

California Drought:

Environmental Considerations in Water Supply and Infrastructure

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California is experiencing prolonged drought conditions which has created severe water shortages throughout the state. Environmental laws and other regulatory compliances have further limited available water supplies. There are many stakeholders seeking legislative reforms including agricultural, environmental, industrial, recreational, and urban groups. Congress is currently considering a variety of bills that aim to address these issues by investing in and maintaining infrastructure, establishing disaster preparedness and response plans, and reforming environmental laws. This report explores the California drought, its effects on state water supplies, and current laws that affect water infrastructure projects and water distribution. The report also discusses proposed legislation that aims to provide relief to the stakeholders.

Over the past decade, the state of California has experienced severe drought conditions which have contributed to a number of social, economic, and environmental consequences. The widespread dry hydrological conditions over the last decade have further exacerbated the state's already limited water supply. Water shortages and water delivery disputes, coupled with no existing federal drought preparedness plan, prompted state officials to implement a series of actions to better conserve and distribute water. In 2014, Governor Jerry Brown declared a State of Emergency and directed state and local officials to prepare for and mitigate the impact of the drought conditions. By the start of the 2015 Water Year,¹ "nearly 60% of Califor-

nia was experiencing [an] exceptional drought" which is the most severe classification at the U.S. federal level (Folger & Cody, 2015: p.16; See Figure 1). By April 2015, the state was experiencing more severe water shortages, which prompted Governor Brown to mandate a 25% reduction in water use for nonagricultural users to better conserve the state's water (California Department of Water Resources (DWR), 2016).

As of November 2016, roughly 20% of the state continues to experience exceptional drought conditions which represents considerable improvement from previous years (See Figures 2 & 3). While overall conditions may have improved, over 93% of the state still faces varying degrees of drought conditions, and most water reservoirs are well below storage capacity and historical averages (See Figure 4). Central and Southern California are hardest hit by the drought.

¹ The term "water year" is used by the U.S. Geological Survey (USGS) to measure the surface water supply between a 12-month period that begins October 1 and concludes on September 30 (USGS, 2016).

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the drought conditions and water shortages, creating tension throughout the region over water deliveries.

California's current hydrological conditions, water infrastructure, and environmental and other regulatory compliances have created a largely unpredictable and unreliable distribution of water to the 25 million people who depend on federal and state water deliveries (Brouger, 2009; National Drought Mitigation Center [NDMC], 2016). These stakeholders, who share competing needs and interests, include the agricultural industry, outdoor recreation and sport industries, urban communities, and wildlife refuges managed by federal agencies. For the fourth consecutive year, many of the stakeholders will experience a severely curtailed water supply because of the drought.

Hydrological Conditions

Historically, California has experienced periods of long-term dry conditions which put stress on the state's water supply. The current drought conditions are unique in this case as they occur during the warmest and driest period of the state's recorded history. Between 2012-2015, the state received a total of 62.2 inches of rain (DWR, 2016), and the average temperature between May 2014 and June 2015 was 61.5°F (National Oceanic and Atmospheric Administration [NOAA] National Centers for Environmental Information [NCEI], 2016). The average annual rainfall California receives is 22.4 inches (NCEI, 2016; See Figure 5); its average temperature is 57.6°F (NCEI, 2016; See Figure 6). These conditions have significant and detrimental consequences for the state as a growing population creates a higher demand for water while simultaneously having less of it. More concerning for the state is the anticipated precipitation patterns for the next couple of years. According to the NOAA's Climate Prediction Center (CPC), California will continue to experience widespread drought conditions through February 2017 (NOAA, 2016).

California receives much of its water supplies from precipitation, runoff from melting snowpacks on the Sierra Nevada Mountains, and groundwater. On an average year, the state receives as much as 80% of its precipitation from winter storms that occur between November and April (Cody, Folger, & Brown, 2015). During the spring months, runoff from the melting snowpacks provide a vital source of water that supplies the state's reservoirs. On an average year, the state receives about 30% of its water supplies from snowpacks (Stern, Sheikh, & Cody, 2016). "If there is no snowpack or the snowpack has low water content," the amount of water available for distribution will not be sufficient to satisfy the state's water needs for the

second half of the year (Cody, 2016: p.2). When there is a gap between the water supplied from these two sources and the demand, the state relies on groundwater supplies to supplement that difference. Accordingly, the demand for groundwater fluctuates depending on the availability of water from other sources.

Water Infrastructure

California's water supply is delivered through two major delivery projects: the federal Central Valley Project (CVP) and the State Water Project (SWP) (See Figure 7). The former is owned and operated by the Bureau of Reclamation (Reclamation) which is situated in the Department of the Interior; the latter by the California Department of Water Resources (DWR) (Cody, Folger, & Brown, 2015). Both projects use "natural waterways and constructed facilities to convey water" to users in Central and Southern California (Reclamation, 2008: p.iii). With roughly 1,400 dams and a complex system of canals and pumps, the projects divert water that flows into the Sacramento-San Joaquin River Delta (the Bay-Delta) which is "formed by the confluence of the north flowing San Joaquin River, and the south-flowing Sacramento River, and the San Francisco Bay, to which the delta of the rivers is linked" (Brouger, 2009: p.1). The diverted water is stored in reservoirs where it will be periodically released back into the Bay-Delta.

The CVP supplies approximately 7 million acre-feet (MAF) of water to agricultural, municipal and industrial (M&I) users, as well as several wildlife refuges (Stern, Sheikh, & Cody, 2016). The CVP covers roughly 400 miles, starting from the Cascade Mountains near Redding in northern California and ending near the Tehachapi Mountains by Bakersfield in Southern California (See Figure 7). The SWP primarily services agricultural and M&I users, delivering an average 2.5 MAF of water (Stern, Sheikh, & Cody, 2016). The SWP starts at Lake Orville in Butte County and ends at Lake Perris in Riverside County (See Figure 7).

The water users who rely on both delivery projects "are experiencing unprecedented water supply shortages" because of the drought conditions. The CVP's water deliveries, for instance, have been drastically curtailed for "many of the state's largest and most prominent agricultural areas for the fourth consecutive year" (Stern, Sheikh, & Cody, 2016: p.4; See Table 1). Most of the contractors affected by this reduction reside south of the Bay-Delta where the drought has been the most severe. SWP's water deliveries has been below contract allotments since 2006, reaching as low as 5% in 2014 (DWR,

2016; See Table 2). However, SWP is estimated to deliver 60% of its water allocations in 2016.

Because of the adverse effects of California's drought conditions, many cities and counties have implemented water rationing policies, and statewide mandatory water usage cutbacks have been enacted. To adjust to water shortages, many agricultural users have started to rely more on groundwater to meet their need. In 2015 for instance, as much as 65% of the state's water needs was met by the usage of groundwater which is about 20% more than an average year (Stern, Sheikh, & Cody, 2016). This dependence on and use of groundwater is currently unregulated as California "lacks a formal state-administered system that regulates and permits groundwater use" Kaldani, 2014). This functions as a short-term solution, though sustained reliance on it will have detrimental environmental consequences.

Environmental Impact

While the drought conditions and water shortages have largely contributed to the deterioration of natural habitats and ecosystems, human activity further exacerbates this decline. For instance, dozens of fish species including salmon, steelhead, and the Delta smelt have experienced significant reductions in their population (Cody, Folger, & Brown, 2015). In 2015, several salmon runs "experienced a 95% loss of eggs laid...and surveys of Delta smelt found fewer than five fish that year" (Stern, Sheikh, & Cody, 2016: p.6). In fact, "more than 80 percent of the state's 122 remaining native freshwater fish species are in decline, with a quarter listed as threatened or endangered" under the Endangered Species Act (Public Policy Institute of California (PPIC), 2014: p.45; See Table 3).

Figure 1: Drought Severity Classification

Category	Description	Possible Impacts
D0	Abnormally Dry	<p>Going into drought:</p> <ul style="list-style-type: none"> • Short-term dryness slowing planting, growth of crops or pastures <p>Coming out of drought:</p> <ul style="list-style-type: none"> • Some lingering water deficits • Pastures or crops not fully recovered
D1	Moderate Drought	<ul style="list-style-type: none"> • Some damage to crops, pastures • Streams, reservoirs, or wells low, some water shortages developing or imminent • Voluntary water-use restrictions requested
D2	Severe Drought	<ul style="list-style-type: none"> • Crops or pasture losses likely • Water shortages common • Water restrictions imposed
D3	Extreme Drought	<ul style="list-style-type: none"> • Major crop/pasture losses • Widespread water shortages or restrictions
D4	Exceptional Drought	<ul style="list-style-type: none"> • Exceptional and widespread crop/pasture losses • Shortages of water in reservoirs, streams, and well creating water emergencies

Source: United States Drought Monitor. (2016). U.S. Drought Monitor Classification Scheme. Retrieved November 22, 2016, from <http://droughtmonitor.unl.edu/aboutus/classificationscheme.aspx>

