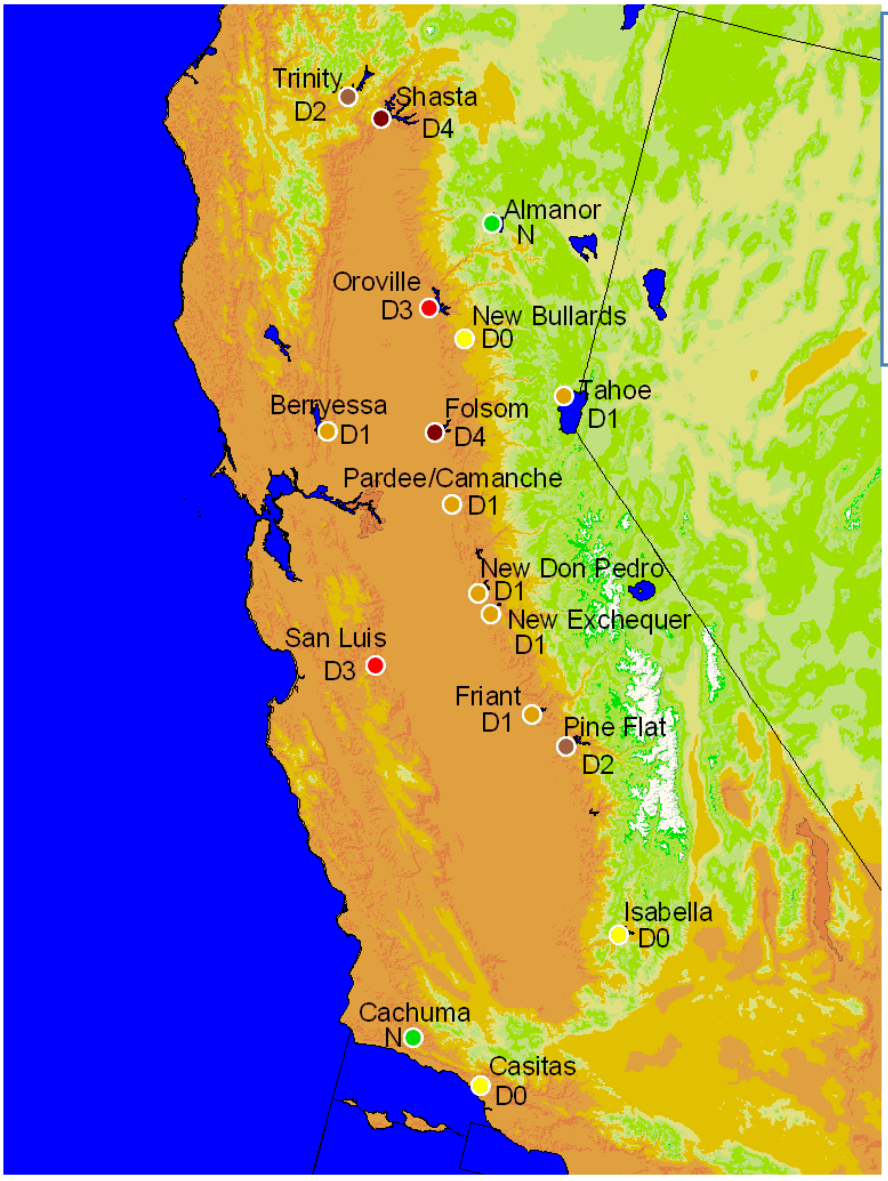

Figure 4

Example map of the drought status of major California reservoirs. The reservoir drought status is for end-of-January 2009.

