California Drought: Hydrological and Regulatory Water Supply Issues

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Summary

California experienced severe water supply shortages in 2009, which led to economic disruption across the state, including concentrated losses in agricultural areas in the western portion of the Central Valley—areas already experiencing declines in the housing industry and the economic downturn in general. At the same time, several fish species whose habitat lie at the heart of California's water supply system and throughout its northern rivers are in decline and some face the possibility of extinction. This situation too has had economic implications, resulting in job and income losses in northern California. The short-term issue for Congress is how to evaluate demands for increasing water supplies that may help some users but may jeopardize the continued existence of several fish species. A longer-term issue for Congress is how to evaluate management alternatives that will protect species, but also help water users and economies that depend on reliable water supplies and healthy ecosystems.

While three years of hydrological drought conditions have created a fundamental shortage of water supply in California, many water users have questioned the extent to which regulatory and court-imposed restrictions on water removed from the Sacramento and San Joaquin Rivers Delta, in order to protect fish habitat, have contributed to water shortages in 2009. Conversely, fishermen and others question to what degree increased Delta pumping in 2004 contributed to fish declines.

Current observations of below-average runoff, reservoir levels, and groundwater levels are broadly comparable to those observed during previous episodes of drought in California. At the end of water year 2008-2009 (October through September), statewide precipitation stood at 76% of average, and water levels in key reservoirs in the state were 69% of average. Groundwater levels from selected wells in the Central Valley are also broadly similar to groundwater levels during two previous historic drought periods. The below-average precipitation, below-average water content of the Sierra snowpack in consecutive winters, and similarity of groundwater levels compared across different periods of California drought support the contention that a multiyear hydrological drought underlies the current water crisis that faces California.

Depending on what baseline is used, total reductions in water exported from the Delta in 2009 are estimated to range from 37% to 42%. Restrictions on water deliveries resulting directly from federal and state regulations, or imposed by courts' interpretation of those rules, are estimated to range roughly from 20% to 25% of the total export reductions for 2009. The remaining 75%-80% of 2009 export reductions, according to the Department of the Interior, are due to "lack of run-off" (i.e., drought) and other factors. The system of state water rights also has a profound effect on who gets how much water and when, particularly in times of drought or other shortages. Water shortages due to drought and regulatory export restrictions have resulted in unequal impacts on Central Valley Project (CVP) and State Water Project water contractors because of differences in priority of water rights underlying different water contracts. Although combined Delta exports have increased on average since the 1980s and early 1990s, even with implementation of several regulatory restrictions, CVP water allocations for some contractors have been significantly reduced.

This report discusses California's current hydrological situation and provides background on regulatory restrictions affecting California water deliveries, as well as on the long-established state water rights system, which also results in uneven water deliveries in times of shortages.

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Introduction

This report analyzes California's current hydrological situation and addresses whether California is experiencing a hydrological drought and to what extent water delivery reductions are linked to regulatory restrictions. Some observers question the Administration's and the state's contention that drought conditions persist and that such conditions are largely to blame for significantly reduced water deliveries in 2009. It appears that three years of hydrological drought conditions have created a fundamental shortage of supply, and that regulatory and court-imposed restrictions, as well as the long established state water rights system, seem to have exacerbated the impacts of drought on water deliveries. An underlying question is not necessarily whether the drought is either hydrological or regulatory, but rather to what extent each affects water deliveries.

The Department of the Interior (hereafter referred to as "Interior") has stated that California is experiencing a hydrological drought.[1] This also was briefly stated by Interior and other federal agencies in response to Member questions during a March 31, 2009, hearing on drought before the House Natural Resources Committee. Further, the governor of California declared a drought emergency in both January 2008 and January 2009. Earlier this year, USDA had designated two California counties as primary natural disaster areas, and most recently the U.S. Department of Agriculture on September 22 designated 21 counties in California as "primary natural disaster areas" because of losses caused by drought in 2009.[2]

CRS has analyzed a variety of data and information on hydrological and regulatory limits on California water resources, as well as restrictions due to water rights allocations. This report provides a summary of California's 2009 hydrological situation with comparisons, where applicable, to other drought years; a summary of the key regulatory requirements that at times limit water deliveries or "exports" from the San Joaquin and Sacramento Rivers Delta (hereafter referred to as the "Delta"); and a brief discussion of California water rights and how they relate to different types of federal contracts and their associated water allocations.

What Is Drought?

Droughts have affected the United States, particularly the American West, for centuries. Drought is defined in a number of ways; the simplest may be as a deficiency of precipitation over an extended period of time, usually a season or more. [3] The deficiency is usually evaluated relative to some long-term average condition, or balance, between precipitation, evaporation, and transpiration by plants. Drought, which has a beginning and an end, is distinguished from aridity, which is restricted to low-rainfall regions and is a relatively permanent feature of climate (e.g., deserts are regions of relatively permanent aridity).[4]

[1] U.S. Dept. of the Interior and Office of Communications, *Reality Check: California's Water Crisis*, Washington, DC, September 17, 2009, p. 1, http://www.usbr.gov/main/docs/CA_Water_Reality_Check.pdf.

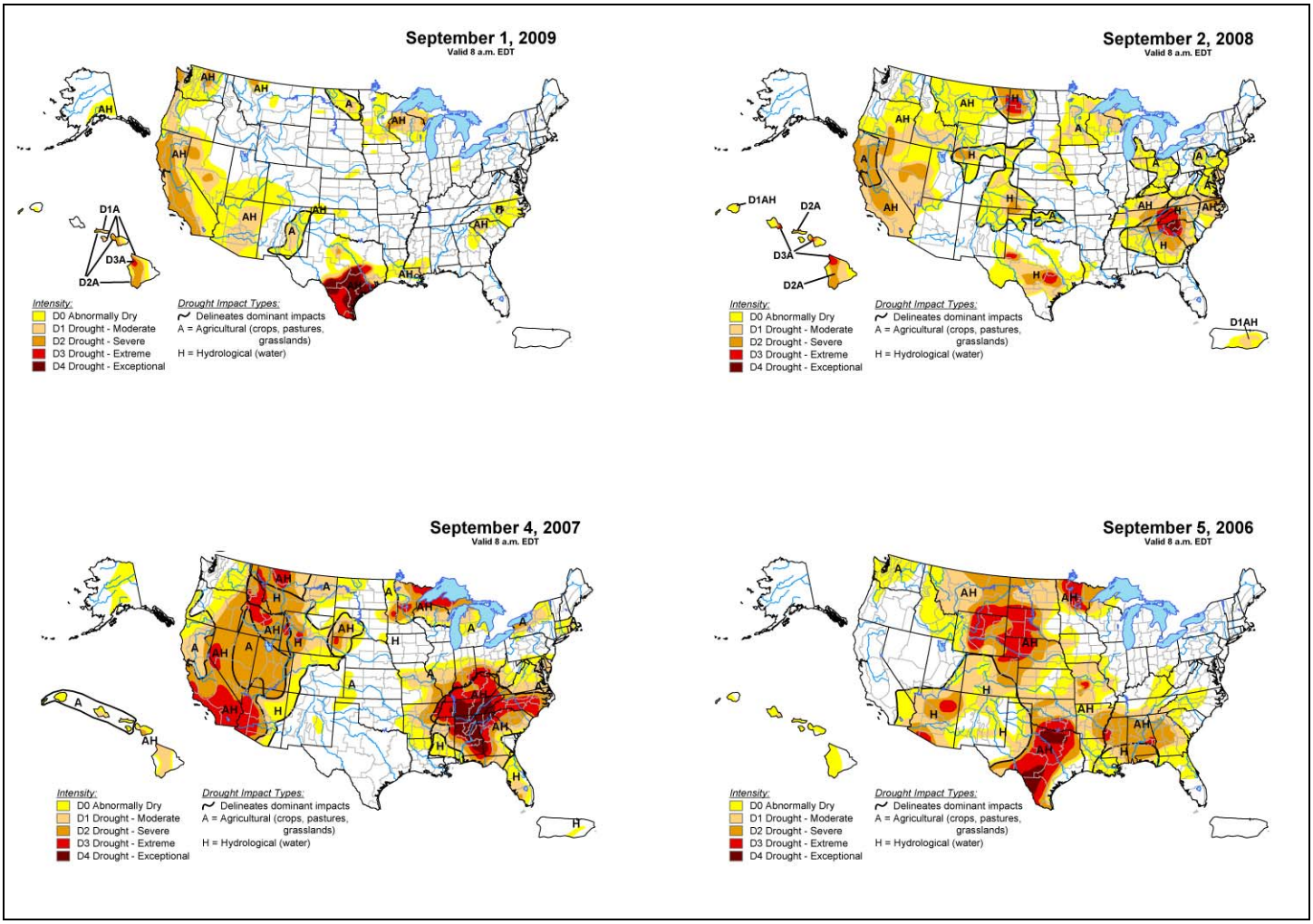
[2] U.S. Dept. of Agriculture, Farm Service Agency, *USDA Designates 21 Counties in California as Primary Natural Disaster Area*, News Release No. 1481.09, Sept. 22, 2009, http://www.fsa.usda.gov/FSA/newsReleases?area=newsroom&subject=landing&topic=edn&newstype=ednewsrel&type=detail&item=ed_20090922_rel_1481.html.

[3] National Drought Mitigation Center (NDMC), at http://www.drought.unl.edu/whatis/what.htm.

[4] NDMC, at http://www.drought.unl.edu/whatis/concept.htm.

At the national level, drought is monitored and reported in an index known as the U.S. Drought Monitor, which synthesizes various drought indices and impacts, and represents a consensus among academic and federal scientists of ongoing drought conditions. The U.S. Drought Monitor uses five key indicators, together with expert opinion, indices to account for conditions in the West where snowpack is relatively important, and other indices used mainly during the growing season. (The five key indicators include the Palmer Drought Index, the Climate Prediction Center soil moisture model, U.S. Geological Survey weekly streamflow data, the Standardized Precipitation Index, and short- and long-term drought indicator blends.)[5] Drought indices are typically used to assess and classify the intensity and type of drought. The classification of drought intensity, such as that shown in **Figure 1**, may depend on a single indicator or several indicators, often combined with expert opinion from the academic, public, and private sectors.

Figure 1. U.S. Drought Monitor Maps for Early September 2006-2009



Source: U.S. Drought Monitor, at http://drought.unl.edu/DM/MONITOR.html.
Notes: The U.S. Drought Monitor map for early September 2006 is shown for comparison, indicating that California was not experiencing drought conditions in 2006.

[5] For a discussion of drought indices, see the NDMC, at http://www.drought.unl.edu/whatis/indices.htm. See also U.S. Drought Monitor, at http://www.drought.unl.edu/dm/classify.htm.

The "A" and "H" terms shown in **Figure 1** give additional information on the nature of the drought in the affected region. Agricultural drought ("A") can be defined as when there is insufficient moisture to meet the needs of a particular crop at a particular time.[6] Hydrological drought ("H") can be defined as deficiencies in water supplies, as measured by stream flows, lake or reservoir levels, or elevation of the ground water surface. Hydrological drought usually lags behind agricultural drought because it takes longer for deficiencies in precipitation to affect the broader hydrologic system. Lack of rainfall during a critical part of the growing season may have an immediate impact on farmers—an agricultural drought—but the deficiency may not affect reservoir or river levels for many months. Because a hydrological drought affects the broader hydrologic system, such as one or several river basins, a severe hydrological drought could exacerbate competition among water uses: irrigation, navigation, recreation, municipal and industrial supply, energy production, preservation of endangered species, and others.

