



PPIC

PUBLIC POLICY
INSTITUTE OF CALIFORNIA

PPIC WATER POLICY CENTER

NOVEMBER 2015

Brian Gray
Ellen Hanak
Richard Frank
Richard Howitt
Jay Lund
Leon Szeptycki
Barton "Buzz"
Thompson

with research support from
Jelena Jezdimirovic

*Supported with funding
from the S. D. Bechtel, Jr.
Foundation*

Allocating California's Water

Directions for Reform



© 2015 Public Policy Institute of California

PPIC is a public charity. It does not take or support positions on any ballot measures or on any local, state, or federal legislation, nor does it endorse, support, or oppose any political parties or candidates for public office.

Short sections of text, not to exceed three paragraphs, may be quoted without written permission provided that full attribution is given to the source.

Research publications reflect the views of the authors and do not necessarily reflect the views of the staff, officers, or board of directors of the Public Policy Institute of California.

SUMMARY

CONTENTS

Introduction	4
Three Directions for Reform	6
Streamline Water Rights Administration	6
Establish Environmental Water Budgets	10
Facilitate Regional Water Sharing	12
Conclusion	16
References	17
About the Authors	19
Acknowledgements	19

California’s system for allocating water prevents it from meeting the state’s diverse needs, especially in times of scarcity. It is fragmented, inconsistent, and lacking in transparency and clear lines of authority—all problems highlighted during the latest drought.

To more effectively serve the 21st century economy, society, and environment, this water allocation system needs an upgrade.

We propose an interlinked set of legal and policy reforms that would significantly strengthen California’s ability to address future droughts, climate variability, and shifting economic demands for water. Our proposals focus on three areas where the water allocation system is especially weak: water rights administration, allocation of water for the environment, and water trading. The common thread in these reforms is to increase coherence, transparency, and flexibility, while protecting water right-holders and public values.

Although our proposals would change a number of key decision making processes, they leave in place the existing priority system that defines and governs water rights. Proposed reforms include streamlining oversight of water rights, improving accuracy and transparency of information, clarifying the rules regarding environmental flows, and facilitating both water sharing and water storage for future droughts. These changes will reduce uncertainty, lower administrative costs, and enable more nimble water management. And they will be less disruptive and easier to implement than a major overhaul of the state’s complex water rights system.

This reform package does not address all of California’s water challenges, but it provides important foundations for more efficient, anticipatory, and effective management of this valuable and essential resource.

Introduction

California’s system for allocating water to its residents, businesses, and ecosystems is weakened by flaws that hamper it from meeting the state’s needs, especially in times of scarcity. It is fragmented, inconsistent, and lacking in transparency and clear lines of authority.

At the heart of this allocation system is an unusually complex array of water rights. In broad strokes, California’s water rights rely on the principle of seniority to allocate surface flows when supplies are scarce. Those who own land along a river or who staked early claims on that water have top priority. Those with rights established before the first state water administrative system was created in 1914 are subject to less direct oversight than those with more recent rights. In times of shortage, junior rights are curtailed and right-holders must either reduce their water use or rely on water from other sources.

Groundwater—which averages about a third of urban and farm use, and more in dry years—has a separate and generally looser system of water rights. Although California law does not authorize unsustainable levels of pumping, overlying landowners in most basins pump as much as they need—a situation that has contributed to long-term declines in water tables.

The latest drought has highlighted important progress in urban preparedness since the last major drought, which lasted from 1987 to 1992 (Hanak et al. 2015). But it also has underscored weaknesses that California needs to address to better prepare for future droughts. Several aspects of the water allocation system are of central concern:

- (1) **Inadequate authority and information to manage shortages:** Problems became evident in both surface water and groundwater oversight. For surface water, extreme low flows prompted the State Water Resources Control Board (“the water board”) to issue curtailment orders in 2014 and 2015—its first exercise of this authority since 1977. But some of the most senior right-holders contested the board’s jurisdiction to curtail them. The curtailment process also revealed large gaps in information the board needs to administer the priority system: water diversions and use are still not measured in much of the state, and self-reporting is incomplete and sometimes of questionable accuracy.

Meanwhile, unprecedented groundwater pumping reduced economic harm but caused other problems, including higher pumping costs, infrastructure damage from sinking lands, depletion of shallow drinking water wells in rural communities, and reductions in groundwater supplies for future droughts (Howitt et al. 2015, Hanak et al. 2015). This experience exposed California’s long-term vulnerability from failing to manage its groundwater, an essential drought reserve.

- (2) **Lack of clarity on priorities beyond water rights.** The water board does not have a clear policy to take public health and safety or the environment into account when ordering surface water curtailments, even though an array of laws designates these public interests as priorities that may take precedence over senior water rights. So far, this omission has been especially costly for the state’s stressed riverine and wetland ecosystems.
- (3) **Difficulties of trading water.** Trading is an essential tool for enabling water right-holders to voluntarily reallocate water to reduce the economic and environmental costs of shortages. Although some trading occurred during this drought, the approval process is hampered by a complex and often opaque set of rules. In part, this reflects the underlying fragmentation of water rights administration and associated information gaps. Infrastructure constraints, particularly for water conveyance, also hamper some types of trades.