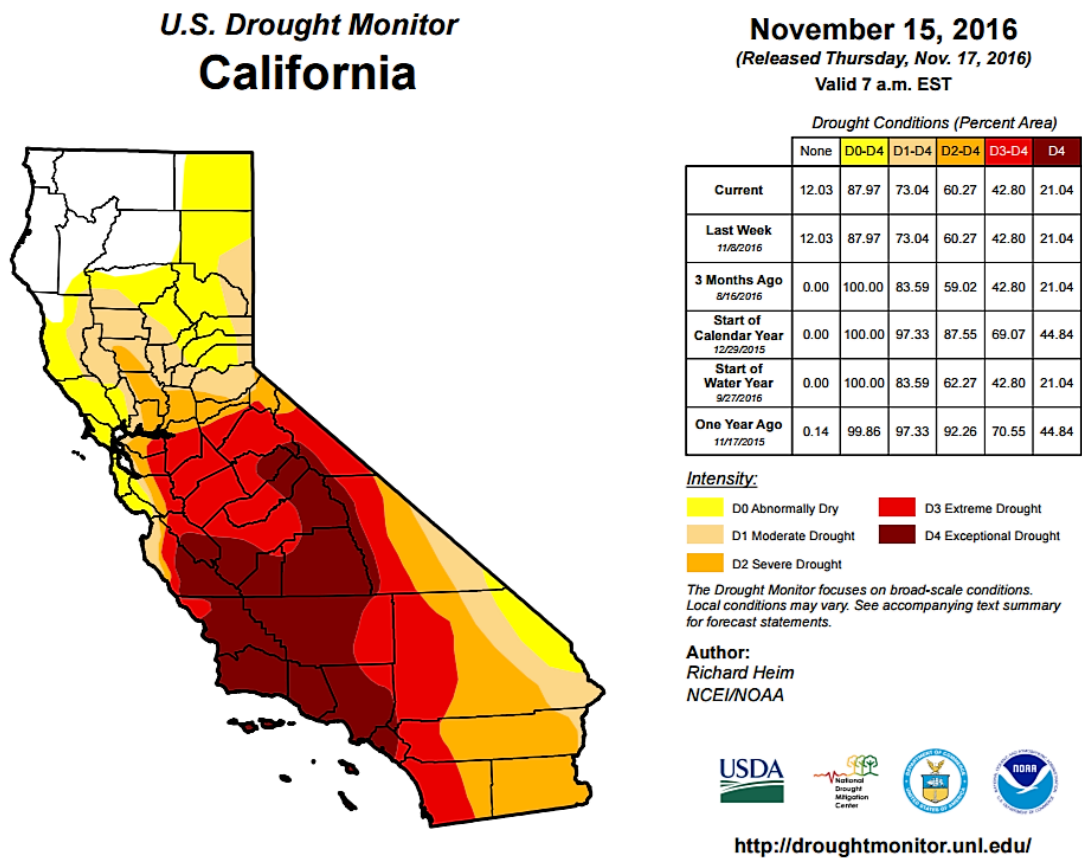
This phenomenon can be attributed to lower water levels, higher water temperatures, and water quality degradation due to salt water intrusion. These effects are a direct result of human activities which include an increasing reliance on groundwater pumping to compensate for reduced surface water supplies. This dependence on groundwater has serious environmental consequences including lower water table levels, reduced availability of groundwater supplies, and an increased probability of land subsidence² (Cody, Folger, & Brown, 2015; See Figures 8, 9, and 10).

² Land subsidence is the gradual sinking of the Earth's surface-level and is often attributed to the removal of large amounts of groundwater from certain types of rocks. As groundwater is removed, the rock begins to fall on itself causing the ground to sink (USGS, 2016).

Environmental Laws and Regulatory Factors

To protect and conserve wildlife species and their habitat, a complex system of state and federal laws have been implemented to regulate human activity and mitigate their effects on natural resources. The Clean Water Act, the Water Resources Planning Act, the National Environmental Policy Act, the Endangered Species Act, the Central Valley Project Improvement Act, Water Resources Development Acts, and California's water rights system are the primary laws that affect water availability and distribution for industries and communities, government-sponsored water infrastructure projects, and ecosystem protec-

Figure 2: California Drought Conditions



Source: United States Drought Monitor. (2016). U.S. Drought Monitor: California. The National Drought Mitigation Center. Retrieved November 22, 2016, from <http://www.californiadrought.org/drought/current-conditions/>

tion and restoration efforts. These laws aim to address three issues that have challenged California: ecosystem health, water quality, and water supply reliability (Sheikh & Cody, 2005).

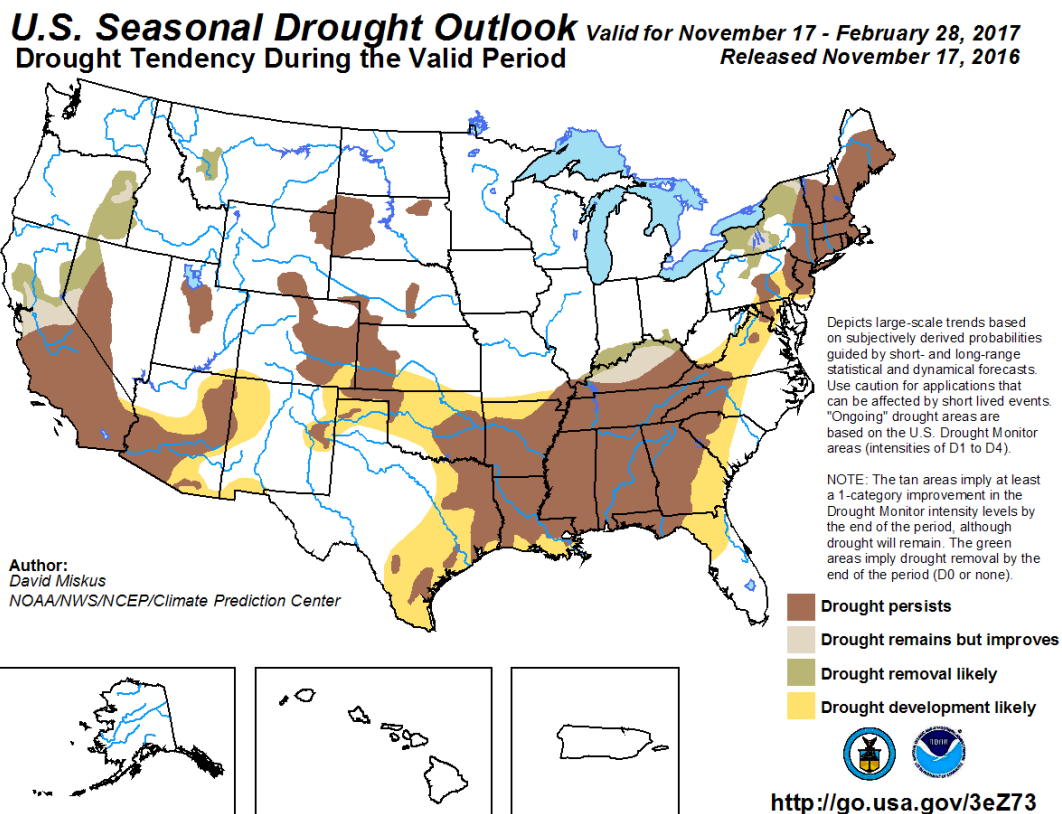
The oversight and enforcement of environmental laws and regulations follows a cooperative federalism model wherein the federal government creates a framework and guidelines for states to operate in. Because the federal government lacks the necessary resources “for [the] day-to-day monitoring and enforcement” of its environmental laws at the state and local levels, most of the actions and responsibilities fall upon the states. Accordingly, the California State Legislature has enacted the necessary state laws that comply with its federal counterparts, and enforce the provisions through the establishment of state agencies (See Table 4). This section will examine and provide background information for the most relevant fed-

eral and state laws that apply to water infrastructure and environmental regulations. The following laws correspond to legislative action taken in the 114th Congress to address drought conditions in California which is discussed in the next section.

Clean Water Act

The enactment of the Clean Water Act (CWA) in 1948 represented “the first comprehensive statement of federal interest in clean water programs” as it established water quality standards and regulations that would provide state and local governments guidance in addressing water pollution problems (Bearden et al., 2013: p.25). The federal government’s role in regulating surface and groundwater quality was expanded with the passage of the CWA insofar as ensuring that water infrastructure projects and water