Drought in California: Hydrological Conditions

The U.S. Drought Monitor in **Figure 1** shows persistent drought in California for 2007-2009. The map does not take into consideration any decisions on reductions in water delivery made by the state or federal government. It is strictly a representation of the hydrological status of California (from factors other than deliveries of water mandated or restricted by regulation). However, increases in 2009 precipitation levels in many California watershed basins and near-average and above-average reservoir levels in some areas of the state have caused some to question the drought determination by state and federal officials. Some parties have pointed in particular to environmental restrictions on Delta exports as causing a regulatory or "man-made" drought.[7] In response to this debate, the Bureau of Reclamation has noted that one-third less water—approximately 2.1 million acre-feet (AF)[8]—is available for export out of the Delta this year. Of that amount, the agency estimates that nearly 25% (500,000 AF) of this year's export reduction is due to recent Endangered Species Act (ESA) restrictions for the Delta smelt and the other 75% is due to dry conditions and other long-standing requirements such as Delta salinity standards. Another less frequently mentioned factor in water allocations is the state system of water rights, which has a large and direct effect on how much water the different state and federal water contractors receive north of the Delta versus south of the Delta, particularly in dry years. Under this system, some federal water contractors are receiving just 10% to 15% of their contracted supplies, while more senior contractors are receiving 100%. (For a summary of the different types of contractors, see "California Water Rights: Acquisitions and Allocations**,"** below.)

The U.S. Drought Monitor map for September 1, 2009 (upper left map in **Figure 1**), includes California within its agricultural and hydrological drought impact classification (the AH symbol on the map), which means that the dry conditions have been severe enough to affect crops, pastures, grasslands, rivers, groundwater supplies, and reservoir levels. **Figure 1** also illustrates the persistent nature of the drought for 2007 through 2009. The figure shows that other parts of the country, such as Texas, the Southeast, and portions of the Great Plains have seen drought conditions come and go since 2006. In contrast, California has faced abnormally dry to extreme drought conditions continuously from 2007 to the present.

[6] NASA Earth Observatory, at http://earthobservatory.nasa.gov/Library/DroughtFacts/.

[7] For example, see floor debate on motion to recommit H.R. 1145, the National Water Research and Development Initiative Act of 2009, *Congressional Record*, daily edition, vol. 155 (April 23, 2009), p. H4715.

[8] An acre-foot is equivalent to 325,851 gallons.

California has experienced years of consecutive drought in the past. Observations of below-average runoff, reservoir levels, and groundwater levels are broadly comparable to those observed during previous episodes of drought in California (e.g., 1977-1978 and 1987-1992).

Runoff and Storage

The California Department of Water Resources (DWR) evaluation (as of August 31, 2009) of the California drought identifies below-average runoff and reservoir storage:

> This water year will be the third dry year in a row for California. Runoff and reservoir storage entering Water Year 2009-2010 will be below average, with key reservoirs significantly lower than average. Emergency declarations are in place in four counties currently experiencing economic or supply difficulties. Drought conditions remain severe at this time, and the developing El Nino over the Pacific Ocean may not improve statewide water supply next year.[9]

Below-average runoff indicates an underlying deficit in precipitation, which would support a common definition of drought: less rain or snow than a region would receive compared to some long-term average (consistent with the description of hydrological drought, discussed above). The California DWR also points out that California has experienced three dry years in a row compared to the long-term average, a persistent and statewide condition that likely underlies much of the discussion and controversy over water allocations in the state. **Figure 2** shows reservoir storage at the end of the water year in California for seven "key" reservoirs identified by the California DWR for 2006-2009. The figure shows that the reservoirs have been at 78% or less of average levels for the last three years compared to 2006, which was 123% of average for the seven reservoirs. Reservoir levels for the seven key reservoirs shown in **Figure 2** were at 69% of historical average as of September 30, 2009, the end of the 2008-2009 water year.

A comparison of reservoir levels for 12 California reservoirs measured in April 2009 and in September 2009 indicates that individual reservoirs' conditions changed in the intervening five months, but that nine of the 12 reservoirs were below historically average levels in both April and September. (See **Appendix A** and **Appendix B** for the comparison between April and September for the 12 reservoirs.) According to the California DWR, statewide reservoir storage was at 79% of average levels at the end of September; however, the two largest reservoirs (Shasta and Lake Oroville) in the federal and state systems serving California remained at 63% and 59% of historical levels for September.[10] Also, comparing the *amount* of water held in storage at each of the 12 reservoirs versus the total amount of storage (i.e., the aggregate amount from the 12 reservoirs) historically held at the same time shows that reservoir levels were at approximately 70% of the historical total, not 79% as indicated by the California DWR.[11] This difference may reflect the way the California DWR calculated the statewide average value from the levels measured in the 12 reservoirs.[12] In addition, of the five reservoirs which historically average

[9] As shown in **Appendix A**, some reservoirs are at or above historically average levels, but overall storage is below the historical average. California Department of Water Resources, "California's Drought Update," August 31, 2009, at http://www.water.ca.gov/drought/docs/DroughtUpdate-083109.pdf.

[10] California Department of Water Resources, "California's Drought Update" (Sept. 30, 2009), at http://www.water.ca.gov/drought/docs/DroughtUpdate_sept30.pdf.

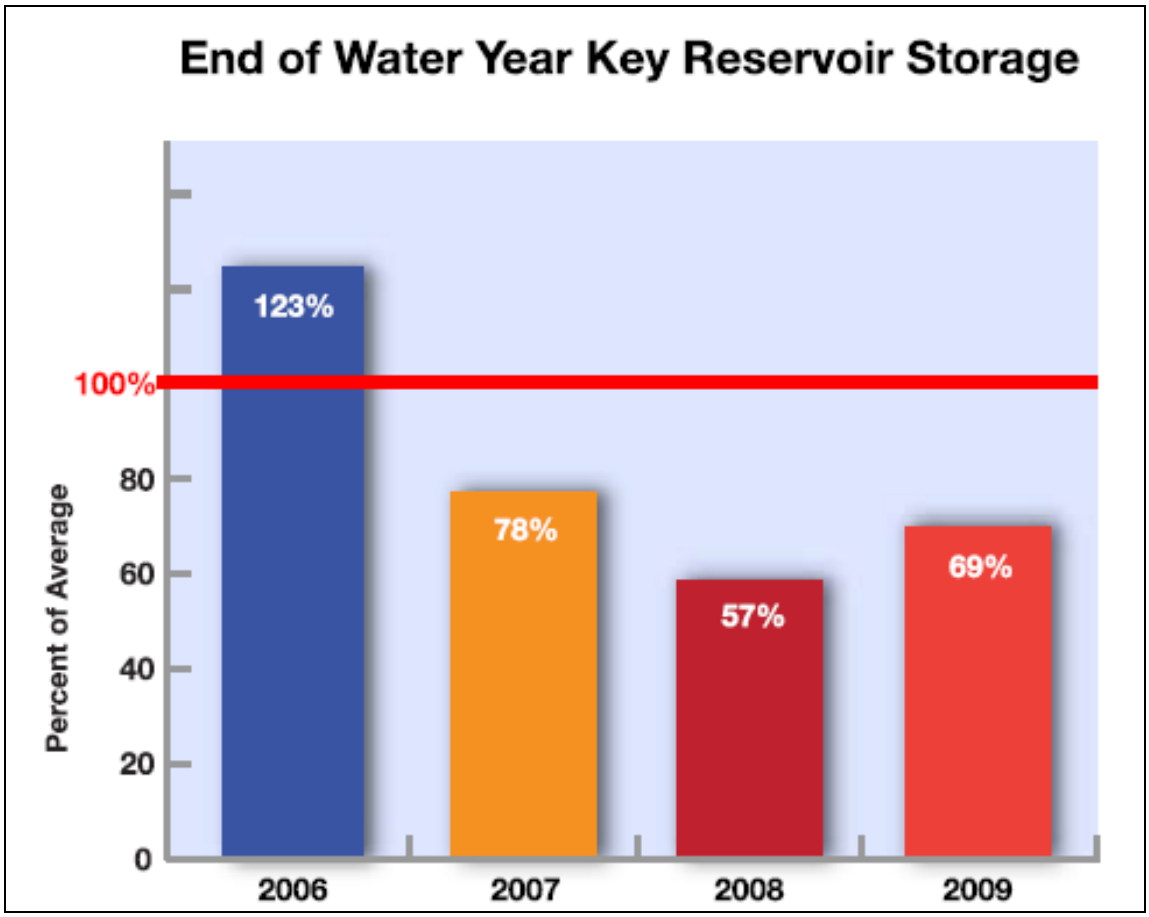
[11] California Department of Water Resources, California Data Exchange Center, *Current Conditions for Major Reservoirs* (as of September 29, 2009), at http://cdec.water.ca.gov/reservoir_map.html.

[12] CRS calculated the 70% value by summing the total amount of water held in storage for the 12 reservoirs and dividing by the total amount of water historically held in storage during the same time period for all 12 reservoirs. The (continued...)

greater than 1 million AF of storage at the end of September, only Don Pedro reservoir was above its historical average (106%); the other four reservoirs ranged from 83% (New Melones) to 54% (Trinity). The three largest reservoirs (Shasta, Oroville, Trinity), which historically contain over 50% of the total storage in September for the 12 reservoirs shown in **Appendix A**, were all well below average historical levels at the end of September 2009, ranging from 54% (Trinity) to 63% (Shasta).

Figure 2. Reservoir Storage at the End of the Water Year, as a Percent of Average, for Seven Reservoirs in California

(2009 levels as of September 30, 2009)



Source: California Department of Water Resources, "California's Drought Update," Figure 2 (Nov. 30, 2009), at http://www.water.ca.gov/drought/docs/DroughtUpdate-113009.pdf.

Notes: The seven reservoirs identified as "key" by the California DWR are Trinity, Shasta, Oroville, Folsom, Don Pedro, New Melones, and San Luis.

(...continued)

CRS calculation thus accounts for the different amount of water held in each reservoir. In contrast, calculating the percent of storage held in each individual reservoir, summing the percentages for all 12 reservoirs, and then taking the average of summed percentages yields a value of 81.5% for September 29, 2009. The latter calculation would give greater weight to smaller reservoirs, rather than reflect the status of total storage compared to a total historical average for all reservoirs.

Timing

Persistent drought conditions in California since 2007 do not necessarily mean that all locations throughout California experienced the same degree of drought at all times. Drought conditions have changed over time and by location, so that despite below-average precipitation and lower-than-average reservoir levels generally, conditions have differed from month to month. For example, January is normally the wettest month for California, averaging 4.35 inches of precipitation in the state.[13] In January 2009, however, California only received 1.25 inches, or 29% of average precipitation for the month. From October through April, a seven-month period, California receives most of its precipitation, an average of approximately 20 inches, or more than 90% of the yearly total. For 2008-2009, only February received above-average precipitation over that seven-month period (**Table 1**). Despite a relatively wet February (138% of average), and a wet May and June (169% and 134% of average, respectively), California had received 76% of its average annual precipitation as of September 30, 2009.[14] The state had received 77% at the end of March and 73% at the end of April 2009[15]—critical times for water delivery decisions (see **Table 1**). The California DWR reported that reservoir storage was 80% of average at the end of August; however, much of that storage was located in smaller reservoirs south of the Delta.[16]

Table 1. Average and Observed Statewide Precipitation, by Month
(shows % of average by month and cumulatively for water year 2008-2009, through September 30, 2009)

Month	Average Precipitation Statewide (inches)	Water Year 2008-2009 Observed Precipitation	% of Average (by month)	% of Average (cumulative)
October	1.22	0.73	60%	60%
November	2.80	2.49	89%	80%
December	3.91	3.05	78%	79%
January	4.35	1.25	29%	61%
February	3.66	5.06	138%	79%
March	3.12	2.13	68%	77%
April	1.64	0.59	36%	73%
May	0.89	1.50	169%	77%
June	0.35	0.47	134%	79%
July	0.18	0.03	17%	78%
August	0.28	0.06	21%	78%
September	0.48	0.09	19%	76%
Total	**22.34**	**17.39**		**76%**

Source: California Department of Water Resources, "California's Drought Update," (Nov. 30, 2009), Table 1, at http://www.water.ca.gov/drought/docs/DroughtUpdate-113009.pdf. CRS provided the last column showing the cumulative % of average precipitation.