The second section shows the past four months of storage percentiles for the 17 reservoirs tracked in this product. The percentiles are color coded according to the Drought Monitor scheme. The percentiles are listed up to three decimals to help gauge how close the reservoirs may be to changing from one category to another. Again, the period of record can have an impact on the result. The 1950s and 1960s had only one dry spell lasting longer than one year. So, a reservoir with a longer period of

record which begins in the 50s will tend to have a lower percentile than a reservoir whose period of record begins in the early 70's. Figure 5 shows the end-of-month storage percentiles for Jan. 31, 2009. The bottom line is a statewide summary of the 17 reservoirs in this product. In general, reservoir percentiles will tend to reflect 24-36 month drought conditions. California's water supply system can usually endure one dry year with only minor disruptions. After two dry years is when reservoir storages will begin to register in the drought categories (percentile 0.2 and below).

	As of Jan 31, 2009		End of Month Storage Percentiles			
Total Capacity (ac-ft)	Storage (ac-ft)	Reservoir	Oct	Nov	Dec	Jan
2477700	981,678	Trinity	0.088	0.088	0.088	0.086
4552000	1,416,145	Shasta	0.018	0.037	0.037	0.018
1143000	735000 *	Almanor	0.325	0.325	0.441	0.568
3537600	1,020,262	Oroville	0.025	0.025	0.000	0.025
966103	476,856	New Bullards Bar	0.236	0.236	0.289	0.230
732000	32,770	Tahoe**	0.224	0.224	0.183	0.180
977000	245,599	Folsom	0.096	0.096	0.019	0.018
1600000	1,123,009	Berryessa	0.266	0.266	0.244	0.195
614070	316,852	Camanche/Pardee	0.121	0.146	0.121	0.142
2030000	1,098,972	New Don Pedro	0.205	0.205	0.205	0.200
1024600	283,900	New Exchequer	0.195	0.195	0.195	0.166
520000	228,577	Friant	0.481	0.277	0.148	0.145
1000000	227,437	Pine Flat	0.134	0.134	0.134	0.094
568000	124,967	Isabella	0.300	0.275	0.300	0.268
2039000	701,877	San Luis	0.051	0.128	0.076	0.050
190500	162,558	Cachuma	0.625	0.625	0.562	0.428
254000	206,396	Casitas	0.447	0.421	0.394	0.282
24225573	8647855	Statewide	0.117	0.117	0.117	0.057