Recent legislation addresses some of these gaps and weaknesses in the water allocation system. The landmark Sustainable Groundwater Management Act of 2014 (SGMA) will require groundwater users to develop and implement local plans to sustainably manage this resource. SGMA authorizes local groundwater sustainability agencies to measure and monitor groundwater levels and to develop rules governing groundwater pumping (Water Education Foundation 2015).¹ It sets timelines for compliance and authorizes the water board to step in if the local sustainability agency fails to act. Importantly, these local plans will need to consider the effects of pumping on both groundwater levels and surface water flows, as well as on water quality in wetlands, rivers, and streams.

Additionally, legislation enacted in 2015 will improve water use information by tightening reporting requirements for surface water users, making well logs public, and requiring all surface water diverters above a certain threshold to meter water use.²

Yet the water allocation system remains hampered by inconsistencies, unclear regulatory authorities, and a lack of transparency and information. Although California has gotten by with this patchwork system in the past, there is diminishing slack in water availability. A growing population, the rising value of agricultural investments, and increased recognition of water demands for the state's threatened ecosystems all make it necessary to manage water more tightly to serve multiple purposes well. Adding to these challenges is the likelihood that the state's climate will become even more variable, with more frequent droughts and greater variability in precipitation (Georgakakos et al. 2014, Diffenbaugh et al. 2015). California's water allocation system needs an upgrade to more effectively serve the 21st century economy, society, and environment.

Recently, calls for a complete overhaul of water rights have been on the rise, with some observers asserting that the seniority-based system is outdated and not up to the task of meeting California's needs.³ In our view, less sweeping, more legally defensible pathways are available to improve water allocation.⁴ This report outlines several reforms that would significantly strengthen the state's ability to weather droughts, climate variability, and shifting economic demands for water, while maintaining existing water rights priorities.

Our proposals focus on three areas where the drought has highlighted weaknesses in California's water allocation system: water rights administration, allocation of water for the environment, and water trading.

The common thread in these proposals is to increase coherence, transparency, and flexibility, while protecting water right-holders and public values. Streamlining oversight of water rights, improving information, and reducing uncertainties in the allocation process will enable California to manage scarce supplies more efficiently and effectively. Greater ease of water trading is a key component, along with greater incentives to store water for future droughts.

¹ Groundwater is subject to even bigger data gaps than surface water, with little measurement of withdrawals and use and even less reporting. The Center for Irrigation Technology at Fresno State University estimates that only about a third of irrigation wells are metered (Pottinger 2015). A 2009 law (Senate Bill X7-6) required counties to report groundwater levels to the state, but not the volume of withdrawals.

² Senate Bill (SB) 88 (2015), codified at Water Code §§ 1840-1841, requires metering of all diversions over 10 acre-feet per year.

³ See for instance: Morin 2015, Los Angeles Daily News Editorial Board 2015, Kahn 2015, Baily 2014.

⁴ The California courts have emphasized that the rule of priority is a fundamental principle of California water rights law (*City of Barstow v. Mojave Water Agency*, 23 Cal. 4th 1224 (2000); *Eldorado Irrigation District v. SWRCB*, 142 Cal. App. 4th 937 (2006)). A wholesale equalization of water right priorities would raise significant due process and takings questions under both the state and federal constitutions. Moreover, because of the express recognition of riparian rights in Article X, Section 2 of the California Constitution, a law that eliminated the senior priority of exercised riparian rights or abrogated the dormant riparian right would raise a significant constitutional question under that provision as well (*In re Waters of Long Valley Creek Stream System*, 25 Cal. 3d 339 (1979); *Tulare Irrigation District v. Lindsay-Strathmore Irrigation District*, 3 Cal. 2d 489, 547 (1935)).

Three Directions for Reform

In the remainder of this report, we lay out the major challenges in each area and offer solutions. Some of these are straightforward and potentially quick to implement, while others may take longer to put into place. And while some will require new legislation, many can be accomplished under existing authorities. State and local agencies each have roles in reform, as does the federal government. As relevant, we indicate these roles in parentheses. “State agency action” refers to cases where multiple state agencies will need to be involved.

Streamline Water Rights Administration

The Big Issue: A Fragmented System

All California water right-holders are subject to the state constitution’s mandate of reasonable use, adopted by voters in 1928.⁵ This mandate grants both the water board and the courts authority to adjust water rights priorities and to disallow water use practices that are deemed unreasonable under current conditions. It is a potentially powerful tool for managing allocations during drought and for facilitating increased water use efficiency as technologies and practices change over time, though it has seen only limited application to date.⁶

Beyond this common mandate, however, California’s water administration is exceptionally fragmented. Groundwater and surface water rights are legally separate, even when the two resources are hydrologically connected and groundwater pumping reduces streamflow available to surface water users and fish and wildlife. Outside of roughly two dozen adjudicated basins (those where all rights to use groundwater have been determined in a judicial proceeding following a trial or settlement), the rights to groundwater are not “quantified”—meaning that, for practical purposes, individual users’ pumping is limited only by the doctrine of reasonable use.⁷

California is also unique in having three broad classes of surface water rights:

- Riparian rights—the most senior—are available to owners of land directly adjacent to rivers, lakes, and estuaries for use on that land. These rights are not available to cities or other municipal water suppliers.
- Pre-1914 appropriative rights were claimed prior to the adoption of the modern water code in 1914. Unlike riparian rights to surface water and overlying rights to groundwater, appropriative rights are not tied to the land.⁸
- Post-1914 appropriative rights were established since 1914.