[13] California Department of Water Resources, "California's Drought Update" (Nov. 30, 2009), Table 1, at http://www.water.ca.gov/drought/docs/DroughtUpdate-113009.pdf.

[14] Ibid.

[15] Ibid.

[16] California Department of Water Resources Data Exchange Center, "Executive Update" (September 1, 2009), at http://cdec.water.ca.gov/cgi-progs/reports/EXECSUM. Also, see footnote 12 for another explanation for the how the 80% value may have been calculated.

When, where, and how precipitation occurs (e.g., snow versus rain) are critical to water allocation decisions typically made in the late spring. The timing of precipitation and runoff critically influences allocation decisions for the State Water Project (SWP) and the Central Valley Project (CVP). For example, both projects rely on precipitation data, including data indicating the water content of snowpack and projected runoff, to decide how much water to allocate to water users early in the water year (February-May). Typically, DWR and the Bureau of Reclamation (hereafter referred to as "Reclamation") announce water allocations for the coming growing season in mid-February of each year. This announcement is generally followed by monthly allocation announcements (through May) based on updated precipitation data and runoff projections. In February 2009, the California DWR (responsible for the SWP) and Reclamation (responsible for the CVP) announced that water allocations would be significantly restricted for all contract categories and severely restricted for some (some CVP contractors were to receive no CVP water). DWR stated that its May allocation for the water year was its last allocation, based on reservoir levels and other factors up to that date. Although early May rain and snow allowed the DWR to increase its allocation of the SWP from 30% to 40%, below-normal precipitation and runoff for six of the preceding seven months kept the allocation low: "This small increase in SWP deliveries does not mean California has overcome the effects of three consecutive dry years. In fact, 2007 to 2009 will likely rank in the top 10 driest three-year periods in the last century."[17] Similarly, Reclamation was able to increase its CVP allocations in April and May; however, south-of-Delta CVP *water service* contractors were still allocated just 10% of their maximum contract amount, while senior north-of-Delta *water rights* contractors and south-of-the-Delta *water rights* contractors were allocated 100% of their contract amounts.[18]

Because the Sierra Nevada snowpack is such a critical component of the California water supply, the amount, timing, and water content of the snowpack influences decisions about water distribution for the rest of the year. For example, January 2009 was the ninth-driest January on record for the state, and the Sierra snowpack contained only 60% of its average water content, prompting the California governor to declare a statewide emergency due to drought on February 27, despite a relatively wet February.[19] The Sierra snowpack was also at 60% of its average water content in January 2008, and the driest spring on record in 2008 also prompted the governor to declare a statewide drought and a state of emergency for nine counties in June 2008,[20] despite improvements in the snowpack in February 2008.

Prospects for a Continuing Hydrologic Drought

California receives the bulk of its precipitation in the late fall and winter months, and it is difficult to predict with any certainty what the precipitation patterns will be for the 2009-2010 water year. Greater than average precipitation fell during October 2009 (2.29 inches received versus 1.22 inches average);[21] however, precipitation in October typically represents only about 5% of the

[17] California Department of Water Resources Director Lester Snow, May 20, 2009 press release, at http://www.water.ca.gov/news/archive/index.cfm.

[18] Maximum contract quantities are not the same as deliveries. A variety of factors influence actual deliveries in any given year and in some cases actual deliveries are often well below a contractor's maximum contracted supply.

[19] California Department of Water Resources, "Drought Timeline," at http://www.water.ca.gov/drought/docs/timeline-present.pdf.

[20] Ibid.

[21] California Department of Water Resources, "California's Drought Update" (Nov. 30, 2009), Table 1, at http://www.water.ca.gov/drought/docs/DroughtUpdate-113009.pdf.

California total. One month of above-average precipitation in the beginning of the 2009-2010 water year does not seem to have affected reservoir levels significantly.[22] Because the drought in California has lasted for three consecutive years, its effects may persist even if the state receives more precipitation in the current water year (October through September) than in the previous three water years, depending on the amount, type (snow versus rain), and timing of precipitation and runoff, and other factors. Despite uncertainties in predicting future precipitation, the California DWR announced on December 1, 2009, an initial allocation of 5% of total contracted water deliveries to SWP contractors for 2010.[23] In its press release, the California DWR noted that its initial allocation is a very conservative estimate of what it expects to deliver; nevertheless, 5% is the lowest initial allocation by the SWP since 1967.

According to NOAA's Climate Prediction Center, this is an El Niño year, and El Niño is expected to continue strengthening and to last at least through the winter in the northern hemisphere.[24] Although this may bring above-average precipitation to California, it is very difficult to predict whether that will occur, and what the amount, timing, and nature of the precipitation might be. Even if an El Niño delivers above-average precipitation to California, other indicators, such as groundwater levels, will likely more fully illuminate the extent to which increased precipitation alleviates effects from the drought.

Groundwater

In the Central Valley, one of the typical consequences of below-average precipitation, reduced snowpack levels, and lower reservoir levels is an increase in groundwater pumping to offset reduced surface water supplies. A result of increased pumping is often a decrease in groundwater storage, as indicated by lower water table levels. (See box for a discussion of groundwater storage and availability in the Central Valley.) **Figure 3** suggests that this has been the case for the current drought. In the figure, the California DWR compared water levels in wells where such data were available for spring 2009, spring 1991 or spring 1992, and spring 1977 or spring 1978, corresponding to two previous historic drought periods. Some of the water levels shown for spring 2009 are above levels in the two previous droughts, but the majority of wells measured show water levels at about the same or below levels during the previous droughts.[25] The water level comparisons shown in **Figure 3** indicate that the effects of the three-year drought are widespread throughout the Central Valley, and are consistent with the U.S. Drought Monitor maps shown in **Figure 1** that indicate the persistent nature of the current drought since 2007.[26] Unlike the Drought Monitor, however, **Figure 3** shows groundwater depletion levels regardless of cause and thus will reflect increased groundwater pumping resulting from dry hydrologic conditions as well as increased pumping due to administratively lowered surface water deliveries, such as reduced water exports from the Delta for protection of threatened or endangered species.

[22] The California DWR reports that statewide reservoir storage at the end of October 2009 was still about 80% of capacity, representing no change from reservoir levels at the end of September. See California Department of Water Resources, "California's Drought Update" (Nov. 30, 2009), p. 3.

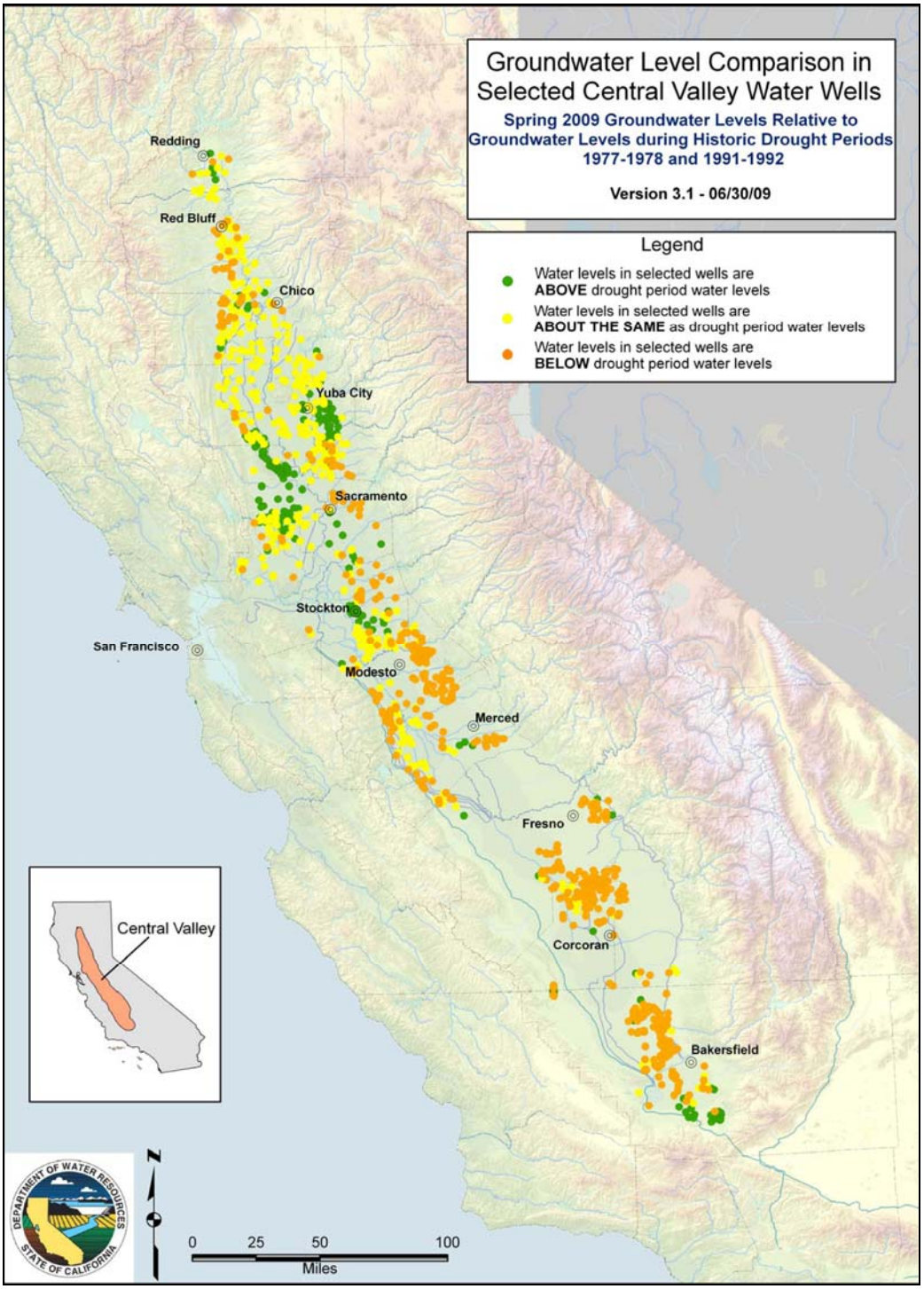
[23] California DWR press release, at http://www.water.ca.gov/news/.

[24] National Oceanic and Atmospheric Administration, National Weather Service, Climate Prediction Center, El Nino/Southern Oscillation (ENSO) Diagnostic Discussion, at http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/index.shtml (as of Dec. 4, 2009).

[25] This interpretation may be limited without a more robust analysis of how groundwater levels changed during the intervening years between droughts.

[26] California Department of Water Resources, "California's Drought Update," August 31, 2009, at http://www.water.ca.gov/drought/docs/DroughtUpdate-083109.pdf.

Figure 3. Comparison of Groundwater Levels from Selected Wells in the Central Valley Between the Current Drought and 1977-1978 and 1991-1992 Drought Periods



Source: California Department of Water Resources, "California's Drought Update," Aug. 31, 2009, at http://www.water.ca.gov/drought/docs/DroughtUpdate-083109.pdf.

Note: Where groundwater levels differed between individual historic drought periods, the lower water level was selected for the figure. For example, if a well showed that the spring 2009 water level was within five feet of the water level in 1991 and more than five feet below the water level in 1977, then an orange dot was selected.

Groundwater Availability and Storage in the Central Valley

Groundwater has been an integral component of water supply for towns and farms in the Central Valley for over a century. Groundwater is the principal supply for municipal and industrial use in the San Joaquin Valley today. By volume, however, agricultural demand for groundwater dwarfs municipal and industrial demand in the Central Valley, which comprises three-quarters of irrigated land in California and one-sixth of all irrigated land in the United States. The huge agricultural demand exceeds the availability of surface water or groundwater by themselves; it is met only by a combination of surface water and groundwater supplies. According to a U.S. Geological Survey (USGS) analysis, between 1961 and 2003 surface water supplied, on average, about 10 million acre feet (MAF) per year for irrigation in the Central Valley, and groundwater supplied slightly less than 9 MAF per year. Groundwater pumping from Central Valley aquifers constitutes about 20% of total U.S. groundwater demand, which makes it the second-most-pumped aquifer system in the nation.