Figure 3: National Drought Conditions

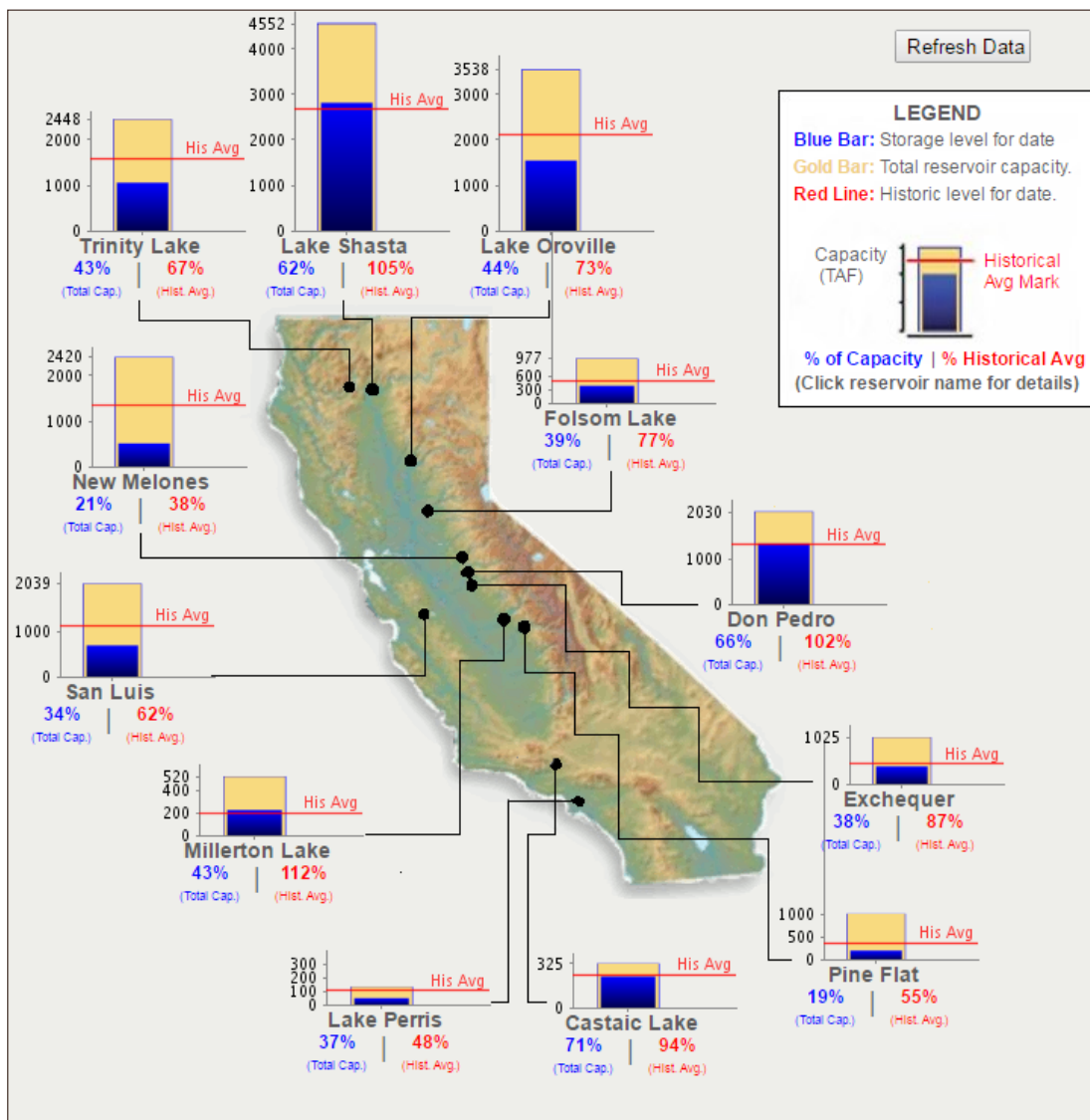


Source: National Oceanic and Atmospheric Administration. (2016). U.S. Seasonal Drought Outlook. Climate Prediction Center. Retrieved November 22, 2016, from http://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_summary.php

distribution practices met federal standards. Those standards were designed to regulate overall quality of water and water supply in such a way that protects and benefits wildlife species and their habitat. In California, the CWA would regulate CVP and SWP operations to ensure that “springtime flow and export limits” in the Bay Delta would comply with ESA standards and other measures to improve environmental conditions such as “water discharge control and habitat restoration” (Sheikh & Cody, 2005: p.7).

There are three main criticisms of the CWA: the lack of regional monitoring and data compilation of water quality; the legislative limitations to enforce environmental protection standards; and the lack of funding to finance water infrastructure projects. Addressing the first criticism, the CWA does not mandate the regional monitoring and data compilation of water quality which makes it difficult to evaluate its effectiveness in improving overall water quality. Although Lyon & Stein (2009) indicate that the CWA has been

Figure 4: State and Federal Reservoirs in California



Source: [Californiadrought.org](http://www.californiadrought.org). (2016). Current Conditions. Pacific Institute. Retrieved November 22, 2016, from <http://www.californiadrought.org/drought/current-conditions/>

Table 1: Water Allocations for CVP Contractors, 2012-2016
(percentage of maximum contract allocation)

	2012	2013	2014	2015	2016 (est.)
North-of-Delta Users					
Agricultural	100%	75%	0%	0%	100%
M&I	100%	100%	50%	25%	100%
Settlement	100%	100%	75%	75%	100%
Refuges	100%	100%	75%	75%	100%
American River M&I	100%	75%	50%	25%	100%
In Delta- Contra Costa	100%	75%	50%	25%	100%
South-of-Delta Users					
Agricultural	40%	20%	0%	0%	5%
M&I	75%	70%	50%	25%	55%
Exchange	100%	100%	65%	75%	100%
Refuges	100%	100%	65%	75%	100%
Eastside Division	100%	100%	55%	0%	0%
Friant Class 1	45%	45%	0%	0%	0%
Friant Class 2	0%	0%	0%	0%	0%

Source: Stern, C. V., Sheikh, P. A., and Cody, B. A. (2016). Central Valley Project (CVP) Operations: In Brief (CRS Report No. R44456). Washington, D.C.: Congressional Research Service.

Table 2: California State Water Project Allocations, 2006-2016
(percentage of maximum contract allocation)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016 (est.)
State Water Project	100%	60%	35%	40%	50%	80%	65%	35%	5%	20%	60%

Source: California Department of Water Resources (2016). State Water Project Allocation Increased: Storms Improve Conditions, but Drought Remains. Retrieved October 28, 2016, from <http://www.water.ca.gov/news/newsreleases/2016/042116.pdf>

successful in reducing the number of contaminants in water sources over the past 35 years, the data is not as accurate and publicly available as it should be. With hundreds of billions of dollars being spent to implement the CWA requirements, the absence of an integrated national database is counterintuitive for legislators and policy experts who attempt to examine the performance of the legislation (Lyon & Stein, 2009). Second, the CWA alone is not sufficient in effectively ensuring ecosystem protection especially in areas like the Bay-Delta where water quality standards and environmental protections directly conflict with consumptive water rights. Doremus & Tarlock (2013) suggest that if the CWA is effectively implemented and enforced, it can extend protections to at-risk species not yet covered by the Endangered Species Act which could reduce costly and less successful attempts to restore endangered and threatened species populations. Third, inadequate funding through the CWA has created a substantial gap between “available funds and projected needs” (Copeland, Maguire, & Mallett, 2016: p.1). This gap has rendered the CWA largely ineffective in addressing state and regional drought conditions because of a growing backlog of water infrastructure project proposals. These projects are necessary in maintaining, repairing, and improving existing infrastructure, developing new facilities to support urban and rural development, and expanding sustainable water collection and recycling programs (Copeland, Maguire, & Mallett, 2016). These challenges have been discussed by Congress though it is unlikely to see comprehensive adjustments made in this Congressional session.

Water Resources Planning Act

During the 1960s and 1970s, Congress began to deliberate and enact legislation that would address

the environmental impact of federal projects and evaluate investments in water resources developments (Luther, 2013). The Water Resources Planning Act of 1965 (WRPA) was the product of this shift in national priorities. The passage of WRPA made two major contributions to federal project development and investment. First, it established “Water Resources Planning” requirements which “created a coordinated planning process related to the conservation, development, and use of water resources” (Luther, 2013: p.4). Second, WRPA created the Water Resources Council (WRC), which was tasked with maintaining an ongoing study and assessment of water supplies and programs in every region of the United States to determine whether federal water requirements were being met. The WRC was also responsible for identifying the impacts of water resource agencies (e.g. Army Corps of Engineers). A WRC Task Force determined that it would measure that impact by four factors: “national economic development, environmental quality, regional economic development, and social well-being” (Luther, 2013: p. 4). The WRC was disbanded in 1988 due to lack of funding, though the provisions set forth in WRPA remain as guiding principles for water resource agencies and projects.

National Environmental Policy Act

The passage of the National Environmental Policy Act (NEPA) in 1969 represented a growing national concern about the consequential impact that human activity has on the environment. NEPA has two main focuses: (1) to require all federal agencies and project sponsors to consider the environmental impact of their action before conducting it; and (2) to inform the public of their proposed action to assure them that all environmental concerns are considered and that the action complies with federal regulations. Accordingly, NEPA has been used as an umbrella statute which provides a framework

Table 3: Status of Five Species of Pacific Coast Salmonids

Species	Population (ESU)	Status	Federal Register (FR) Citation	Pending Action
Coho Salmon	1. Central California Coast	Endangered	70 FR 37160 (June 28, 2005)	
(Oncorhynchus kisutch)	2. Southern Oregon/Northern California	Threatened	70 FR 37160 (June 28, 2005)	
	3. Lower Columbia River	Threatened	70 FR 37160 (June 28, 2005)	Critical habitat under review by NMFS
	4. Oregon Coast	Threatened	73 FR 7816 (Feb. 11, 2008)	
	5. Puget Sound/Strait of Georgia	Species of Concern	69 FR 19975 (Apr. 15, 2004)	
	6. Southwest Washington	Undetermined		
	Chinook Salmon	1. Sacramento River winter-run	Endangered	70 FR 37160 (June 28, 2005)
(Oncorhynchus tshawytscha)	2. Upper Columbia River spring-run	Endangered	70 FR 37160 (June 28, 2005)	
	3. Snake River fall-run	Threatened	70 FR 37160 (June 28, 2005)	
	4. Snake River spring/summer-run	Threatened	70 FR 37160 (June 28, 2005)	
	5. Central Valley spring-run	Threatened	70 FR 37160 (June 28, 2005)	
	6. California coastal	Threatened	70 FR 37160 (June 28, 2005)	
	7. Puget Sound	Threatened	70 FR 37160 (June 28, 2005)	
	8. Lower Columbia River	Threatened	70 FR 37160 (June 28, 2005)	
	9. Upper Willamette River	Threatened	70 FR 37160 (June 28, 2005)	
	10. Central Valley fall and late fall-run	Species of Concern	69 FR 19975 (Apr. 15, 2004)	

to coordinate all major federal actions in a responsible manner. In this sense, federal action refers to any action “that are potentially subject to federal control and responsibility” (Luther, 2011: p.11-12).