⁵ The mandate is set forth in Article X, Section 2 of the state constitution. To possess a valid right, all water right-holders must use the water for a socially beneficial purpose. In addition, the quantity used cannot exceed what is reasonable, taking into account other potential beneficial uses of the water. Although some senior right-holders have argued that the law of reasonable use does not apply to them, the California Supreme Court has held that it applies to all water rights: “[T]he rule of reasonable use as enjoined by ... the Constitution applies to all water rights enjoyed or asserted in this state, whether the same be grounded on the riparian right or the right, analogous to the riparian right, of the overlying land owner, or the percolating water right, or the appropriative right.” (*City of Barstow v. Mojave Water Agency*, 23 Cal. 4th 1224, 1241-42 (2000), quoting *Peabody v. City of Vallejo*, 2 Cal. 2d 351, 383 (1935)).

⁶ See Gray 2015 and Hanak et al. 2011, chapter 7. As a recent example of how this doctrine can be used to manage allocations during drought, in the summer of 2015 the water board ordered enhanced outdoor water conservation by more than 10,000 properties in priority areas within the Russian River watershed to protect endangered coho salmon and steelhead trout. The board’s regulation “determined that it is a waste and unreasonable use of water under Article X, section 2 of the California Constitution to divert or use water sourced from within the watersheds listed... [for the listed purposes] during the current drought emergency, regardless of water right seniority, given limited available supply and the need for the water to support other more critical uses.” 23 California Code of Regulations § 876 (http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/russian_river/emreg_final070615.pdf)

⁷ Those who own land that overlies an aquifer have first-priority shared rights to groundwater. Appropriators may pump water that the overlying owners do not need, and their rights are junior to those of the overlying owners. Municipal water suppliers must hold appropriative rights, even when their service area is on overlying land. All groundwater rights are limited by the doctrine of reasonable use, and aggregate pumping may not exceed the “safe yield” (i.e., sustainable supplies) of the aquifer (*City of Barstow v. Mojave Water Agency*, 23 Cal. 4th 1224 (2000)). These limitations have been difficult to enforce outside of comprehensive groundwater rights adjudications.

⁸ Appropriative rights to use water are based on actual amount used, with a priority of right based on the date of the initial appropriation.

In addition, “area-of-origin” laws allow individuals and communities to establish new rights for surface water in their local watersheds. These rights are senior to those of water users who export water from these areas.⁹

Like most groundwater rights, riparian rights are not quantified, and they are not lost if they are not used.¹⁰ In contrast, all appropriative surface rights are quantified and subject to the “use it or lose it” provision that requires demonstration of beneficial use within the past five years. Seniority is based on the original date of appropriation, and the newest water rights are curtailed first in times of shortage. Until recently, only post-1914 right-holders were required to report their monthly diversions to the water board.¹¹ Moreover, only post-1914 right-holders are subject to direct oversight by the water board, which defines and regulates their rights through a permitting system.¹²

Reform Proposals

We recommend streamlining this system to address several problems highlighted by the drought, including fragmented and unclear oversight authority for surface water, the lack of quantification of both riparian and groundwater rights, and overarching gaps in information needed to manage the system more efficiently.

Bring all surface water users under the water board’s permitting system

When the water board sought to curtail pre-1914 appropriators in 2015, some sued, claiming that the board lacked authority to curtail their use of water because pre-1914 rights are exempt from the permit system.¹³ The lack of a unified permitting authority for surface rights hinders the effectiveness of a seniority-based system, which requires timely and orderly implementation of curtailments to protect higher priority uses. Although some pre-1914 right-holders may prefer taking their chances with the courts, a unified permitting system—backed by solid information on water rights and use—will reduce uncertainty for all right-holders and enable more efficient and transparent real-time management of water, including water trading.

Suggested reform: Amend the Water Code to extend the water board’s permitting jurisdiction to all surface water rights, not just those with rights established since 1914 (legislative action). In addition, clarify the quantities for senior water rights (water board action). These changes would not alter any water rights but merely add certainty and efficiency by bringing all rights under the umbrella of a common, coherent administrative system. Area-of-origin laws would continue to grant seniority of new water rights to qualifying individuals and communities relative to right-holders that export water from the source watershed or region.¹⁴ Proposed changes include:

⁹ For a general discussion of the area-of-origin laws, see *El Dorado Irrigation District v. SWRCB*, 142 Cal. App. 4th 937 (2006).

¹⁰ As with overlying groundwater rights, riparian rights share the same level of seniority within a river system (*US v. SWRCB*, 182 Cal. App. 3d 82 (1986)).

¹¹ The reporting requirements began with the enactment of SB X7-8 (2009), which required riparians and pre-1914 appropriators to report monthly water use every three years. SB 88, enacted in June 2015, made this a yearly requirement and added metering for all surface water diversions exceeding 10 acre-feet per year.

¹² In this report, we use the term “permit” to refer to both permits and licenses. A permit is a provisional water right; a license is a permanent, “vested” water right. The legal distinctions between permittees and licensees have diminished, however, in the wake of the California Supreme Court’s decision in *National Audubon Society v. Superior Court*, 33 Cal. 3d 419 (1983), which held that all water rights are subject to revision to ensure that they are exercised consistent with the reasonable use and public trust doctrines. Most permits and licenses were issued by the predecessor to the State Water Resources Control Board, which was formed in 1967.