Groundwater Demand Increases in Dry Years

The relationship between surface water use and groundwater use for irrigation in the Central Valley is complex and variable, but historically the proportion of groundwater use has increased during drier and drought years and has decreased during wetter years. That is, the aquifers function to some extent as multiyear reservoirs that are tapped more heavily when surface water is less available. In the USGS modeling analysis, for example, in a wet year groundwater pumping may be only 4.5 MAF, about half of the surface water deliveries for irrigation; whereas in a dry year groundwater pumping may be nearly 12 MAF and exceed the amount supplied by surface water.

Central Valley Groundwater Supply Decreases

A reasonable question to ask is whether groundwater stored in Central Valley aquifers could be further used to help farmers meet their irrigation demands during periods of extended drought, or as a long-term substitute for decreased deliveries of surface water as a result of regulatory requirements, legal actions, or other curtailments. The answer depends in part on what is known as the water budget. Put simply, when the amount of groundwater pumped from the Central Valley equals the amount of water returned to the aquifer system, then the amount of groundwater held in storage remains the same—the hydrological equivalent of a balanced budget. However, if the amount of groundwater pumped exceeds the amount returned, then groundwater storage decreases. Over the period 1961-2003, the USGS estimated that the amount of groundwater held in storage decreased by an average of 1.4 MAF per year, signifying that pumping exceeded recharge even though California went through cycles of wetter and drier years. Decreases in groundwater storage typically are indicated by declines in the water table (i.e., the elevation of the groundwater surface that lies below the land surface). Thus, if groundwater storage continues to decline, then water levels would be expected also to decline.

Increased Groundwater Use has Consequences

How much the water table would decline is difficult to predict because the geology of the Central Valley aquifer system is not homogenous, and different agricultural regions would likely pump groundwater at different rates depending on a host of factors, such as cost of pumping (which depends partly on the depth to the water table), availability of alternate supplies, groundwater quality, and others. Parts of the Central Valley, such as the western side of the San Joaquin Valley, experienced hundreds of feet of water table decline in the 20th century because of groundwater pumping, which in some place resulted in actual land subsidence of over 20 feet. Reduced pumping in some of those areas has allowed groundwater levels to recover, however, the compaction of the aquifer from land subsidence means that the volume of groundwater storage has been permanently decreased.

The use of groundwater to offset diminished surface water supplies during droughts is therefore not without consequences. Although the absolute amount of groundwater held in storage in the Central Valley aquifer system is likely huge (one estimate is 800 MAF in the upper 1,000 feet of sediments), increased pumping that outstrips the amount of water returned means that water table levels will likely drop. Lower water tables generally increase pumping costs, increase the likelihood of land subsidence, and may also reduce the availability of groundwater to regions where the aquifer sediments are thinner and less extensive, or may have impaired water quality.

Sources: C. C. Faunt et al., *Groundwater Availability of the Central Valley Aquifer, California*, U.S. Geological Survey Professional Paper 1766, 2009, p. 62, http://pubs.usgs.gov/pp/1766/PP_1766.pdf; U.S. Bureau of Reclamation, *The Central Valley Project: Introduction*, by Eric A. Stene, available at http://www.usbr.gov/history/cvpintro.html; W. M. Alley, "Tracking U.S. Groundwater Reserves for the Future," *Environment*, vol. 48, no. 3 (2006), pp. 10-25; Devin Galloway, David R. Jones, and S.E. Ingebritsen, *Land Subsidence in the United States, San Joaquin Valley, California*, U.S. Geological Survey Circular 1182, 2005, http://pubs.usgs.gov/circ/circ1182/.

The below-average precipitation for consecutive years during the crucial winter months; the below-average water content of the Sierra snowpack in consecutive winters; and similarity of groundwater levels compared across different periods of California drought support the contention that a multiyear hydrological drought underlies the current water crisis that faces California. That said, other factors also have contributed to the availability of groundwater supplies in 2009.

Regulatory Restrictions Affecting Water Deliveries[27]

An estimated 25 million people get some portion, if not all, of their drinking and agricultural water supplies from the Delta.[28] For decades, transfer of water from northern California through the Delta to supply farms and cities in southern California has had profound impacts on fish and wildlife resources, water quality, and regional water supplies. For example, commercial and recreational fisheries on which many north coast fishermen depend are affected by water management and water quality in the Delta and its tributaries, as are communities and farmers who divert water from the Delta. Over the years, both state and federal laws have been enacted to protect Delta resources and the fish, wildlife, and human populations that rely on these resources.

Thus, in addition to drought-related restrictions on water supplies, also at issue is how laws and resultant regulatory restrictions affect deliveries of water from the CVP and SWP. Changes in water deliveries due to reduced water supplies pit large and widespread economic losses in some areas of central and southern California against possible extinction of several species and large economic losses to north coast communities and others dependent on salmon and recreation industries. For example, the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) have each issued federal biological opinions (BiOps)[29] on the effects of changes to the coordinated operation of the SWP and CVP and have found that proposed changes, including increased pumping, would jeopardize the continued existence of several species protected under the Endangered Species Act (ESA),[30] and thus risk their extinction. To avoid such jeopardy, the FWS and NMFS BiOps contained reasonable and prudent alternatives (RPAs) for continued project operations. Actions needed to avoid jeopardy to Delta smelt under the FWS BiOp issued in December 2008[31] resulted in restrictions on the amount of water exported via

[27] For a legal analysis of the Delta water projects, see CRS Report RL34554, *California Water Law and Related Legal Authority Affecting the Sacramento-San Joaquin Delta*, by Cynthia Brougher.

[28] State of California, Department of Natural Resources and Department of Water Resources, *Sacramento-San Joaquin Delta Overview*, Sacramento, CA (no date), p. 2, http://baydeltaoffice.water.ca.gov/sdb/tbp/deltaoverview/delta_overview.pdf.

[29] Federal agencies are required to consult with either the Fish and Wildlife Service (FWS) or the National Marine Fisheries Service (NMFS) to determine whether an agency project might jeopardize the continued existence of species listed as endangered or threatened, pursuant to the federal Endangered Species Act (ESA), or destroy or adversely modify a species' critical habitat. This process is known as consultation. The consultation concludes with the appropriate service issuing a biological opinion (BiOp) as to the harm the project poses. If a project could jeopardize a species, a *jeopardy opinion* is released along with any reasonable and prudent alternatives (RPAs) to the agency action that would avoid jeopardy. If no jeopardy is found, a *no jeopardy opinion* is issued.

[30] Act of December 28, 1973, P.L. 93-205; 87 Stat. 884, codified at 16 U.S.C. § 1531 *et seq*. This report assumes a basic knowledge of the act; an overview of the ESA and its major provisions may be found in CRS Report RL31654, *The Endangered Species Act: A Primer*, by M. Lynne Corn, Kristina Alexander, and Eugene H. Buck.

[31] U.S. Dept. of the Interior, Fish and Wildlife Service, California and Nevada Region, *Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP)*, Memorandum to Operation Manager, Bureau of Reclamation, from Regional Director, FWS Region 8, Sacramento, CA, December 15, 2008, http://www.fws.gov/sacramento/es/documents/SWP-CVP_OPs_BO_12-(continued...)

SWP and CVP Delta pumps (Delta exports). The actions were initially estimated to reduce Delta exports by 500,000 AF (approximately 25% of the total reductions in Delta exports of 2,100,000 AF) for the 2009 water year.[32] However, a district court prevented those measures from fully taking effect in 2009.[33] Further, a June 2009 NMFS BiOp on salmon and other anadromous and ocean species is expected to result in another 330,000 AF reduction in Delta exports when it is implemented.[34] These restrictions, combined with reductions necessitated by drought conditions, have resulted in some water users receiving a fraction of water normally supplied by the SWP and CVP.

In addition to the ESA, several other state and federal laws enacted to protect Delta resources have resulted in restrictions on how much, and when, water may be pumped from the Delta by the SWP and CVP. For example, the California Endangered Species Act (CESA) was the basis for halting pumps in 2008.[35] These restrictions, while protecting the interests of those who rely on and value Delta resources and the goods and services they provide (e.g., cleaner, less saline water; viable fish habitat for recreational and commercial fish species; and water supply for in-Delta or near-Delta users), have also resulted in some water users receiving less water than they originally contracted to receive from the SWP and CVP. Although many of these water users benefit from better-quality water than what might otherwise be delivered, these recent restrictions to protect threatened and endangered species have reduced the quantity of water available to those south-of-Delta SWP and CVP contractors with junior priority rights. Many of those adversely affected have expressed anger over export reductions and frustration with federal and state officials who are responsible for or who implement Delta export reductions.[36] Others, however, including Pacific Coast fishermen's organizations, and groups concerned about the effects of increased pumping on declining fish species and north coast fish-dependent economies, generally oppose efforts to halt implementation of the BiOps.[37]

The following is a brief description of some of the major regulations, statutory requirements, and biological opinions that at times restrict flows or otherwise affect Delta pumping and thus may limit Delta exports. Some of these requirements serve more than one purpose. For example, D-1641, discussed below, includes a significant number of water quality and flow actions to protect fish and wildlife habitat. For purposes of this report, regulatory restrictions are defined as

(...continued)

15_final_OCR.pdf.

[32] The "water year" runs from October 1 through September 30 and is used for water allocation purposes.

[33] *San Luis and Delta-Mendota Water Authority v. Salazar*, 2009 WL 1575169 (E.O. Cal. May 29, 2009). It is not clear what effect this decision had on the 500,000 AF estimate.

[34] U.S. Dept. of Commerce, National Marine Fisheries Service, Southwest Region, Biological Opinion and Conference Opinion on the Long-term Operations of the Central Valley Project and State Water Project, Endangered Species Act Section & Consultation, Sacramento, CA, June 4, 2009, http://swr.nmfs.noaa.gov/ocap/NMFS_Biological_and_Conference_Opinion_on_the_Long-Term_Operations_of_the_CVP_and_SWP.pdf.

[35] *Watershed Enforcers v. California Dep't of Natural Resources*, No. RG06292124 (Sup. Ct. Alameda Co. March 22, 2007).

[36] See U.S. House of Representatives floor debate on H.R. 2847, "Commerce, Justice, Science, and Related Agencies Appropriations Act, 2010," *Congressional Record*, daily edition, vol. 155 (June 17, 2009), pp. H6945-H6948. See also http://www.foxnews.com/story/0,2933,552081,00.html.

[37] Pacific Coast Federation of Fishermen's Association, *Environmental Groups, Water Advocates, and Fisheries React to Sean Hannity Spreading Misinformation on California Water Crisis; Burson-Marsteller PR Firm Hosts 'Astroturf' Rally at Expense of Pacific Ecosystem/Economy*, press release issued Sept. 17, 2009. See also U.S. House of Representatives floor debate on H.R. 2847, "Commerce, Justice, Science, and Related Agencies Appropriations Act, 2010," *Congressional Record*, daily edition, vol. 155 (June 17, 2009), pp. H6946-H6948.

restrictions whose basis in state or federal law generally falls into three categories: (1) water quality protection; (2) fish and wildlife protection, enhancement, and restoration; and (3) threatened and endangered species protection.