Section 102 (2)(C) of NEPA requires all federal agencies to conduct an environmental impact statement (EIS) whenever it proposes an action. An EIS is a “full disclosure document [which] provides a

description of the proposed actions, and the existing environment, as well as analysis of the anticipated beneficial and adverse environmental effects of all reasonable alternatives” (Bearden et al., 2013: p.125). If it is determined that there will be likely adverse environmental costs because of the proposed government action, the agency is given the authority to continue the action only if it can demonstrate

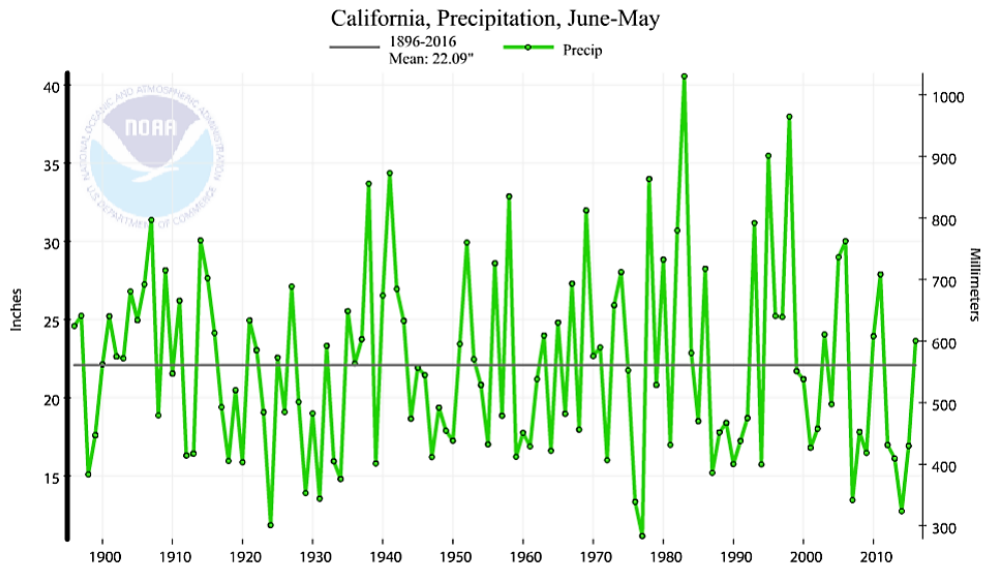
Species	Population (ESU)	Status	Federal Register (FR) Citation	Pending Action
Chum salmon	1. Hood Canal summer-run	Threatened	70 FR 37160 (June 28, 2005)	
(Oncorhynchus keta)	2. Columbia River	Threatened	70 FR 37160 (June 28, 2005)	
Sockeye salmon	1. Snake River	Endangered	70 FR 37160 (June 28, 2005)	
(Oncorhynchus nerka)	2. Ozette Lake	Threatened	70 FR 37160 (June 28, 2005)	
Steelhead trout	1. Southern California	Endangered	71 FR 834 (Jan. 5, 2006)	
(Oncorhynchus mykiss)	2. Upper Columbia River	Threatened	74 FR 42605 (Aug. 24, 2009)	
	3. Central California Coast	Threatened	71 FR 834 (Jan. 5, 2006)	
	4. South Central California Coast	Threatened	71 FR 834 (Jan. 5, 2006)	
	5. Snake River Basin	Threatened	71 FR 834 (Jan. 5, 2006)	
	6. Lower Columbia River	Threatened	71 FR 834 (Jan. 5, 2006)	
	7. California Central Valley	Threatened	71 FR 834 (Jan. 5, 2006)	
	8. Upper Willamette River	Threatened	71 FR 834 (Jan. 5, 2006)	
	9. Middle Columbia River	Threatened	71 FR 834 (Jan. 5, 2006)	
	10. Northern California	Threatened	71 FR 834 (Jan. 5, 2006)	
	11. Puget Sound	Threatened	72 FR 26722 (May 11, 2007)	Critical habitat under review by NMFS
	12. Oregon Coast	Species of Concern	69 FR 19975 (Apr. 15, 2004)	

Source: Upton, H.F. (2012). Pacific Salmon and Steelhead Trout: Managing Under the Endangered Species Act (CRS Report No.98-666). Washington, D.C.: Congressional Research Service.

that the benefits will outweigh the costs. In this regard, NEPA has proven effective in “getting agencies to incorporate environmental values in their making” (Mandelker, 2010: p. 294). However, there are some critical limitations to NEPA which

have been source of criticism since it was enacted.

The Council on Environmental Quality (CEQ) was developed in 1970 to provide the President advice on environmental matters which would eventually be submitted to Congress in an annual Environmental

Figure 5: California Average Precipitation, 1895-2016

Source: National Oceanic and Atmospheric Administration. (2016). National Centers for Environmental Information. Climate at a Glance: U.S. Time Series, Precipitation. Retrieved on November 23, 2016 from <http://www.ncdc.noaa.gov/cag/>

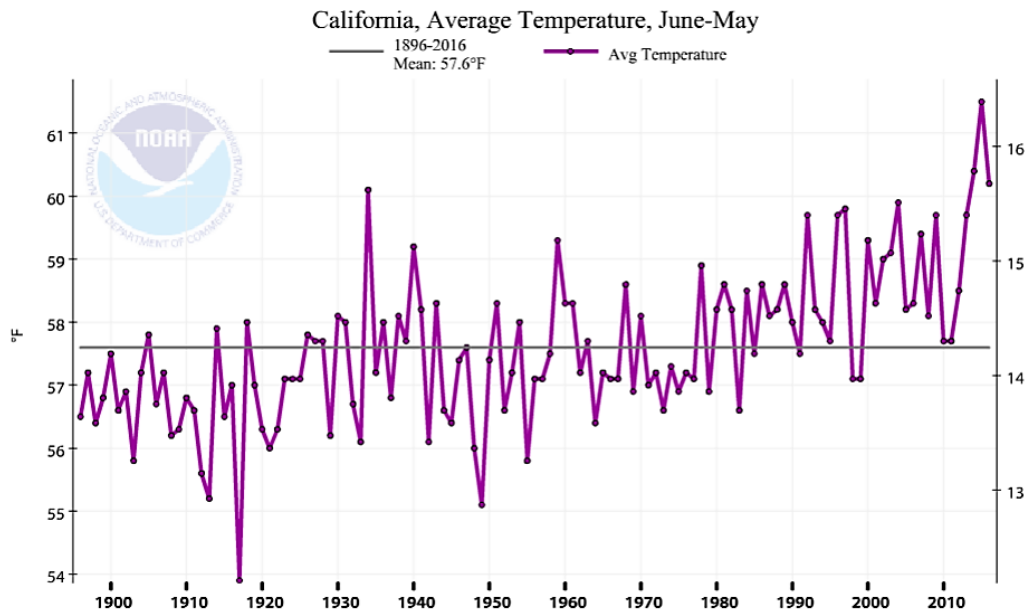
Quality Report (Luther, 2011). Recent studies by the CEQ have found that NEPA's application is subject to structural problems which affect the effectiveness in implementing its statutory provisions. One problem lies with federal agencies that fall under NEPA's jurisdiction. Although agencies are required to submit an EIS before starting a project, agencies have developed a general practice to skip this step if the agency determines that the environmental impact is not significant (Mandelker, 2010). Another problem lies with NEPA's slow bureaucratic process which some argued have been used to obstruct and delay federal agencies as they develop programs and projects though the extent of this delay is unknown due to the lack of data (Luther, 2011). Generally, legislative efforts have been directed to streamline the NEPA environmental review and compliance process, to establish time limits on EISs, and to emphasize interagency cooperation on federal projects and programs (Luther, 2007).

Endangered Species Act

The Endangered Species Act of 1973 (ESA) was a federal attempt to identify threatened and endangered plant and animal species and provide legal protection to those species. Preserving the species' habitat is con-

sidered a critical part of the ESA's purpose. Under the ESA, an endangered species is defined as "any species which is in danger of extinction throughout all or a significant portion of its range" (Corn & Wyatt, 2016: p.7). A threatened species is one "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (Corn & Wyatt, 2016: p.7). As of November 2016, 1,604 animal and plant species have been listed as either endangered or threatened in the United States (FWS, 2016). Since its passage, the ESA has been largely successful, preventing over 225 species from extinction (Center for Biological Diversity, 2011).