¹³ These appropriators pointed to Water Code §1831(e), which states that the board’s statutory power to issue “cease and desist” orders against unlawful water diversions “does not authorize the board to regulate in any manner, the diversion or use of water not otherwise subject to regulation [by] the board” under its permitting and licensing jurisdiction. They argued that only water right-holders can enforce the seniority system for pre-1914 appropriators, not the state. See *Westside Irrigation District v. SWRCB* (Sacramento County Superior Court, July 10, 2015) and State Water Resources Control Board, *Partial Rescission of April, May, and June 2015 Curtailment Notices and Clarification of State Water Resources Control Board Position Re: Notices of Unavailability of Water for Those Diverting Water in the Sacramento River Watershed, San Joaquin River Watershed and Delta, and Scott River* (July 15, 2015).

¹⁴ A good recent example of how this can work is the case of several Solano County communities (within the Sacramento River watershed), which were granted contracts for State Water Project (SWP) water in the mid-2000s. In 2014, the SWP settled with the Solano County Water Agency and several other northern California SWP contractors, providing them with greater water allocations during droughts (Department of Water Resources 2013, Solano County Water Agency 2015).

- Pre-1914 appropriators would receive permits with a priority date of their original appropriation, for demonstrated volumes of uninterrupted use.¹⁵
- Riparians could obtain permits that retain the characteristics of riparian rights, including both active uses and the “dormant” right to use water that is not currently exercised.¹⁶ Alternatively, riparians could convert to an appropriative right, based on the water board’s assessment of actual water use over some hydrologically representative period of time. An incentive for conversion to an appropriative right is that riparians would gain rights to store and trade water, which are currently unavailable to them. Either way, riparians would retain the highest seniority within the water rights system—and they would need to demonstrate that their land is eligible for its riparian status.¹⁷

Require surface right-holders to choose between riparian and appropriative rights

The current ability to maintain dormant riparian rights alongside actively used appropriative rights for the same land creates incentives to game the system and confounds the effective administration of water rights.¹⁸ When ordered to curtail their appropriative rights, some water users in the Delta informed the water board that they would henceforth divert water pursuant to their dormant riparian rights, which were not subject to curtailment (State Water Resources Control Board 2015).

Suggested reform: Amend the Water Code to require water right-holders to choose between maintaining riparian or appropriative rights on the same land (legislative action). This would not change the amount of water these landowners could use—it would simply prevent them from frustrating the administrative system by toggling between rights.

Quantify groundwater rights in priority basins

The lack of clear rules on groundwater pumping has caused several problems. Most in the spotlight during this drought has been severe overdrafting of basins, such as many in the San Joaquin Valley. Excess pumping has caused long-term declines in groundwater levels, resulting in high pumping costs, sinking lands, and dry wells. In some regions where groundwater tables are closer to the surface, such as the Russian River, pumping causes other problems by reducing streamflow, harming fish and wildlife, and reducing water available to surface right-holders.¹⁹ SGMA requires local water users to develop plans that address these issues, but it does not require that these plans quantify pumping rights for individual groundwater users.²⁰

Suggested reform: Legislation enacted in September 2015 provides a streamlined pathway for groundwater users to adjudicate their rights (Chappelle and McCann 2015). Local groundwater users should seize this

¹⁵ In the Sacramento Valley and the Delta, the water board has already begun to require riparians and pre-1914 appropriators to demonstrate evidence of their original appropriations and records of actual diversions, a useful input for the permitting process recommended here (see materials related to the February 4, 2015 order in the following link: www.waterboards.ca.gov/waterrights/water_issues/programs/drought/informational_orders.shtml). On some Russian River tributaries, the board has also required riparians to confirm that “the parcel is adjacent to the stream, or [present] evidence to support preservation of the riparian water right after severance from the stream.” *State Water Resources Control Board, Water Right Order 2015-0026*.

¹⁶ This could be based on a reasonable use standard of irrigation water per unit of riparian land within the region.

¹⁷ A riparian’s use of water is limited to land that is physically riparian to, and within the watershed of, the river or estuary from which the diversion occurs. Riparians also must prove that the land has been in continuous riparian status dating back to the original land grant (*Anaheim Union Water Co. v. Fuller*, 150 Cal. 327, 88 P. 978 (1907)). The water board has recently required the recommended “proving up” process for some riparians within the Russian River system and the Delta (see note 15).

¹⁸ In the water diversion and use data reported to the water board for 2010-13, nearly 2,400 water rights (77% within the legal Delta, and the remainder within the greater Sacramento and San Joaquin watershed) were reported as being both riparian and pre-1914 appropriative rights. The estimated annual water demand for these rights over this period was over 2.3 million acre-feet, roughly evenly split between the Delta, the Sacramento River region, and the San Joaquin River region. (Author calculations using “2010-2013 Average Demand Dataset” from the State Water Resources Control Board, accessed on September 3, 2015.)

¹⁹ This is generally true within the Sacramento River hydrologic region (The Nature Conservancy 2014), as well as in the Russian River watershed, where pumping has been demonstrated to reduce critical streamflow for salmon and steelhead (*Light v. State Water Resources Control Board*, 226 Cal. App. 4th 1463, 2014). Pumping has completely dewatered the Scott River at some times of the year (*Environmental Law Foundation v. County of Siskiyou*, Sacramento County Superior Court No. 34-2010-80000583).