- **The 1995 Delta Water Quality Control Plan (WQCP) and D-1641.** After nearly 20 years of litigation, the WQCP was issued by the California State Water Resources Control Board (SWRCB) to comply with state obligations under the federal Clean Water Act (CWA).[38] The plan requires the SWP and CVP to meet certain water flow objectives in the Delta to maintain desired salinity and other water quality objectives, including conditions and actions to support fish and wildlife habitat. These objectives can affect the amount and timing of water available to be pumped or "exported" out of the Delta, and thus at times may result in reduced Delta exports.[39] Inability to reach agreement on water quality objectives through deliberation and litigation nearly shut down Delta pumping in the early 1990s and was a significant factor in creation of the Bay-Delta Accord—a partnership between federal and state agencies with projects, responsibilities, and activities affecting the Delta. Habitat protection commitments in the accord were incorporated into the WQCP, as were actions called for under the Vernalis Adaptive Management Program (VAMP), and were included by the SWRCB in a document known as D-1641, which amended the underlying water rights of the SWP and CVP.[40] According to Reclamation, implementation of D-1641 significantly reduced water for export and included significant "new 'export limitation' criteria such as the export to inflow [E/I] ratios and San Joaquin River pulse period export limits"[41] to manage Delta salinity levels and protect fish and wildlife. Implementation of the Bay-Delta Accord led up to the establishment of the CALFED program.[42]

[38] The CWA requires the states to implement water quality standards that designate water uses to be protected and adopt water quality criteria that protect the designated uses. For application to California, see *United States v. State Water Resources Control Board (Racanelli)*, 182 Cal. App. 3d 82, 109 (Cal. Ct. App. 1986). Through the Porter-Cologne Act (a state law), California implements federal CWA requirements and authorizes the SWRCB to adopt water quality control plans, or basin plans (see Cal. Water Code § 13160).

[39] The regulation of Delta water quality has a long history. For example, the state in 1959 enacted the Delta Protection Act, which provided a specific law to govern Delta waters based on the unique problems posed by the California Water Code (§12200 et seq.). In 1978, the SWRCB issued a water quality control plan that established new standards for salinity control and protection of fish and wildlife in the Delta. In 1986, a state appellate court upheld SWRCB modification of Reclamation and DWR water rights permits, which the SWRCB found necessary to fully implement the 1978 standards. (See Racanelli, 182 Cal. App. 3d 82.) However, the appellate court also held that the water quality standards were insufficient in light of the scope of the board's duty to act in accordance with the Porter-Cologne Act. Litigation over the control and management of salinity levels and water pollution in the Delta culminated in 1995 with the board adopting a new water quality control plan that provided 17 beneficial uses in three categories (municipal and industrial, agricultural, and fish and wildlife) and permitted water flow to be regulated because of its impact on beneficial uses. See State Water Resources Control Board Cases, 136 Cal. App. 4th 674, 701 (Cal. Ct. App. 2006). The implementation of this plan led to another series of lawsuits. After setting flow objectives in the plan, the board implemented alternate flow objectives upon which interested parties agreed instead. The board's action was held to be improper by a state court, which required that any alternate objections that the board deemed appropriate must be accounted for in the plan before they could be implemented. Id. at 690, 719. The plan (1995 Delta Water Quality Control Plan) is now the guiding authority of water quality control for the Delta.

[40] U.S. Dept. of the Interior, Bureau of Reclamation, Mid-Pacific Region, *Long-Term Central Valley Project Operations Criteria and Plan (CVP-OCAP)*, Sacramento, CA, May 22, 2008, p. 2-6.

[41] Ibid.

[42] For more information on CALFED, see CRS Report RL31975, *CALFED Bay-Delta Program: Overview of Institutional and Water Use Issues*, by Pervaze A. Sheikh and Betsy A. Cody.

- **Central Valley Project Improvement Act (CVPIA).** In 1992 (at the end of the last major California drought), Congress passed the CVPIA.[43] The act established fish and wildlife purposes as official project purposes of the CVP and called for a number of actions to protect and restore fish and wildlife resources, and to mitigate CVP damages to fish and wildlife resources. These actions included directives to double certain fish populations by 2002 (which has not occurred), allocate 800,000 AF of project water to fish and wildlife purposes (often referred to as (b)(2) water, after the provision in the act calling for the allocation), and provide water supplies for Central Valley refuges (full "Level 4" supplies have not been implemented). The (b)(2) allocation has often resulted in less water being exported annually from the Delta and thus has reduced the amount of water available to junior CVP contractors in several years. However, the (b)(2) allocation is also sometimes used to meet other state and federal requirements such as fish and wildlife aspects of the WQCP as implemented under D-1641.
- **ESA Biological Opinions (BiOps).** Both state and federal endangered species laws affect Delta water management, including Delta exports.[44] These laws have played a larger role as more species are listed for protection. Until 2004, a federal 1993 winter-run Chinook salmon BiOp and a 1995 Delta smelt BiOp (as amended) governed limitations on Delta exports for federal ESA purposes. However, a proposed change in coordinated operation of the SWP and CVP in 2004 (including increased Delta exports), known as OCAP (Operations Criteria and Plan),[45] resulted in development of new BiOps (NMFS, 2004; and FWS, 2005) to assess the effects of the proposed changes in operation on threatened and endangered species. In 2007, a federal court held that the 2005 FWS BiOp, which found that OCAP posed no jeopardy to the Delta smelt, was unlawful and inadequate.[46] The court ordered development of a new BiOp by September 15, 2008, and established interim pumping restrictions.[47] The 2004 NMFS BiOp, which also initially found "no jeopardy," was subsequently voluntarily withdrawn and redone. These activities ultimately resulted in the issuance of the two new jeopardy BiOps (FWS, 2008; and NMFS, 2009),[48] which restrict SWP and CVP Delta exports as proposed in OCAP and bring them back to levels more commonly experienced prior to the year 2000 (see **Table 2**, column 5).

[43] P.L. 102-575, Title 34, 106 Stat. 4706.

[44] DWR has relied on federal restrictions for compliance with the California Endangered Species Act (CESA), a decision that has been the subject of controversy.

[45] U.S. Dept. of the Interior, Bureau of Reclamation, Mid-Pacific Region, *Long-Term Central Valley Project Operations Criteria and Plan (CVP-OCAP)*, Sacramento, CA, June 30, 2004.

[46] *Natural Resources Defense Council v. Kempthorne*, 506 F. Supp. 2d 322 (E.D. Cal. 2007).

[47] *Natural Resources Defense Council v. Kempthrone*, No. 1:05-cv-1207 OWW GSA (E.D. Cal., Dec. 14, 2007).

[48] The first FWS BiOp on OCAP was issued in 2004 and a revised version issued in 2008; the NMFS OCAP BiOp was issued in 2005 and a revised version issued in 2009. U.S. Dept. of the Interior, Fish and Wildlife Service, California and Nevada Region, *Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP)*, Memorandum to Operation Manager, Bureau of Reclamation, from Regional Director, FWS Region 8, Sacramento, CA, December 15, 2008, http://www.fws.gov/sacramento/es/documents/SWP-CVP_OPs_BO_12-15_final_OCR.pdf. U.S. Dept. of Commerce, National Marine Fisheries Service, Southwest Region, *Biological Opinion and Conference Opinion on the Long-term Operations of the Central Valley Project and State Water Project, Endangered Species Act Section & Consultation*, Sacramento, CA, June 4, 2009, http://swr.nmfs.noaa.gov/ocap/NMFS_Biological_and_Conference_Opinion_on_the_Long-Term_Operations_of_the_CVP_and_SWP.pdf. Both agencies had issued earlier BiOps which found that the proposed OCAP changes would not jeopardize listed species or harm their habitat.

Effects of Regulatory Restrictions

These regulatory restrictions, combined with drought factors, have contributed to significant reductions in south-of-Delta water deliveries for some water users during 2009, as well as in other dry years. It is not clear, however, to what extent each of these requirements independently has contributed to 2009 Delta export reductions. In managing SWP and CVP operations, both DWR and Reclamation must balance flow and other criteria in the Delta with temperature requirements and other factors in disparate places within the projects' system. Thus, some of these requirements overlap, and at times may also conflict with one another. These factors make it especially difficult to ascertain to what extent the different water quality and/or CVPIA obligations noted above contributed to 2009 Delta export reductions. For example, at a March 31, 2009, House Committee on Natural Resources hearing, acting Reclamation Commissioner William McDonald noted that although FWS Delta smelt BiOp pumping restrictions became effective in early March, Reclamation at the same time needed to restrict pumping due to other statutory restrictions (i.e., CVPIA). The Commissioner stated: "There was actually no net reduction in pumping [from federal pumps in early 2009] merely because of ESA."[49] Additionally, in years past it has been noted that up to 450,000 AF annually could be used to meet Delta D-1641 water quality and habitat obligations from the 800,000 AF (b)(2) allocation set aside for fish and wildlife purposes under the CVPIA.[50]

In sum, although the RPAs for threatened and endangered species protection have significant effects on Delta exports, other requirements also restrict exports and contribute to RPA actions. Together these elements provide a network of protection for species, and one element is not easily separated from others. Thus, even if the ESA were waived or overridden, federal and state agencies would still be required to comply with several state and federal laws and directives limiting Delta exports (e.g., the federal Clean Water Act, the state Porter-Cologne Act and its implementing directive D-1641, the California Endangered Species Act, the California Fish and Game Code, and the CVPIA).

2009 Delta Export Reductions

Depending on what baseline is used, reductions in Delta exports in 2009 are estimated to range from 37% to 42% of total average annual exports.[51] Of this amount, Reclamation estimates that 0.5 MAF, or approximately 25% of the reduction, can be attributed to pumping restrictions required to protect Delta smelt under the December 2008 BiOp—restrictions that ended June 30, 2009.[52] The other 75% (1.6 MAF) was due to a "lack of run-off" and operational changes needed

[49] Statement of William McDonald, Acting Commissioner of Reclamation, during a U.S. House of Representatives Natural Resources Committee hearing on drought conditions in California, *The California Drought: Actions by Federal and State Agencies to Address Impacts on Lands, Fisheries, and Water Users*, March 31, 2009, pp. 124-125.

[50] According to CALFED documents, the agencies, "in conjunction with the Governor's Drought Contingency Plan ... will use their available resources to create an insurance policy that will seek to eliminate impacts to water users, while not adversely affecting other uses." See CALFED Bay-Delta Program, Programmatic Record of Decision, vol. 1, Record of Decision and Attachments 1-4, Aug. 28, 2000, p. 55.

[51] See **Table 2**. The annual combined exports of the SWP and CVP averaged 5.7 MAF from 1998 through 2007. However, a five-year average (2003-2007) was 6.1 MAF, and a three-year average (2004-2006, when OCAP changes were in effect), was 6.2 MAF. U.S. Dept. of the Interior, Bureau of Reclamation, Mid-Pacific Region, *Biological Assessment on the Long-Term Operations of the Central Valley Project and the State Water Project*, Sacramento, CA, August 2008, Table 2-25, p. 120, at http://www.usbr.gov/mp/cvo/OCAP/sep08_docs/OCAP_BA_Aug08.pdf (hereafter referred to as the 2008 BA).

[52] U.S. Dept. of the Interior and Office of Communications, *Reality Check: California's Water Crisis*, Washington, DC, (continued...)

to control salinity levels in the Delta.[53] Reclamation estimates that exports for 2009 totaled 3.6 MAF, approximately 2.1 MAF less than the 10-year average annual export level of 5.7 MAF.

Alternatively, the average annual export level based on a five-year average (2003-2007) is 6.1 MAF (see **Table 2**). The estimated exports for 2009 of 3.6 MAF represent a reduction of 2.5 MAF, or 41%, from this five-year average. Of this amount, approximately 20% (0.5 MAF) could be attributed to Delta smelt restrictions and 80% (2.0 MAF) to drought and other factors.

Under a third scenario, the average annual export level based on a three-year average (2004-2006) is 6.2 MAF (see **Table 2**). This three-year window approximates the time between the issuance of the new coordinated operations plan (OCAP) and court-imposed restrictions on pumping levels. The estimated exports for 2009 of 3.6 MAF under this scenario would thus represent a reduction of 2.6 MAF for 2009, or 42% from the three-year average. Of this amount, approximately 19% (0.5 MAF) could be attributed to Delta smelt restrictions and 81% (2.1 MAF) to drought and other factors. The average pumping levels during this time were 0.05 MAF higher than the average from 1998 to 2007 and substantially higher than in any other period except 1989 and 1990. The percentage reductions attributable to Delta smelt restrictions in non-dry (non-drought) years in all scenarios are estimated to be higher than those estimated for 2009. **Figure 4** shows CVP and SWP pumping levels from 1978 through 2007.