The two main federal agencies that administer the ESA are the Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS). The Secretary of the Interior and the Secretary of Commerce manage the ESA species listings and coordinate efforts to enforce the provisions of the act. The authority of the ESA is exercised through both statutory provisions and appropriations authorizations. As either Secretary endeavors to improve the conditions for a listed species, they can designate land that is both occupied by that species as well as surrounding land that is considered "essential for the conservation of the species" (Corn & Wyatt,

Figure 6: California Average Temperature, 1895-2016

Source: National Oceanic and Atmospheric Administration. (2016). National Centers for Environmental Information. Climate at a Glance: U.S. Time Series, Average Temperature. Retrieved on November 23, 2016 from <http://www.ncdc.noaa.gov/cag/>

2016: p.15). In 2015, ESA regulations accounted for approximately 236,000 acre-feet (AF) of water reductions between the CVP (144,000 AF) and the SWP (92,000 AF) (Cody, Folger, & Brown, 2015). These restrictions were applied, in part, to protect the natural habitat and ecosystems of ESA-listed salmon and steelhead species (NMFS, 2014).

Water Resources Development Act

Water Resources Development Acts (WRDA) are omnibus bills that authorize the Corps to undertake the construction and maintenance of national water resource infrastructure projects (Luther, 2013). The Corps is an agency within the Department of Defense that undertakes the planning, construction, operation, and maintenance of national water resource infrastructure projects. A WRDA bill may authorize “Corps studies, projects, programs, and establish policies for Corps civil works activities” (Carter & Stern, 2016: p.2). Since the enactment of the first WRDA bill in 1974, Congress has used WRDA bills as directives for the Corps to address region-

al water resource and management activities. These activities primarily pertain to “maintaining navigable channels, reducing flood and storm damage, and restoring aquatic ecosystems” (Sargent, 2016). Generally, Corps’ projects are aimed at addressing national priorities in relation to water resources, and should balance sustainable economic development with environmental protection and restoration.

Central Valley Project Improvement Act

Acknowledging that the CVP was initially designed and operated for the sole purpose of transporting water for agricultural and municipal uses, Congress passed the Central Valley Project Improvement Act (CVPIA) which was signed into law in 1992. CVPIA mandated several changes in the operation and management of the CVP to include “fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic uses” (Interior & FWS, 2016: p.1). Specifically, provisions within the CVPIA were designated towards: improving the natural production

Figure 7: Water Infrastructure Facilities in California
(federal, state, and local water infrastructure facilities)



Source: Cody, B. A., Folger, P., and Brown, C. (2015). California Drought: Hydrological and Regulatory Water Supply Issues. (CRS Report No. R40979). Washington, D.C.: Congressional Research Service.

of fish species in Central Valley rivers and streams (Section 3406(b)); mitigating adverse environmental impacts of the CVP on endangered and threatened fish species (3406 (b)(1); and providing quality water supplies to “maintain and improve wetland habitat areas” within the National Wildlife Refuge System located in the Central Valley (Section 3406 (d)) (Interior & FWS, 2016: p.1-2). These provisions reduced the amount of water available for distribution from the Bay-Delta which have environmental benefits but may worsen economic consequences. For instance, the California State Water Resources Control Board (SWRCB) estimated that the drought caused a total of \$2.2 billion in economic losses in 2014 alone (Cody, Folger, & Brown, 2015). Most of that amount was dealt to the agricultural industry and stemmed from reduced water exports from the Delta.

California Water Rights

California utilizes a dual system of water rights—“one that recognizes riparian and prior appropriation doctrines”—which has a profound effect on the allocation of water (Cody, Folger, & Brown, 2015). The riparian doctrine grants water rights based on landownership. If a person owns land that physically borders a watercourse (river, stream, lake, etc.), they have an equal right to use that water. The prior appropriations doctrine grants persons a right to water they diverted from its course if they have made a reasonable and beneficial use of that water (Brougher, 2009: p.2). This hierarchical system is based on seniority and does not guarantee that

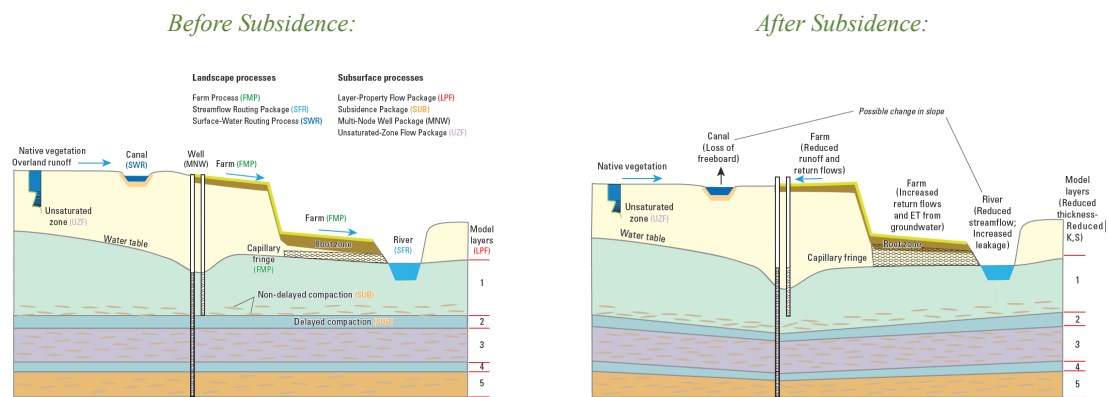
all users will receive their contracted allotment of water, especially during drought conditions. Recognizing that the water of California is the shared ‘property of the people of the State’, California requires that water users utilize their supply of water in a manner that is “reasonable and for a beneficial purpose” (appropriative rights) (Brougher, 2009: p.1-2). Those who obtain water rights by the latter doctrine must obtain permission from the SWRCB.

When California’s major water infrastructure projects were installed, appropriative water rights were necessary to ensure that it could operate as designed. Between 1927 and 1967, Reclamation and the DWR obtained appropriative rights for the CVP and SWP so it could divert water without interfering with senior water users that predated both projects (Cody, Folger, & Brown, 2015). These water rights were secured through settlement contracts and exchange contracts. In both instances, the state and federal projects secured appropriative rights to water to allow their projects to operate free from interference. This decentralized water management system has created conflicts among the thousands of local entities that provide water to their communities.

Congressional Response to California Drought and Selected Legislative Action

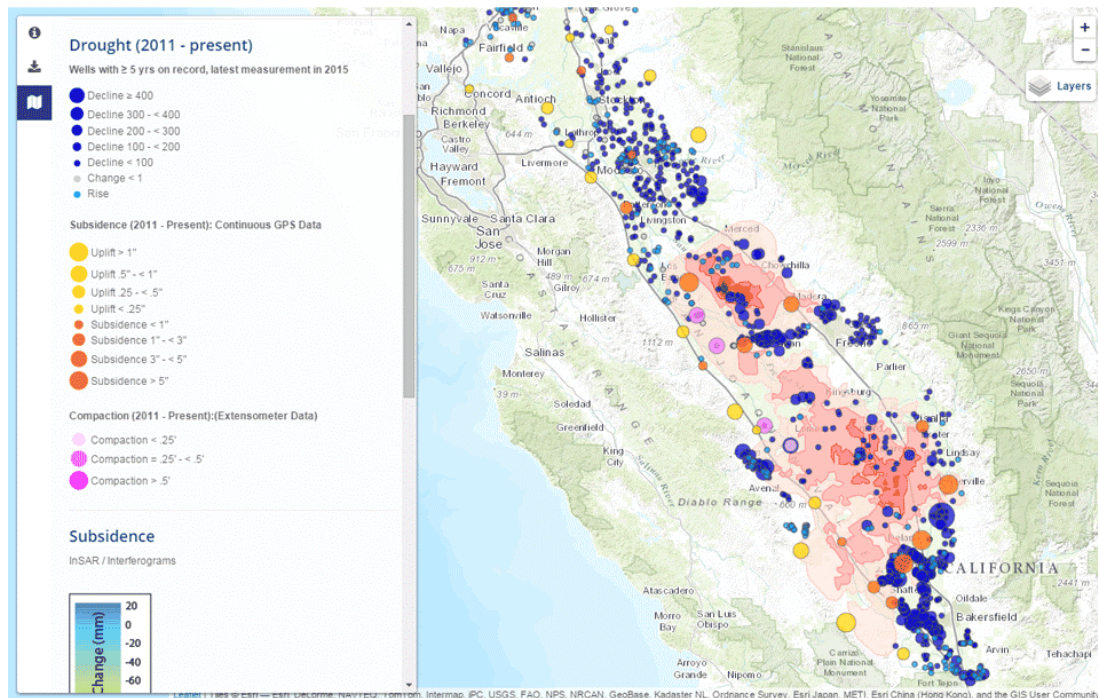
The 114th Congress currently faces numerous water resource issues as it deliberates appropriations and authorizations for water resource development, management, maintenance and protection. Some of

Figure 8: Land Subsidence Simulation (before and after)



Source: California Water Science Center. (2016). Simulating Land Subsidence. United States Geological Survey. Retrieved November 23, 2016, from http://ca.water.usgs.gov/land_subsidence/california-subsidence-simulation.html

Figure 9: Land Subsidence in Central Valley (measurements conducted in 2015)



Source: United State Department of the Interior. (2016). Groundwater Depletion and Land Subsidence in California's Central Valley. United States Geological Survey. Retrieved November 16, 2016, from <http://ca.water.usgs.gov/data/drought/drought-water-decisions.html>.

the most pressing issues include maintaining and re-investing in an aging infrastructure, investing in new infrastructure and programs, and establishing flood and drought preparedness and response plans to assist states who are impacted by such events. Reaching a consensus regarding these issues is further complicated because of the many competing interests that often pit stakeholders against each other (Cody, Stern, Carter, & Sheikh, 2015). In California, for instance, "agricultural needs are often in direct conflict with urban needs, as well as with water demand for threatened and endangered species habitat, recreation, and scenic enjoyment" (Cody & Sheikh, 2006). With a complex system of federal and state laws and regulations that affect water deliveries from the CVP and SWP, resolving these issues will be difficult.