²⁰ Once a plan is adopted, local agencies will have 20 years to attain sustainable management, although the Department of Water Resources may grant two five-year extensions upon a showing of good cause (Water Code § 10727.2(b)). Basins designated as critically overdrafted have until 2020 to adopt their plans, and other priority basins have until 2022 (Water Code § 10720.7(a)(1)).

opportunity to quantify their rights, not only in critically overdrafted basins but also in basins where groundwater pumping impairs surface water flows (local action). There are many benefits to assigning pumping rights as part of sustainable basin management. It facilitates trading within basins, which can lower the costs of limiting pumping to bring groundwater levels into balance. Trading has helped water users in the Mojave and Chino basins in Southern California, for instance.²¹ It also increases incentives to invest in groundwater recharge, which will be an essential tool for basin management.

Local groundwater sustainability agencies can also play a significant role by adopting plans that address the hydrological connection between groundwater pumping and surface flows and by facilitating coordinated management of these resources. The goal should be to move toward regional permitting plans that integrate surface water and groundwater within these basins.²²

Develop an authoritative water accounting system

Regions with drought-prone climates need reliable accounting of water availability and use. Authoritative water accounting is a foundation for the transparent, reliable, timely administration (and, if necessary, curtailment) of water rights, management of groundwater, and water trading. This drought spotlighted serious gaps and fragmentation in California’s water accounting system, hampering such actions.

Suggested reform: Recent legal reforms require more water use reporting, but several additional steps are needed to build an effective accounting system:

- Key state agencies—including the water board, the Department of Water Resources, and the Department of Fish and Wildlife—should develop a common water accounting framework, including a process for timely vetting and updating information they receive from water right-holders (state agency action). For SGMA to succeed, integration of surface water and groundwater information within this common framework will be essential, both to understand availability of surface water for use within basins and to prevent groundwater pumping from depleting surface flows.
- Reporting and measurement requirements should be extended to include not only water diversions and use, but also return flows—i.e., the amount of water that returns to rivers and streams or recharges groundwater basins (legislative action). Understanding net water use (the amount applied minus return flow) is key to understanding water availability and also the amount of water that can be traded without harming other water users.
- The frequency of required reporting should be set to match operational needs. For instance, operations of reservoirs and diversions related to flows in the Sacramento–San Joaquin Delta are adjusted daily. To assist in this process, some agencies already report daily without difficulty.²³ The law now requires surface water users to report their monthly use once a year, but the water board will soon have authority to adopt regulations that require more frequent and detailed reporting as needed.²⁴ The board should exercise this authority (water board action).
- The state should promote the adoption of new technologies, such as remote gauge and meter reading and remote sensing of cropland, to reduce the costs of measurement and improve accuracy (state agency action).

²¹ See Hanak and Stryjewski 2012, Technical Appendix A.

²² The water board also has an important supervisory role to play. Under SGMA, it must ensure that local groundwater sustainability plans prevent pumping that unreasonably affects surface flows and water quality. In addition, if a local plan fails to correct these problems, then effective 2025 the board may directly establish an interim sustainability plan “to remedy a condition where the groundwater extractions result in significant depletions of interconnected surface waters” (Water Code § 10735.8(h)).

²³ This includes the State Water Project, the Central Valley Project, Byron Bethany Irrigation District, Contra Costa Water District, and water users served by the North Bay Aqueduct. The Sacramento Regional County Sanitation District reports daily discharges of treated wastewater, which is used to adjust Sacramento River inflows into the Delta. (Personal communication, Greg Gartrell, October 25, 2015) This latter case is an example of the value of reporting information on return flows.

²⁴ Water Code § 5101 requires annual reporting of monthly use. However, § 5103(e) authorizes the water board, effective July 1, 2016, to adopt regulations that require more frequent and detailed reporting as needed for diversions of 10 acre-feet per year or more. Both changes were introduced with SB 88 in June 2015.

- Water accounting information should be made publicly available in the interests of transparency and efficient management (state agency action). The goal should be to build an electronic atlas of water availability and use data.²⁵

Establish Environmental Water Budgets

The Big Issue: Lack of Clarity on Environmental Flow Priority

The recent experience with curtailments has highlighted important gaps in both common understanding and practice regarding protections for public health and safety and the environment in the surface water allocation process. Although these public interests can take precedence over water rights seniority, the water board has lacked a systematic policy on how to factor them into the curtailment process.²⁶

The board did adopt temporary emergency regulations to exempt supplies necessary for human health and safety from curtailments.²⁷ These exemptions have not yet been tested, in part because streamflow protections for public health and safety have not yet been a major concern in this drought. Urban water agencies have generally had adequate supplies, and drinking water shortages in some rural communities have principally been caused by dry wells in areas not served by surface supplies, rather than curtailments of surface water rights.²⁸ Because these issues could become important in more extreme droughts, the water board should adopt a permanent policy that narrowly defines urgent public health and safety considerations affected by water scarcity and prioritize these needs within the curtailment process.²⁹

The allocation of water to increase river flows and support other environmental uses such as wetlands is already both a serious problem and a contentious issue. The low flows and high water temperatures caused by this drought have created an environmental crisis, with at least 18 species of fish at near-term risk of extinction and risks of significant deaths of waterbirds of the Pacific Flyway from reduced wetland habitat (Hanak et al. 2015). These conditions have been aggravated in some places by the relaxation of environmental flow standards to increase supplies for cities and farms.³⁰ The water board did adopt emergency regulations authorizing curtailment of diversions to protect endangered salmon and steelhead trout in three small tributaries to the Sacramento River, and it also ordered reductions in groundwater use to protect fish in parts of the Russian River basin.³¹ But this

²⁵ For an example of what is possible with an authoritative accounting system, see the online decision support system administered by the [Colorado Water Conservation Board \(CWCB\)](#) and the [Colorado Division of Water Resources \(DWR\)](#): <http://cdss.state.co.us/pages/CDSSHome.aspx>. This system includes real-time information on water availability in stream systems for water rights of different priorities (<https://data.colorado.gov/Water/DWR-Active-Calls-Map-Statewide-/sjpy-y3gm>).