Another estimate of reductions needed to satisfy a December 2008 court order to protect threatened Delta Smelt was 584,000 AF for both the SWP (414,000 AF) and CVP (170,000 AF).[54] However, it is unclear how this estimate relates to reductions necessitated by the December 2008 Delta smelt BiOp. Estimates of reductions due to the new NMFS BiOp (June 2009) covering salmon and other anadromous fishes and ocean species are 330,000 AF.[55] It appears that the reduction will be in addition to Delta smelt ESA requirements. However, because of the complex nature of CVP/SWP operations, the different flow and quality requirements at different times and places, and the uncertainty of continuing drought, it is too early to know the full effect of both opinions on Delta exports. Water users fear that reductions could top 1 million acre-feet of water in some years, particularly wet years when requirements for species are more stringent.[56] Regardless of the variation in numbers, it is clear that various regulatory restrictions, and in particular, Delta smelt pumping restrictions, have resulted in reductions in Delta exports for the 2009 water year. These reductions combined with reductions due to low runoff and reservoir storage have resulted in the lowest level of Delta exports since 1992, then end of the last drought. Exports during the current drought, however, have yet to dip below the export levels experienced then (see below), even though water allocations to some CVP users are significantly lower.

(...continued)

September 17, 2009, p. 1, http://www.usbr.gov/main/docs/CA_Water_Reality_Check.pdf.

[53] Ibid., and U.S. Dept. of the Interior, Bureau of Reclamation, *California Drought Response Fact Sheet*, revised September 17, 2009, p. 1.

[54] Sunding, D., N. Ajami, S. Hatchet, D. Mitchell, and D. Zilberman, *Economic Impacts of the Wanger Interim Order for Delta Smelt*, Berkeley Economic Consulting, December 8, 2008, at http://www.sustainabledelta.com/pdf/BEC.FinalReport.8 Dec08.pdf.

[55] U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration (NOAA), *NOAA Biological Opinion Finds California Water Projects Jeopardize Listed Species; Recommends Alternatives*, June 4, 2009, at http://www.noaanews.noaa.gov/stories2009/20090604_biological.html.

[56] Seth Nedever, "Water officials: Pumping restrictions cost Westside agriculture 2,000 jobs," *The Sentinel (Hanford, CA)*, September 21, 2009, at http://hanfordsentinel.com/articles/2009/09/19/news/doc4ab5679f27c3f041959766.txt; and Sunding, D., N. Ajami, S. Hatchet, D. Mitchell, and D. Zilberman, *Economic Impacts of the Wanger Interim Order for Delta Smelt*, Berkeley Economic Consulting, December 8, 2008, Executive Summary, p. 1.

Table 2. CVP and SWP Delta Exports, 1978-2007

(in million acre-feet)

Water Year	Water Year Type	CVP Total	SWP Total	CVP/SWP Combined Exports	CVP SOD-Ag	Shasta Index Critical
1978	AN	2.38	2.01	4.39	100%	
1979	BN	2.61	1.76	4.37	100%	
1980	AN	2.43	2.17	4.60	100%	
1981	D	2.80	1.97	4.77	100%	
1982	W	2.25	2.43	4.68	100%	
1983	W	2.72	1.76	4.48	100%	
1984	W	2.54	1.40	3.94	100%	
1985	D	3.43	2.16	5.59	100%	
1986	W	2.94	2.46	5.40	100%	
1987	D	3.16	2.01	5.17	100%	
1988	C	3.42	2.32	5.74	100%	
1989	D	3.40	2.70	6.10	100%	
1990	C	3.07	2.85	5.92	50%	
1991	C	1.65	1.64	3.29	25%	
1992	C	1.49	1.51	3.00	25%	X
1993	AN	2.22	2.53	4.75	50%	X
1994	C	2.37	1.73	4.10	35%	
1995	W	2.70	2.48	5.18	100%	X
1996	W	2.68	2.66	5.34	95%	
1997	W	2.96	2.12	5.08	90%	
1998	W	2.66	2.09	4.75	100%	
1999	W	2.44	2.37	4.81	70%	
2000	AN	2.83	3.45	6.28	65%	
2001	D	2.65	2.38	5.03	49%	
2002	D	2.75	2.70	5.45	70%	
2003	AN	2.86	3.39	6.25	75%	
2004	BN	2.93	3.14	6.07	70%	
2005	AN	2.83	3.58	6.41	85%	
2006	W	2.74	3.50	6.24	100%	
2007	D	2.90	2.82	5.72	50%	

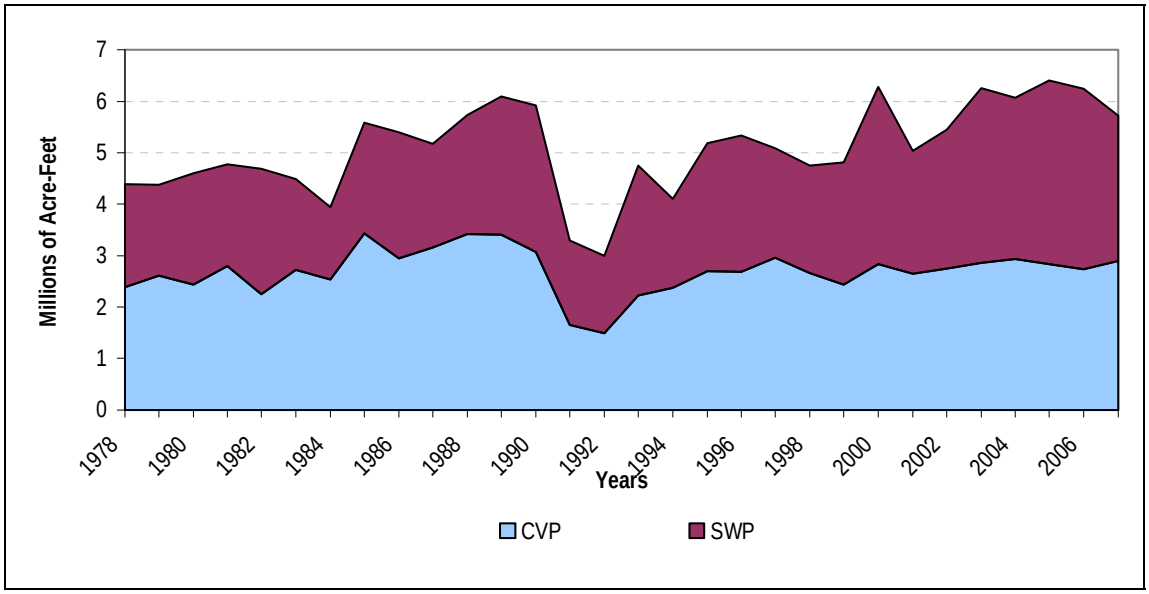
Source: U.S. Dept. of the Interior, Bureau of Reclamation, Mid-Pacific Region, *Biological Assessment on the Long-Term Operations of the Central Valley Project and the State Water Project,* Sacramento, CA, August 2008, p. 2-120.

Notes: In the second column of the table, AN=Above Normal; BN=Below Normal; D=Dry; W=Wet; and C=Critical. In the sixth column, SOD-Ag refers to south-of-Delta agricultural water service contractors (junior water rights holders under California water law). Percentages show water allocations for these contractors as a percentage of their maximum contract total. In the seventh column, the "Shasta Index" refers to an index used to determine water allocations based on unimpaired inflows into Shasta Lake. Water year types and thus water allocations are determined based on the elevation of Shasta Lake at certain times of the year. Critical refers to a critically dry year in which the Shasta inflows were below specified levels, triggering reduced water allocations.

How Do Current Exports Compare to the Last Drought?

During 1991 and 1992, the last two years of the previous major drought (see **Table 2**), combined CVP and SWP exports were 3.3 MAF and 3.0 MAF, respectively. Reclamation estimates that combined 2009 exports totaled 3.6 MAF, a difference of +0.3 to +0.6 MAF compared to 1991 and 1992. So far (it is earlier in the potential drought cycle now than in the previous drought) it appears that more water is being exported in 2009 than during the worst years of the previous major drought, even accounting for reductions due to the new Delta smelt BiOp (see **Figure 4**) and post-1992 regulatory restrictions such as those contained in CVPIA, and D-1641.

Figure 4. CVP and SWP Delta Water Exports 1978 - 2007



Source: U.S. Dept. of the Interior, Bureau of Reclamation, Mid-Pacific Region, *Biological Assessment on the Long-Term Operations of the Central Valley Project and the State Water Project,* Sacramento, CA, August 2008, p. 2-119.

Note: The spike in 2001 correlates to the filling of Diamond Valley reservoir and the ability of the SWP to export high excess winter flows; albeit in an overall dry year. The trough in 1991 and 1992 correlates to the last years of the last major California drought.

Further, combined exports averaged roughly 5.18 MAF for the 10 years (1981-1990) prior to the last drought reduction, a full 0.6 MAF less than the average deliveries from 1998-2007, despite implementation of CVPIA, D-1641, and standing BiOps under the ESA since that earlier time. Thus, even with numerous restrictions, combined CVP and SWP Delta exports have in recent times averaged more annually than in any time prior to enactment of the CVPIA and other more recent regulatory restrictions. Some of this difference can be explained by more "wet" and "above normal" years in the latter period (following successive wet years in 1995, 1996, and 1997) and significant increases in SWP pumping (see **Table 2**) from 2003 through 2006.[57] It is not clear, however, how much of the difference can be explained without analyzing total supplies available

[57] Demand for water from growing urban areas in Southern California, which have experienced an increase in population of 8-10 million people since the early 1990s, development of new SWP contractor storage facilities south of the Delta, and declines in water availability to Southern California from the Colorado River have resulted in increased pressure on Delta and northern California supplies and increased SWP exports from the Delta.

for each year, the timing of supplies available for export, and the availability of south-of-Delta storage capacity and canal capacity. Regardless of the exact differences, CVP agricultural water service contractors have received less water than contracted for in most of the last 15 years (see sixth column in **Table 2**), due to relatively static CVP pumping levels (relative to SWP pumping levels) as indicated in **Figure 4**, and restrictions affecting Delta exports. Further, CVP water allocations have been reduced, due in part to obligations under CVPIA to deliver water to south-of-Delta wildlife refuges and factors sometimes limiting storage at San Luis Reservoir (south-of-Delta). Thus, although combined exports have increased since the early 1990s, even with implementation of several regulatory restrictions, CVP water allocations for south-of-Delta agricultural water service contractors have been significantly reduced. Meanwhile, SWP exports, primarily serving municipal and industrial contractors, increased in 2000 and 2003-2006 (see **Table 2** and **Figure 4**).

California Water Rights: Acquisitions and Allocations

Another less frequently mentioned factor affecting water allocations is state water rights. The system of state water rights has a profound effect on who gets how much water and when, particularly during times of drought or other restrictions on water supply. Water shortages and export restrictions due to drought and other factors have resulted in unequal impacts on CVP and SWP water contractors because of differences in priority of water contracts, which are based on underlying water rights. California law provides for several limits on the use of the state's waters, which has a direct effect on how much water state and federal contractors receive both north and south of the Delta.[58] Because the waters of California are considered to be "the property of the people of the State," anyone wishing to use those waters must acquire a right to do so.[59] California follows a dual system of water rights, recognizing both the riparian and prior appropriation doctrines.[60] Under the riparian doctrine, a person who owns land that borders a watercourse has the right to make reasonable use of the water on that land (riparian rights). Under the prior appropriation doctrine, a person who diverts water from a watercourse (regardless of his location relative thereto) and makes reasonable and beneficial use of the water acquires a right to that use of the water (appropriated rights). Before exercising the right to use the water, appropriative users must obtain permission from the state through a permit system run by the SWRCB.