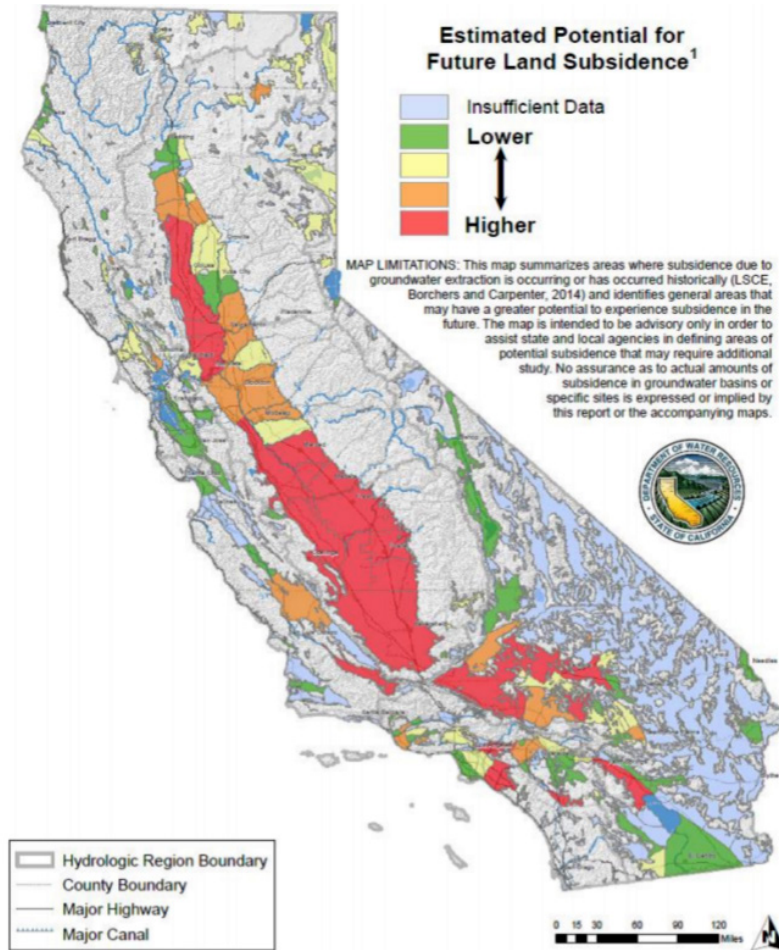
As of November 2016, there are over 341 legislative proposals that deal with federal investment in water resources and environmental protection. Multiple bills have been introduced to address California drought conditions by maximizing water exports

while adhering to environmental regulations like the ESA, CWA, and NEPA (e.g. H.R.2983, H.R.2898, H.R.3045, H.R.5247, H.R.6022, S.1894, and S.2533). Several bills have been introduced to amend existing laws including the ESA (e.g. H.R.1667, H.R.5281, and S.292) and the CVPIA (H.R.4582). A set of companion bills has been introduced which aim to designate the Bay-Delta a national heritage area to preserve the land for outdoor recreation and environmental conservation as well as to promote businesses in the local economy (H.R.1208 and S.630). Finally, two WRDA bills (H.R.5303 and S.2848) have passed their respective chambers in September 2016. Both bills include provisions that would authorize Corps water resource development projects, studies, and partnerships with nonfederal sponsors.

Drought Preparedness and Response Plan

Members of the California delegation have introduced legislation to address the recent drought condi-

Figure 10: Estimated Future Land Subsidence



Source: Cody, B. A., Folger, P., and Brown, C. (2015). California Drought: Hydrological and Regulatory Water Supply Issues. (CRS Report No. R40979). Washington, D.C.: Congressional Research Service.

tions that have plagued the state over the past decade. H.R.5247 and S.2533 (California Long-Term Provisions for Water Supply and Short-Term Provisions for Emergency Drought Relief Act), which were introduced in early 2016, are companion bills which would authorize Reclamation to provide cost-shared financial assistance to nonfederal sponsors to facilitate the development of new water storage and reclamation projects. The bills would direct the Environmental Protection Agency (EPA) to utilize State Revolving Fund (SRF) programs³ to fund the development of

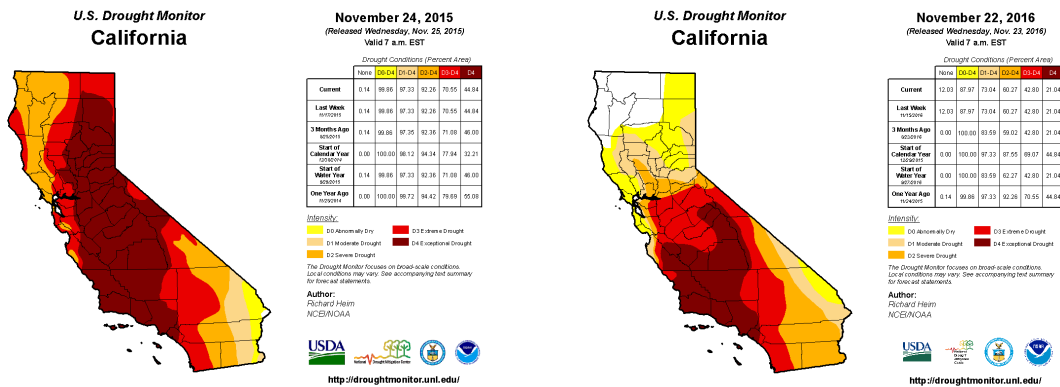
³ State Revolving Fund (SRF) programs are the most “prominent source of federal financial assistance for municipal water infra-

those projects which prioritize providing “additional water supplies to areas at risk of having inadequate supplies for public health and safety purposes, or to improve resiliency to drought” (H.R.5247, 2016). If enacted, these bills would direct Interior and Commerce to identify ways to increase water supplies to CVP and SWP contractors and the other stakeholders that rely on those water projects for their deliveries.

H.R.5247 and S.2533 also contain provisions that aim to protect and enhance native fish species and

structure projects” (Copeland, Maguire, & Mallett, 2016: p.3). SRFs can be used to develop new projects and improve existing ones such as wastewater and drinking water treatment facilities.

Figure 11: Comparison of California Drought
{November 24, 2015 and November 22, 2016}



Source: United States Drought Monitor. (2016). U.S. Drought Monitor Map Archive. The National Drought Mitigation Center. Retrieved November 22, 2016, from <http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx>.

their natural habitat. NOAA would receive appropriations to restore the natural habitat in the Sacramento River for the “benefit of Chinook salmon and steelhead trout” and to conduct studies of CVP and SWP operations to predict their effects on those fish species (H.R.5247, 2016; S.2533, 2016). Interior and Commerce would receive directives to implement pilot programs that would improve survival rates of juvenile fish species in the Bay-Delta, and in conservation hatchery programs to rebuild fish populations. Interior would also be directed to conduct studies to determine potential methods that would reduce the impact CVP and SWP operations have on native fish species. Lastly, the NMFS would be tasked with pilot programs that remove nonnative fish species to maximize other agencies’ efforts to protect and rebuild native species populations. Both bills are under committee consideration in their respective chambers.

Amendments to Existing Laws

The ESA – and to a lesser extent the CVPIA – have been the center of controversy as critics suggest that neither law has been effective in achieving its purpose of protecting and restoring threatened and endangered species. To the contrary, the regulatory restrictions that these laws impose on water deliveries have been cited as actually worsening the impact of the recent drought conditions in California which

has prompted legislators to deliberate changes to existing laws (Cody & Sheikh, 2009; Stern, Sheikh, & Cody, 2016). H.R.1667 and S.292 (21st Century Endangered Species Transparency Act) are companion bills that were introduced by Rep. Cynthia Lummis (R-WY) and Sen. John Cornyn respectively.⁴ H.R.1667 and S.292 would amend the ESA by requiring Interior and Commerce to “make publicly available on the Internet the best scientific and commercial data” used for each regulation enacted for the protection of an endangered or threatened species (H.R.1667 & S.292, 2016). Both bills are under committee consideration in their respective chambers.