²⁶ A variety of laws require the water board to consider the effects of its water rights decisions on public health and the environment. These include sections 106 and 106.3 of the Water Code, which define domestic use as the “highest” use of water and declare that “safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes” is a human right. They also include the federal Clean Water Act, the Porter-Cologne Act, Fish and Game Code § 5937, the federal and state Endangered Species Acts, the public trust doctrine, and Article X, Section 2 of the California Constitution. For further discussion, see our comments to the board on the 2014 curtailment process in Hanak et al. 2014b and Gray 2012.

²⁷ 23 California Code of Regulations § 878.1. The regulations specifically exempt from curtailment diversions of up to 50 gallons per person per day for domestic and municipal use “after all other alternate sources of potable water have been used” (*id.* 878.1(b)), as well as water for other essential public purposes such as fire protection and electric grid reliability (*id.* § 878.1(d)).

²⁸ In a few cases, the water board has informally negotiated with senior agricultural right-holders to deliver supplies to local communities facing shortages, rather than enforcing the exemption.

²⁹ These factors would include adequate supplies for safe drinking water, cooking, and sanitation (see Water Code § 106.3)—approximately 50 gallons per person per day—plus water for fire suppression. Water allocation under this provision would need to be clearly spelled out, quantified, and limited to urgent conditions when users cannot reasonably be expected to find alternative sources in a timely way. These amounts would count against other allocations to these users. Reliable and up-to-date metering and monitoring would be needed to implement this fairly and transparently.

³⁰ From January 2014 through July 2015, the water board granted 35 temporary urgency change permits that relaxed environmental flow standards, including 13 regarding Central Valley Project and State Water Project operations and 22 other changes in 14 counties (Hanak et al. 2015, technical appendix Table A1). For a description of the difficulties of managing cold water for salmon in Shasta Reservoir, see Mount 2015.

³¹ The emergency regulations authorize curtailment of diversions on Mill, Deer, and Antelope Creeks to protect endangered and threatened salmon and steelhead (23 California Code of Regulations § 877). In October and November 2015, the board issued curtailment notices to water right-holders on [Deer Creek](#) and [Antelope Creek](#) to ensure “drought emergency minimum flows” for migrating salmon and steelhead. For a discussion of actions in the Russian River watershed, see note 6.

policy has been piecemeal and far too limited relative to the scale of the problem. California needs to develop a more effective and accessible policy for managing this critical issue.

Reform Proposals

We recommend an important structural change in the way that water for environmental uses is defined, allocated, and administered.

Assign an environmental water budget for each river system

Although a variety of laws require dedication of water for environmental uses, there is a lack of clarity on the standards in many places, as well as uncertainty among regulators and water managers on how to ensure adequate water for the environment within the structure of the water rights system.

Suggested reform: Adopt a process for the local development of watershed-based environmental flows, combining a state mandate and local authority to flesh out details (water board and local action).³² The water board should assign interim environmental water budgets (EWB) on different river and stream systems based on the requirements of the applicable environmental laws. These EWBs would vary by season and type of water year (ranging from critically dry to wet), and would be subject to periodic revision and review. Local water users within the watershed would then develop procedures for meeting these requirements, and they could return to the board with alternative proposals for meeting environmental goals targeted by the EWB. To ensure consideration of the effects of both surface water and groundwater use on streamflows, the plans would need to be tied to the local groundwater sustainability plans developed under SGMA.

A good example of this process is the Yuba River Accord, in which local water users and environmental groups developed an alternative to the water board's own flow plan. The locally developed plan included incentives for managing groundwater and surface water jointly to meet flow standards, and it facilitated some water trading for the environment and parties outside the basin. Funds raised through water trading helped support local projects.³³

Administration of the EWB could occur in two ways:³⁴

- The EWB could be defined as a regulatory baseline that would be subtracted from the water available for diversions by water right-holders.
- Alternatively, the EWB could be defined as a water right that would function as the most senior water right within the river system.³⁵ As with other water right-holders, the EWB manager would have to operate within this water budget or acquire additional water from other sources. The EWB administrator could decide, for example, to place a call on water stored in upstream reservoirs to guard against the risk of low flows and high temperatures when salmon are spawning. The EWB would then have to offset these higher releases with reductions in environmental water use during other times of the year or in other locations within the water system.

We prefer the second option, because it would add flexibility and enable EWB managers to decide how best to use the water to achieve a range of environmental goals within the watershed. This could include trading of EWB

³² Although legislation is not required to implement this change, the legislature could speed this important process by exempting the water board from conducting a full CEQA review for the development of initial environmental water budgets.

³³ See Hanak et al. 2011, pp. 335, 408.