Priority of Water Rights

California law provides for a hierarchy of rights for users sharing water that may not meet all users' needs.[61] Because riparian users share the rights to the water with other riparians, no one

[58] For a legal discussion of California's water laws and system of allocation, see CRS Report RL34554, *California Water Law and Related Legal Authority Affecting the Sacramento-San Joaquin Delta*, by Cynthia Brougher.

[59] Cal. Water Code § 102. See *National Audubon Society v. Superior Court*, 33 Cal. 3d 419, 441 (Cal. 1983).

[60] See *In re Determination of Rights to Water of Hallett Creek Stream System*, 44 Cal. 3d 448, 455 (Cal. 1988); *National Audubon Society v. Superior Court*, 33 Cal. 3d 419, 441 (Cal. 1983); *People v. Shirokow*, 26 Cal. 3d 301, 307 (Cal. 1980).

[61] These rules are specific to California. Rules in other western states may differ.

riparian user's right is considered superior to another's riparian right. Therefore, riparian rights are reduced proportionally in times of shortage. With regard to appropriative rights, the person's right that was appropriated first is considered superior to later appropriators' rights to the water. Between the two types of rights, users with riparian rights generally have superior claims to those who have appropriative rights.[62] That is, riparians generally may fill their needs before appropriators (and thus hold "senior" rights), and appropriators fill their needs according to the order in which they secured the right to the water.[63] Appropriated rights may be senior or junior to another's appropriated right depending upon the time the rights were secured.

Water Rights and Allocations for Water Delivered via the CVP and SWP

Both the CVP and SWP acquired appropriative rights from the state of California, receiving several permits at various points between 1927 and 1967.[64] Section 8 of the Reclamation Act of 1902[65] requires Reclamation to comply with state law, including requiring the agency to acquire water rights for its projects, including the CVP.[66] If Reclamation found it necessary to take the water rights of other users, those users would be entitled to just compensation.[67] In some cases, Reclamation found it necessary to enter into "settlement" or "exchange" contracts with water users who had rights pre-dating the CVP, and thus were senior users in time and right. Many of these special contracts were entered into in areas where water users were diverting water directly from the Sacramento and San Joaquin Rivers. **Figure 5** shows the distribution of areas served under different types of CVP contracts.

For example, many farmers were diverting water from the Sacramento River before construction of Shasta Dam. In order for Reclamation to undertake the CVP as planned, it was necessary to come to agreement with these prior users on use and delivery of Sacramento River water supplies. The result was a series of "Sacramento River Settlement Contracts," which guarantee prior users certain amounts of "base supply" water. Some of these contractors also have contracts for CVP "project" water. North-of-Delta settlement contracts total approximately 2.1 MAF. Similarly, Reclamation entered into "exchange contracts" with certain water users (south of the Delta) who diverted water from the San Joaquin River prior to construction of Friant Dam. These users exchanged their direct diversion of river water for water delivered from the Delta via the CVP

[62] While users acquire appropriative rights through a permit system, riparian users are required to file a statement with the SWRCB that declares their right. With regard to later riparians, the California Supreme Court has noted that an appropriator may have a superior right to a riparian if the appropriator acquires his right before the riparian secures his right in the land. See *Lux v. Haggin*, 69 Cal. 255, 344-49 (Cal. 1844).

[63] See *Meridian, Ltd. v. San Francisco*, 13 Cal. 2d 424, 445-47 (Cal. 1939).

[64] For a discussion of the projects' permit process, see *Racanelli*, 182 Cal. App. 3d at 106.

[65] 43 U.S.C. § 383.

[66] The U.S. Supreme Court has held that Section 8 "requires the Secretary to comply with state law in the 'control, appropriation, use or distribution of water'" by a federal project. See *California v. United States*, 438 U.S. 645, 674-75 (1978). This requirement to comply with state law applied so long as the conditions imposed by state law were "not inconsistent with clear congressional directives respecting the project." See id. at 670-73; see also *Ivanhoe Irrig. Dist. v. McCracken*, 357 U.S. 275 (1958); *City of Fresno v. California*, 372 U.S. 627 (1963). In the context of the CVP, a court has held that the permit conditions were consistent with the project purpose of river regulation. *Racanelli*, 182 Cal. App. 3d at 135. See also *United States v. State Water Resources Control Board*, 694 F.2d 1171 (9th Cir. 1982).

[67] See *Int'l Paper Co. v. United States*, 282 U.S. 399, 407 (1931); *United States v. Gerlach Live Stock Co.*, 339 U.S. 725, 736-39 (1950).

Delta-Mendota canal; however, they retain a right to divert water from the San Joaquin River if Reclamation cannot deliver CVP water. South-of-Delta water rights contracts total approximately 880,000 AF. (See **Table 3** for a summary of 2009 water allocations by contract type.) For more information on settlement and exchange contracts, see CRS Report RL34554, *California Water Law and Related Legal Authority Affecting the Sacramento-San Joaquin Delta*, by Cynthia Brougher.

Table 3. CVP Contractors and 2009 Water Allocations

(allocations as percentages of maximum contract quantities)

CVP Contractors	February	March	April	May
Senior Water Rights				
San Joaquin Exchange Contractors	75%	100%	100%	100%
Sacramento River Settlement Contractors	75%	100%	100%	100%
Wildlife Refuges				
NOD Refuges	75%	100%	100%	100%
SOD Refuges	75%	100%	100%	100%
Friant Division				
Class I Contractors	25%	65%-85%	90%	100%
Class II Contractors	0%	0%	0%	18%
Other CVP Water Service Contractors				
NOD Ag. Service	0%	5%	15%	40%
NOD M&I	50%	55%	65%	75%- 100%
SOD Ag. Service	0%	0%	10%	10%
SOD M&I	50%	50%	60%	60%

Source: U.S. Department of the Interior, Bureau of Reclamation, *Summary of Water Supply Allocations*, p 4, http://www.usbr.gov/mp/cvo/vungvari/water_allocations_historical.pdf.

Notes: Increases in allocations were made on March 20, March 30, April 21, and May 22, 2009. NOD refers to north-of-Delta; SOD refers to south-of-Delta.

Other CVP contracts, known as "water service" contracts (generally shown as light purple in **Figure 5**), are held by other users for water supply based on water rights Reclamation holds (issued by the state) for water stored and delivered as part of the CVP. The water supplied to users under these contracts is generally determined by the terms of the contract, rather than the legal doctrines of water rights (although their priority is based on the state water rights doctrine). These contracts incorporate the requirements of federal Reclamation law.[68] Specifically, the contracts typically include provisions that address the possibility of water shortages due to drought and other conditions that may affect users' access to water provided under their contract.[69] Generally,

[68] CVP Contract preamble. For a CVP-wide form of contract (CVP Contract) that Reclamation uses, see http://www.usbr.gov/mp/cvpia/3404c/lt_contracts/cvpwide_final_form_contract_04-19-04.pdf.

[69] See CVP Contract art. 3(b) ("Because the capacity of the Central Valley Project to deliver Project Water has been constrained in recent years and may be constrained in the future due to many factors including hydrologic conditions and implementation of Federal and State laws, the likelihood of the Contractor actually receiving the amount of Project Water set out [in this contract] in any given Year is uncertain.") See also contract articles 11 and 12.

courts have allowed the government to reduce water allocations provided by contract if the reduction is made necessary by federal law, but the extent of liability depends on the terms of the specific contract used in each case.[70]

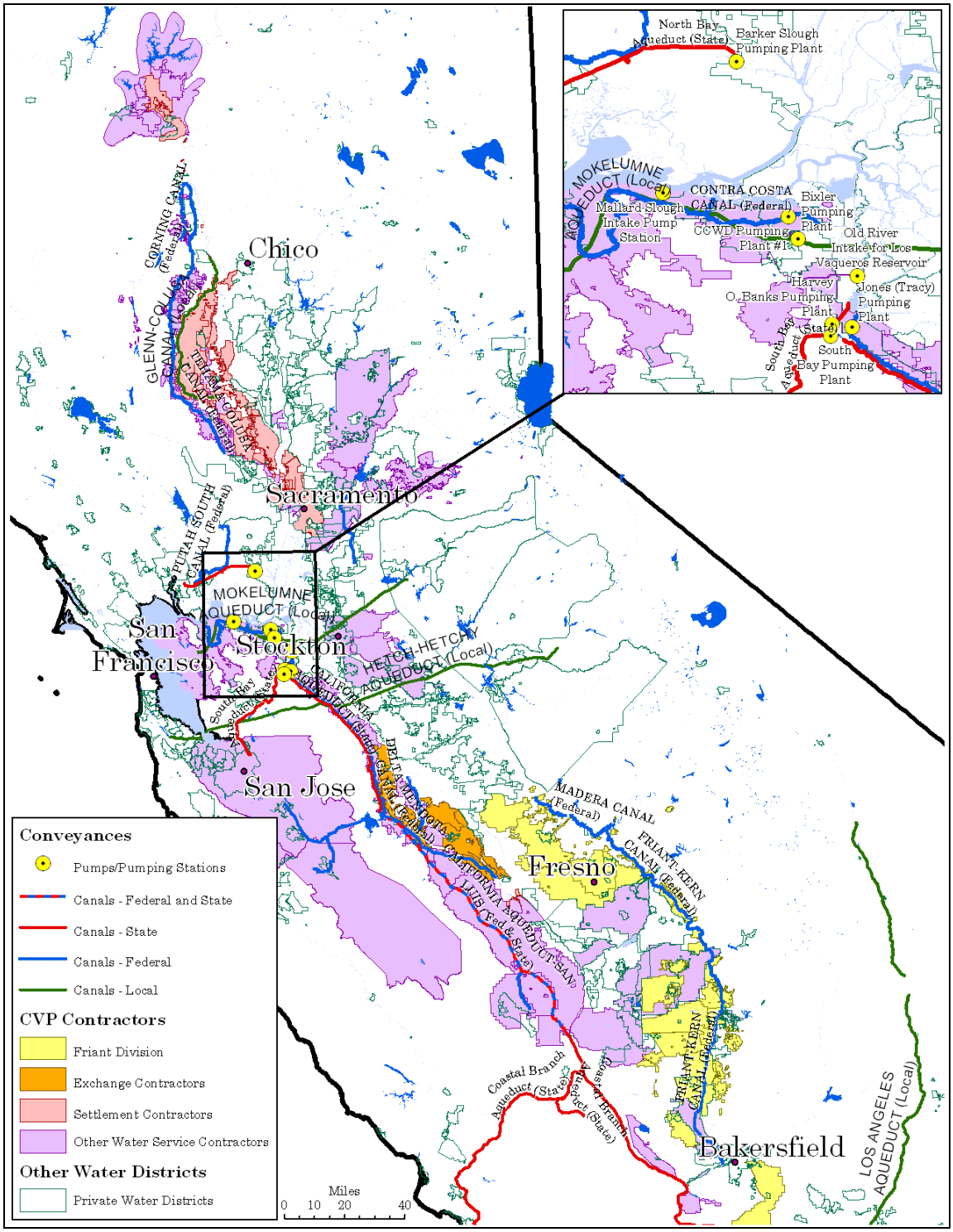
In all, senior water rights holders (i.e., settlement contractors—shown in pink—and exchange contractors—shown in orange—in **Figure 5**) together hold senior rights and thus first priority to approximately 3 million AF of CVP water. This factor, combined with drought and regulatory restrictions, results in significant cuts during times of water supply shortages to water contractors with contracts based on water rights that are junior to settlement and exchange contractors (particularly for junior contractors south of the Delta). For example, in dry years (indicated by certain water levels at Shasta Lake by a certain time early in the water year), senior contractors are allocated 75% of their contract amounts; whereas more junior contractors might be allocated as little as 0% of their contracted supplies. As noted earlier, for the latter part of the 2009 water year, exchange and settlement contractors were allocated 100% of contracted CVP supplies, while some junior CVP contractors have been allocated 10%. (See **Table 3**.) For example, senior CVP water contractors both north and south of the Delta are allocated 100% of contracted supplies, while junior agricultural water service contractors south of the Delta, largely on the west side of the San Joaquin Valley, have been allocated 10% of their maximum contracted supply and junior agricultural water service contractors north of the Delta have been allocated 40%. Municipal and industrial water service contractors north of the Delta have been allocated 75% to 100% of contracted supplies, while those south of the Delta have been allocated 60%.[71]