H.R.4582 (Save Our Salmon Act) was introduced by Rep. Jeff Denham (R-CA) in June 2016. The bill would amend the CVPIA to “exclude striped bass from the fish doubling requirement and other provisions” of the law to ensure the protection and recovery of ESA-listed native salmon and steelhead species (House Committee on Natural Resources, 2016). Striped bass are non-native, predatory fish species that have undermined conservation efforts in the Central Valley to protect threatened and endangered species (H.R.4582, 2016). H.R.4582 passed the House on July 5, 2016 and is currently under consideration by the Senate Committee on Energy and Natural Resources.

⁴ A similar bill (H.R.4315) passed the House of Representatives in the 113th Congress in 2014 but it was not enacted.

*Sacramento-San Joaquin Delta
National Heritage Area*

H.R.1208 and S.630 (Sacramento-San Joaquin Delta National Heritage Area Establishment Act) are companion bills that were introduced by Rep. Garamendi and Sen. Feinstein in March 2015. The bills propose making the Bay-Delta a national heritage area (NHA)⁵ to secure federal assistance to “help implement the locally-developed Heritage Area management plan to conserve and protect the delta’s natural, historical and cultural resources” (Feinstein,

⁵NHAs are regions that are managed by local coordinating entities and receive federal financial and technical assistance (Delta Protection Commission, 2012).

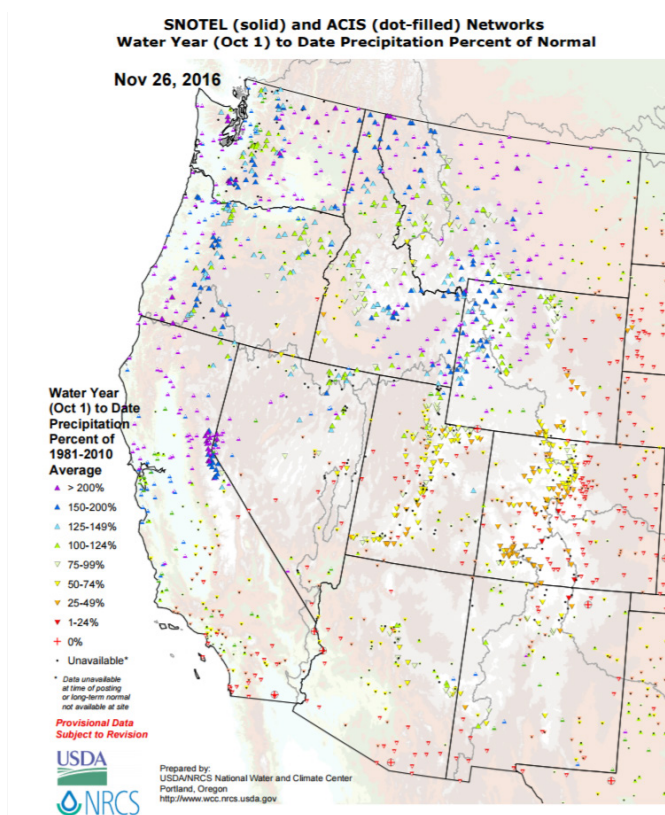
2015). The industries and their economic activities in the region largely depend on its ecological, historical, “cultural, recreational, natural...and agricultural values” which make supporting those values critical for the State (Delta Protection Commission, 2012: p.33). By making the Bay-Delta an NHA, a regional network of businesses, property owners, and government agencies can build support to preserve, protect, and enhance the region through a balance of economic development and environmental preservation. The bills are also praised for not implementing new regulations on water deliveries or property rights (Feinstein, 2015). Both bills are currently under consideration in their respective chambers with hearings already held.

Water Resources Development Act

In September 2016, two WRDA bills, H.R.5303 and S.2848, were passed in their respective chambers but have not been enacted. Most provisions in the bills relate to authorization for cost-sharing Corps projects that focus on disaster response and recovery, environmental restoration and protection, water supply, and infrastructure. H.R.5303 would authorize 30 new construction projects which are estimated to cost the federal government \$8.7 billion. Similarly, S. 2848 would authorize 29 new construction projects, costing roughly \$8.4 billion (Carter, 2016).

H.R.5303 and S.2848 also contain revisions to existing policies to better address national water resource issues. Several provisions in both bills would authorize the Secretary of the Army “to review and approve proposals to increase the quantity of water available from federal water resource projects” insofar as those proposals comply with applicable environmental laws (Carter, 2016: p.1). The bills would establish operation and maintenance responsibilities for nonfederal sponsors that will remain in effect 10 years after a restoration project has been determined successful by the Secretary. H.R.5303 would also authorize the Secretary to “design and develop a structural health monitoring

Figure 12: Current California Precipitation



Source: United States Department of Agriculture (2016). Map Products: Precipitation. Natural Resources Conservation Study & National Water and Climate Center. Retrieved November 26, 2016, from <http://www.wcc.nrcs.usda.gov/ftpref/data/water/wcs/gis/maps/WestwideWYTDPrecipPercentACIS.pdf>

program to assess and improve the condition of” infrastructure managed by the Corps (H.R.5303, 2016).

Analysis

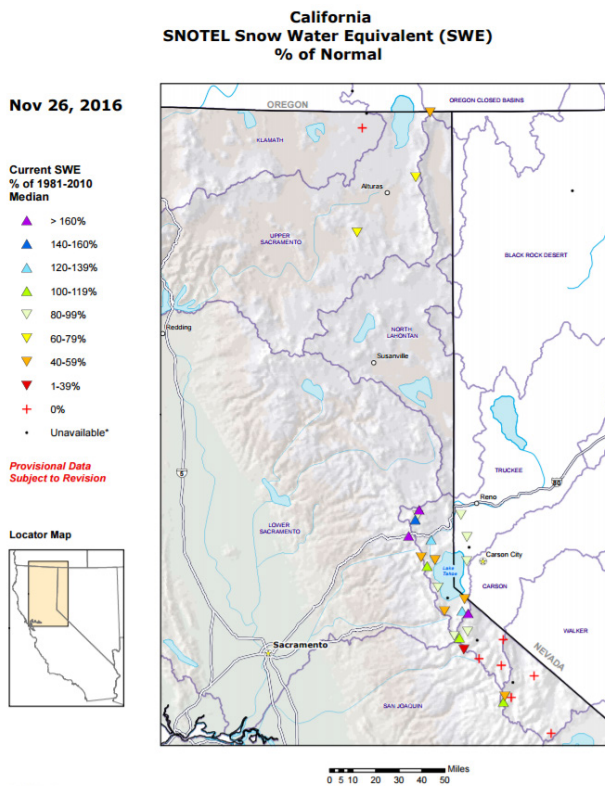
Although the current hydrological conditions in California have considerably improved from recent years (See Figures 11, 12, & 13), the effects of the drought remain severe. Challenged with balancing economic prosperity with environmental protection, legislators must find solutions that encourage the sustainable management of the state’s limited water resources. Achieving this end is no easy task however, as there are many stakeholders involved in the decision-making process. This process is further complicated with the hundreds of legislative propos-

als under Congressional consideration and growing federal budgetary constraints which limit the government’s ability to implement potential legislation.

A popular approach to addressing the drought conditions in California revolve around improving and expanding the state’s water infrastructure to more efficiently utilize and store available water supplies. H.R.5247 and S.2533 prioritize federal investment in water recycling and desalination projects that will provide additional supplies to states. In California, over 1.4 MAF of water supplies can be made available through 137 identified water recycling and desalination projects (H.R.5247, 2016). This approach will certainly assist California in developing long-term, sustainable, and reliable sources of water as it provides alternative resources that have minimal environmental impact. One shortcoming of these bills however, is their failure to maximize other natural sources of water. Previous bills (e.g. H.R.2983)⁶ indicated that storm-water capture projects in urban and suburban areas in California could increase water supplies by as much as 600,000 AF annually (H.R.2983, 2015). Yet even this proposal does not entirely resolve the issue. As Kaldani (2014) suggests, there have been “no significant infrastructure investments since the 1970s” when the CVP and SWP facilities were designed to satisfy water demands for 19 million people, or half of the state’s current population. Furthermore, the existing infrastructure was designed with little consideration for its environmental impact and it is becoming more expensive to maintain.

Resolving this issue is not necessarily a matter of build

Figure 13: Current Snowpack Levels



Prepared by:
USDA/NRCS National Water and Climate Center
Portland, Oregon
<http://www.wcc.nrcs.usda.gov>

* Data unavailable at time of posting or unavailable long-term normal.

Source: United States Department of Agriculture (2016). Map Products: Precipitation. Natural Resources Conservation Study & National Water and Climate Center. Retrieved November 26, 2016, from http://www.wcc.nrcs.usda.gov/ftpref/data/water/wcs/gis/maps/ca_swepctnormal.pdf

⁶ H.R.2983 (Drought Recovery and Resilience Act of 2015) was introduced by Rep. Jared Huffman (D-CA) in July, 2015. H.R.2983 received considerable support in the House, gathering 38 cosponsors. The last action on the bill took place in August, 2015 when it was referred to the House Subcommittee on Environment.