³⁴ The EWB might be managed by a state agency, such as the Environmental Water Holders in the Australian state of Victoria and at the federal level. California already has significant authority to administer the federal Clean Water Act in conjunction with state water quality and water rights laws. Section 6 of the federal Endangered Species Act (ESA) grants the US Fish and Wildlife Service and the National Marine Fisheries Service authority to make similar delegations to enable California to administer the federal ESA in a coordinated and integrated manner with state law. For a discussion of these types of "cooperative federalism" options see Gray et al. 2013, pp. 41-43 and Hanak et al. 2011, chapter 9.

³⁵ In times of extreme scarcity, however, public health and safety would take precedence even over this top priority water right.

resources to maximize benefits.³⁶ Recognition of the EWB as a regulatory baseline could be achieved without changing existing statutory law. Although definition of the EWB as a water right is more complicated, it is consistent with governing state and federal statutes.³⁷

Encourage environmental water trading

Increased water allocations for the environment can create concentrated economic losses for some water users. By the same token, relaxation of environmental standards—as has occurred during this drought—can exacerbate environmental harm.³⁸ Trading can mitigate such losses and reduce conflict, and it can improve the flexibility of environmental water management. Although California has experimented with environmental water trading, the state lacks a consistent set of market rules and funding sources.

Suggested reform: Environmental water trading would benefit from the trading reforms recommended in the next section. In addition, several specific measures are needed:

- Dedicate funding for the state or other entities to purchase some environmental water (legislative, local, federal actions). The latest water bond provides a start, with \$200 million for the acquisition of instream flows in upper watersheds. A reliable funding stream—for instance, from a small ecosystem surcharge on all water users—is needed to make this effective at scale and over time. (For comparison, Australia dedicated roughly \$3 billion dollars for acquisition of water for the environment.)³⁹
- Streamline review for temporary acquisitions of environmental flows by environmental nonprofits or other entities under Water Code §1707 (legislative action). This law is designed to encourage voluntary dedications of water to the environment, but it is proving too cumbersome and costly for short-term trades. Oregon and Washington have streamlined procedures for environmental leases of five years or less. Together, the two states have approved approximately 3,000 such leases. In contrast, through 2014 California had seen only 34 transfers under section 1707 (Szeptycki et al. 2015).
- Require water users to pay into an ecosystem fund when they benefit from a relaxation in environmental flow standards (legislative, water board, federal action).⁴⁰ This will create appropriate incentives for water users (who would have to pay other right-holders for their water), while providing funds that can help mitigate the loss of environmental flows.

Facilitate Regional Water Sharing

The Big Issue: Barriers to Water Trading

California has a highly decentralized system of water supply management, with hundreds of large urban agencies and irrigation districts, and thousands more that serve smaller towns and farm communities. Two strands of state policy have encouraged cooperation among local agencies to reduce the costs of this fragmentation and enable agencies to benefit from economies of scale. In the 1980s, the state adopted laws to facilitate water trading, and it then helped jumpstart the market by establishing a Drought Water Bank during the early 1990s drought.⁴¹ In the

³⁶ Temporary trading of environmental water is common in the Australian state of Victoria, for instance. This allows the Environmental Water Holder to move water to the places where it is most needed, by leasing out water in some locations and purchasing it in others, and to lease water to raise funds for other environmental investments.

³⁷ As long as the EWB holds sufficient water to fulfill the mandates of water quality, endangered species, and other applicable environmental standards, there would be no conflict between the definition of an environmental water right and existing statutes.

³⁸ This drought also highlighted tradeoffs in managing water for different, competing environmental purposes, such as cold water for salmon versus fresh water for delta smelt and longfin smelt (Mount and Hanak 2015).

³⁹ Most environmental water purchases to date in California have occurred through temporary leases, using one-time funding sources such as state water bonds (Hanak and Stryjewski 2012). To ensure that environmental water is available when needed, it is preferable to acquire permanent water rights (which might be leased back to the original owners or others in years when the water is not needed for the environment) or else to establish a reliable funding source (such as an endowment) that can be used for temporary leasing of water for the environment.

⁴⁰ For a discussion of this proposal, see Lund et al. 2014.

⁴¹ For the history of state policies and water market trends, see Hanak and Stryjewski 2012.

early 2000s, the state also began to promote regional planning and joint investments in water infrastructure, making available hundreds of millions of dollars in matching funds from state bonds. Increasingly, these regional approaches involve partnerships with agencies involved in water management functions such as wastewater treatment, stormwater management, and flood control, in addition to water supply (Hanak et al. 2011, chapter 6, Hanak et al. 2014a).

These approaches have borne fruit. Regional cooperation has helped cities and suburbs weather the current drought—thanks to investments in interconnections among local systems, joint water storage projects, and new regional supplies such as recycled wastewater (Hanak et al. 2015). Within agricultural regions, cooperative approaches—including groundwater storage projects and water trading—have also helped. Storage and trading programs have sometimes involved agricultural-urban partnerships within and across regions.

But the drought has also highlighted major barriers to sharing water, reflecting complicated rules for trading water from different sources and conveyance limits on physically moving water. Because changing the place where a water right will be used can affect flows available to other water users and the environment, water trading requires some regulatory oversight. However, California’s trading rules are fragmented and inconsistent. Different rules apply to different types of water rights and water agencies.⁴² There is also a lack of clarity on some basic issues, such as how much water can be traded when land is fallowed. The large role of the federal government, as owner of the Central Valley Project (CVP), adds to the complexity because federal water trades require additional layers of review (Gray 1996).