[70] See *Stockton E. Water Dist. v. United States*, 76 Fed. Cl. 321, 358-59 (Fed. Cl. 2007) (Bureau not liable where reductions "occurred due to implementation of amendments to federal Reclamation law"); *O'Neill v. United States*, 50 F.3d 677, 682-83 (9th Cir. 1995) (contract provision relieving government of liability "for any damage ... arising from a shortage on account of errors in operation, drought, or any other causes" included protection for shortages caused by "the effects of subsequent Congressional mandates"). But see *Tulare Lake Basin Water Storage Dist. v. United States*, 49 Fed. Cl. 313 (Fed. Cl. 2001) (holding that the federal government was liable when federal legislation forced reductions under state contract to which the federal government was not a party). Six years later, the same judge that wrote the *Tulare* decision repudiated the physical taking characterization, citing intervening caselaw and noting the absence of a physical diversion. See *Casitas Municipal Water Dist. v. United States*, 76 Fed. Cl. 100 (Fed. Cl. 2007). On appeal, the U.S. Court of Appeals for the Federal Circuit reversed the district court's holding in *Casitas*, noting that the intervening caselaw did not bear on the case. *Casitas Municipal Water Dist. v. United States*, 543 F.3d 1276 (Fed. Cir. 2008).

[71] Historical CVP water allocations can be viewed at http://www.usbr.gov/mp/cvo/vungvari/water_allocations_historical.pdf.

Figure 5. CVP Water Contract Service Areas in the Central Valley, CA

(also shows location of some of the major federal and state water conveyance systems)



Source: Prepared by CRS based on data from the U.S. Bureau of Reclamation; California Spatial Information Library; Census Bureau TIGER/Line data files; and ESRI Community Data, 2008.

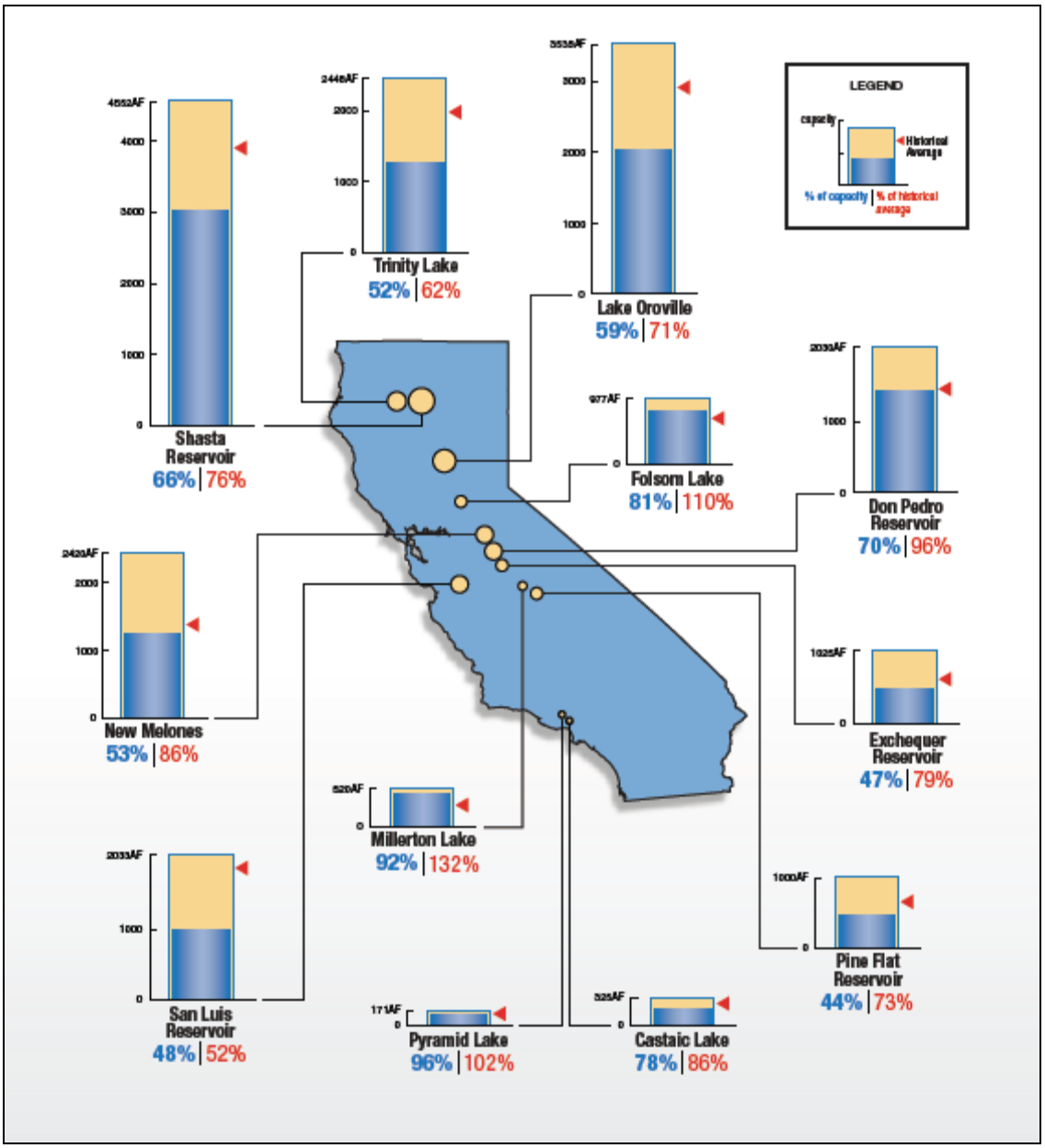
Conclusion

Restrictions on water deliveries resulting directly from federal and state regulations, or imposed by courts' interpretation of those rules, are estimated to range roughly from 20% to 25% of total water delivery reductions for 2009, depending on the time period used for estimating annual deliveries. The remaining 75%-80% of 2009 water reductions, according to the Department of the Interior, are due to "lack of run-off" (i.e., drought) and other factors.

In the absence of the current three-year hydrological drought, it is unlikely that the existing regulatory water delivery restrictions would have created controversy of a similar magnitude. Rather, the current drought has created a fundamental shortage of supply. Regulatory or court-imposed restrictions, as well as the long-established state water rights system, exacerbate the effects of the drought for agricultural and urban water users. These effects are not always perceived as equitable or fair to those with junior water rights, or to those who otherwise have lower priority for receiving SWP and CVP water. However, the restrictions are imposed largely to protect fish resources integral to the Delta ecosystem and Sacramento River, upon which many north coast fishermen and local communities depend.

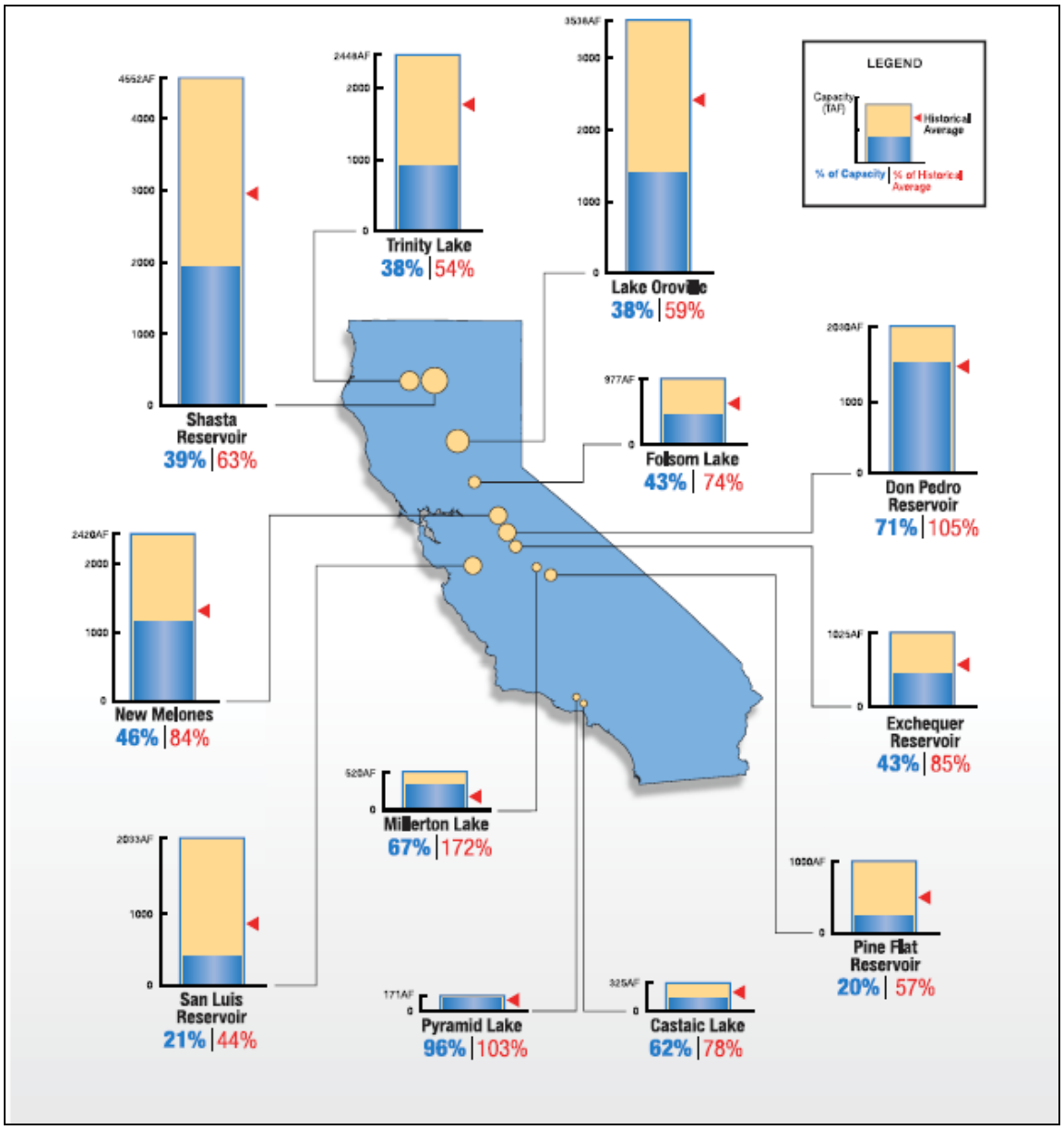
At issue for Congress in the short term is how to evaluate legislative proposals for waiving the federal ESA or otherwise increasing water supplies that could result in the extinction of several fish species. Congress may also consider broader legislation that would help water users while working within the boundaries of the ESA, thereby attempting to protect endangered species as well as economies dependent on both reliable water supplies and healthy ecosystems, including declining fish populations.

Appendix A. Reservoir Conditions for 12 Reservoirs as of April 27, 2009



Source: California Department of Water Resources, "California's Drought Update," April 30, 2009, at http://www.water.ca.gov/drought/docs/drought_update.pdf.

Appendix B. Reservoir Conditions for 12 Reservoirs as of September 27, 2009



Source: California Department of Water Resources, "California's Drought Update," September 30, 2009, at http://www.water.ca.gov/drought/docs/DroughtUpdate_sept30.pdf.

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