Table 4: Cooperative Federalism (federal and state laws and enforcing agencies)

Federal Law	Enforcing Federal Agency	State Law	Enforcing State Agency
Clean Water Act of 1948	Environmental Protection Agency	Porter-Cologne Water Quality Control Act of 1969	State Water Resources Control Board
Water Resources Planning Act of 1965	Water Resources Council (defunct due to lack of funding)	None	None
National Environmental Policy Act of 1969	Environmental Protection Agency	California Environmental Quality Act of 1970	Self-executing statute
Endangered Species Act of 1973	-Fish and Wildlife Service -National Marine Fisheries Service	California Endangered Species Act 1970	California Department of Fish and Wildlife
Water Resources Development Act	U.S. Army Corps of Engineers	None	None
Central Valley Project Improvement Act of 1992	-Fish and Wildlife Service -Bureau of Reclamation	California Natural Resources Agency	California Department of Fish and Game

Sources: California Natural Resources Department. (2014). Frequently Asked Questions About CEQA. Retrieved November 25, 2016, from <http://resources.ca.gov/ceqa/more/faq.html>; Corn, L. M., and Wyatt, A. M. (2016). The Endangered Species Act: A Primer. (CRS Report No. RL31654). Washington, D.C.: Congressional Research Service; Luther, L. (2011). The National Environmental Policy Act (NEPA): Background and Implementation. (CRS Report No. RL33152). Washington, D.C.: Congressional Research Service; Luther, L. (2013). Environmental Requirements Addressed During Corps Civil Works Project Planning: Background and Issues for Congress. (CRS Report No. R43209). Washington, D.C.: Congressional Research Service; Sheikh, P. A., and Cody, B. A. (2005). CALFED Bay-Delta Program: Overview of Institutional and Water Use Issues (CRS Report No. RL31975). Washington, D.C.: Congressional Research Service.

ing more reservoirs, dams, and levees. Building and maintaining these infrastructure projects have high financial implications⁷ as well as lasting environmental consequences. On the other hand, if the infrastructure is left at or near its current state, environmental consequences are likely to follow, undermining existing federal and state efforts to invest in and implement ecosystem and wildlife restoration projects. For example, if water deliveries from the CVP and SWP continue to be reduced in response to drought conditions and environmental regulations, users (particularly in the Central Valley) will rely more heavily on groundwater supplies to supplement the gap. Sustained reliance on groundwater will only further increase the already alarming rate of groundwater basin declines which “could lead to irreversible land subsidence, poor water quality, reduced surface flows, ecosystem impacts, [infrastructure damage,] and the permanent loss of capacity to store water as groundwater” (California Natural Resources Agency, California Department of Food & Agriculture, & California Environmental Protection Agency, 2016: p.15). The financial implications of this damage will be crippling and will limit the state’s flexibility to utilize water sources and storage options. Simply put, if H.R.5247 or S.2533 are enacted, some relief will be provided to California but it will not completely address the fundamental issues in the state’s aging infrastructure.

Protecting the environment and restoring degrading ecosystems are critical components to ensuring a reliable water supply that complies with federal and state regulations. The House of Representatives and Senate each passed a WRDA bill (H.R.5303 and S.2848) which, among many other provisions, contain authorizations to conduct feasibility studies for federal actions regarding flood control and ecosystem restoration in California (See Table 5). These provisions target important infrastructure projects across the state, but they do not address the more pressing issues within the CVP and SWP which is the hub of the state’s water conveyance and storage system. For instance, there are no provisions to monitor or provide technical assistance for groundwater usage. This is a critical issue for the state, as current groundwater pumping is causing potentially irreversible environmental damage to one of the state’s largest water supply and storage mechanisms. Two additional long-term environmental issues for Cali-

fornia’s infrastructure which are not addressed in the current WRDA bills are: (1) a rapidly deteriorating habitat in the Bay-Delta; and (2) degrading habitat in the upper watersheds of the Sierra Nevada and Cascade Mountains whose runoff accounts for as much as two-thirds of the state’s surface water supply.

However, these issues extend much further than environmental concerns. Most of the state’s economy relies on the existing water infrastructure, especially outdoor recreation, sport and commercial fishing, and tourism. A 2012 NMFS economic report found that recreational expenditures on groundfish alone contributed an estimated \$2.7 billion to California’s economy, supporting roughly 13,000 jobs (California Fish and Game Commission, 2014). Similarly, sport and commercial salmon industries in northwest and northern California generate roughly \$1.25 billion annually (Upton, 2012). In the Bay-Delta, the outdoor recreation and tourism industries generate \$353 million annually, supporting over 5,300 jobs throughout the state (Delta Protection Commission, 2012). These industries depend largely on the health of the ecosystems in that region and further decline of those resources will have detrimental consequences on the local economy.

H.R.1208 and S.630 represent initiatives wherein the federal, state, and local government cooperatively implement a framework that could help balance economic, residential, and environmental interests. Historically, water supply and economic growth has been developed at the expense of environmental health. Human activity has significantly altered the ecosystem which has led to the decline of many wildlife species. To date, 31 of the state’s 122 native freshwater fish are listed under the ESA as endangered or threatened and there is no local funding source to supplement federal and state investments in restoring these populations (PPIC, 2014). Both bills aim to preserve the historical, cultural, and natural values of the Delta which would promote and support the economic development of those industries that rely on those values. While these initiatives do not directly target environmental quality and preservation, they do add incentives for local and regional entities to better manage those natural resources. These bills, however, have not gained much support in Congress and have been introduced and reintroduced in every Congressional session since the 111th Congress (2010, 2011, 2013, and 2015).

Another critical component of improving water management and enhancing the ecosystem is fixing the inefficiencies of existing laws. The enactment of H.R.1667 or S.292 could prove beneficial by publicly disclosing the scientific and commercial data Interior

⁷ Some estimates suggest that the maintenance of California’s current water infrastructure costs \$30 billion each year (PPIC Water Policy Center, 2014). Another estimated \$34 billion will be needed to improve the state’s infrastructure to increase water supply and restore ecosystem health (PPIC Water Policy Center, 2016).

and Commerce use for listing and delisting species under its legal protection as well as regulations to improve species population. The ESA has been controversial, especially in California during the recent drought conditions as its regulations have restricted water deliveries from the CVP and SWP. California state officials have not “identified the quantity, quality, and timing of water required to sustain ecosystem health,” which makes it difficult to monitor the performance of certain regulatory efforts (PPIC Water Policy Center, 2016). In this regard, the legislation would require government agencies to justify ESA regulations and track the progress of species population recovery and the health of designated critical habitats. H.R.4582 would accomplish a similar result as it removes the nonnative striped bass from the CVPIA’s population doubling requirement. With the federal and state governments investing millions of dollars each year for enhancing the ecosystems and native wildlife species, retaining a nonnative predatory fish that threatens the salmon population undermines restoration efforts. These laws can help utilize government funding more efficiently and improve the performance of existing legislative efforts to improve the health of aquatic ecosystems and biodiversity.

Conclusion

With California continuing to experience long-term drought conditions, Congress faces several

pressing issues to provide relief for the state. Those issues include improving the state’s aging water infrastructure and water delivery reliability; protecting and restoring the ecosystems and native plant and animal species; and exploring long-term solutions that will help the state prepare for and mitigate the impact of future drought conditions. Addressing all three issues is essential to ensure the state can support its diverse economic sectors, residential growth, and environmental integrity. The legislative proposals covered in this report touch upon a few options that Congress has deliberated. However, none of those bills have been enacted, and many of them have circulated committees and subcommittees for a number of years. With the current Congressional session ending on January 2, 2017, those bills will have to be reintroduced and begin the legislative process again in the 115th Congress.

Congress must be proactive in passing legislation, anticipating long-term issues and developing solutions before a crisis strikes. Implementing reforms are going to be costly, especially in California whose water infrastructure stretches across most of the state. But if Congress continues to delay addressing the larger issues with California’s current infrastructure, it will be harder and more expensive to find viable and effective solutions. Federal and state officials need to coordinate their resources to develop plans that benefit its vast economy, diverse population, and critical ecosystems.

Table 5: Comparing H.R.5303 and S.2848

(federal Authorizations of feasibility studies for water resources development and ecosystem restoration)

H.R.5303	S.2848
Cache Creek Settling Basin	Cache Creek Settling Basin
Coyote Valley Dam	Coyote Valley Dam
Del Rosa Channel, City of San Bernardino	Del Rosa Drainage Area
Merced County Streams	Merced County
Mission-Zanja Channel, Cities of San Bernardino and Redlands	Mission-Zanja Drainage Area
Soboba Indian Reservation	Santa Ana River Basin

Sources: Water Resources Development Act, H.R.5303, 114th Cong. (2016). <https://www.congress.gov/bill/114th-congress/house-bill/5303?q=%7B%22search%22%3A%5B%225303%22%5D%7D>; Water Resources Development Act, S.2848, 114th Cong. (2016). <https://www.congress.gov/bill/114th-congress/senate-bill/2848?q=%7B%22search%22%3A%5B%22s.2848%22%5D%7D&r=1>.

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