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0.05 - 0.10	D2	Drought - Severe
0.10 - 0.20	D1	Drought - Moderate
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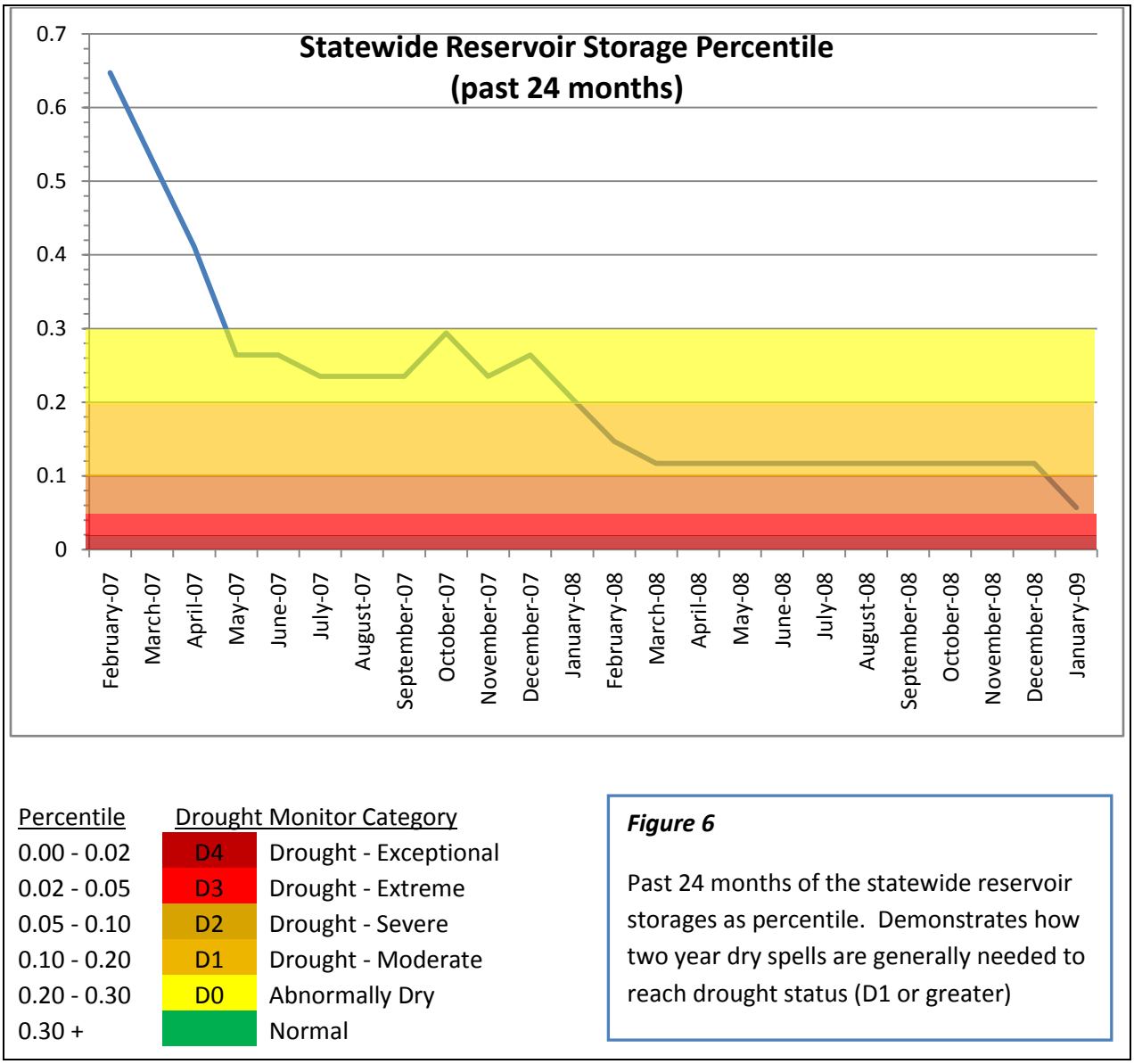
0.30 +		Normal

Figure 5

Example of past four months of reservoir storage percentiles, taken from Jan. 31st 2009 storages

Figure 6 is an example of how California's reservoir system responds to a multi-year drought. WY2006 was very wet, and most reservoirs at the start of WY2007 were well above average. WY2007 was moderately dry, with a below normal snowpack throughout the State. So by the summer of WY2007 the statewide reservoirs were at a .235 percentile, which corresponds to a pre-drought "abnormally dry" (D0) conditions. Only after the second year of below average rainfall in WY2008, did the statewide reservoir storages drop into the D1 category, beginning in March 2008. So far in WY2009 (as of mid-January 2009), the statewide reservoir system remains in better condition than during both the 1976-1977 drought and the 1990-1992 three year drought.

One caveat is needed to the general rule. While it generally takes two dry years to reach D1 status, the extremely dry year of 1976 reached D1 status for reservoir storage by the end of September (See Figure 2 above).



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0.30 +		Normal

Figure 6

Past 24 months of the statewide reservoir storages as percentile. Demonstrates how two year dry spells are generally needed to reach drought status (D1 or greater)

One “reservoir” included in the product which is tied more closely to water supply for western Nevada is Lake Tahoe. It was included to provide a look at central Sierra conditions. Since Tahoe responds to both runoff and direct precipitation on the lake it can represent both eastern Sierra runoff and conditions in the Sierra Nevada in general. The historic data for Lake Tahoe does not include the storage of the reservoir below the natural rim of the lake (6223 ft.). The lake level has dipped below this natural rim on several occasions. Therefore, there are some months with up to 10 storage levels at 0 ac-ft. These zeroes make it impossible to compute accurate percentiles. So when the lake level falls below the natural rim, a 0.000 percentile will be listed even though the condition may not be the worst on historical record.

For any additional information on this product, please contact our webmaster at: Cnrfc.Webmaster@noaa.gov