Since water trading became more widely used in the early 1990s, there have been numerous proposals to make the review process more transparent and flexible while continuing to protect against unreasonable harm to other water users and the environment.⁴³ Yet the required administrative reviews are becoming more difficult. The volume of trading barely increased during the two most recent droughts, despite especially high demand from water users facing shortages.⁴⁴ This stands in sharp contrast to trading behavior during the early 1990s drought.

Infrastructure barriers to physically moving water from one place to another can also impede trading. Investments in new interconnections and storage have greatly reduced these physical barriers in some regions, particularly in the San Francisco Bay Area and Southern California. However, water conveyance constraints in the Sacramento–San Joaquin Delta limit trading from the relatively water-rich Sacramento Valley to regions further south (Hanak and Stryjewski 2012). Conveyance constraints also limit trades within the southern Central Valley.

Reform Proposals

We recommend several steps to improve trading flexibility. We emphasize facilitating trades within regions, where harmful impacts from trades are less likely because of a shared watershed. But these reforms often can apply to interregional trades as well.

Consolidate regional places of use

Local agencies within the same region now need to seek approval—often involving multiple layers of review by multiple agencies—each time they want to share water from different water rights that are authorized for use by distinct parties in distinct places. This process needlessly complicates what should be a commonplace regional water management practice.

⁴² Different rules also apply to water users served by different water right-holding entities—including local irrigation districts, the State Water Project, and the federal Central Valley Project.

⁴³ See Gray et al. 1996 and related articles in the same journal issue; Water Transfer Workgroup 2002; Hanak et al. 2011, chapter 7; Association of California Water Agencies 2015.

⁴⁴ See Hanak and Stryjewski 2012 and Hanak et al. 2015, technical appendix Figure A5.

Suggested reform: The state should facilitate the consolidation of places of use assigned to different water rights to provide blanket permitting for regional water sharing (state, federal, local agency actions). Because regional supplies often include an amalgam of locally held water rights, federal rights (for CVP water), and state rights (for State Water Project [SWP] water), this will generally require approval by agencies beyond the water board. A useful model is the temporary consolidation of place of use for the CVP and the SWP within the San Joaquin Valley during the last two droughts, which enabled farmers in that water-scarce region to trade more freely. Such consolidations should be made permanent and include conditions to protect local water uses that might be harmed by a change in place of use (e.g., environmental flows in some streams). Trades that comply with these rules could then occur quickly, with minimal prior review and oversight.

Preauthorize some transfers and expedite reviews

Because regional consolidation will take time to implement widely, other measures to facilitate water sharing are needed.

Suggested reform: Some types of transfers should be preauthorized because they are unlikely to cause unreasonable harm. These include:

- Transfers below a specific size threshold. The quantity limits would vary depending on factors such as hydrologic conditions and the effects of changing the point of diversion, place of use, or point of return flow on other water users and the environment (state, federal agency actions).
- Transfers of “consumptive use”—e.g., the net amount that crops or landscaping would have used if the seller had used the water. This is usually less water than the total applied to the land, because a portion often returns to the river or recharges groundwater basins where it is available for reuse. (Transferring the net water use is much less likely to cause harm than transferring this return flow.) To implement this recommendation, the state will need to publish guidelines on how much water different crops consume in different climatic zones (state agency action).⁴⁵

In exchange for this preauthorization, sellers could be required to mitigate potential harm by submitting to expedited review of complaints, posting bonds, or providing other recourse such as binding arbitration.⁴⁶

Suggested reform: Streamline approvals for temporary transfers. California law now provides some streamlining for temporary water rights transfers, defined as transfers lasting one year or less.⁴⁷ Some states have a more expansive definition of “temporary,” which has helped to promote water trading.⁴⁸ Such a change would exempt slightly longer trades from review under the California Environmental Quality Act (legislative action). Exemption of temporary transfers of federal water from review under the National Environmental Policy Act (NEPA) would also facilitate drought water sharing (federal action).⁴⁹

⁴⁵ Accounting for the consumptive use at the receiving end will also be useful in some situations. For instance, if a fraction of the transfer is returned as wastewater to the system, the net impact on flows is smaller and can be taken into account in the permitting. Such calculations can also be done in advance for areas that receive water transfers.

⁴⁶ The bond idea was proposed by the authors of the Model Water Transfer Act in the mid-1990s (Gray et al. 1996). If affected parties subsequently demonstrate the transfer to have caused unreasonable harm, they could seek damages from the bond fund. If not, the bond would be discharged. In either event, the transfer would be allowed to proceed. For a detailed discussion of this recommendation, see Gray 1996, pp. 40-41.

⁴⁷ California Water Code §§ 1725-1728. This exemption only applies to transfers that require approval of the water board; it is not available to transfers of water held pursuant to pre-1914 appropriative rights.

⁴⁸ For example, Oregon defines as “temporary” water rights transfers lasting five years or less (Oregon Revised Statutes § 540.523). Oregon law allows the state to revoke these leases if they harm other water right-holders to compensate for the quicker up-front review.

⁴⁹ Currently, even one-year trades of federal water must comply with NEPA’s environmental review requirements.

Encourage drought storage

The drought has underscored the importance of storing water for dry times. Yet California law does not encourage water storage investments if the party storing the water cannot identify a specific end use.⁵⁰ This discourages investments to store water for sale during droughts, when demand is highest. It is essential for California to more actively store water to cope with future droughts, and water rights law should support this.

Suggested reform: Amend the Water Code to define storage (both above and below ground) as a beneficial use, even where the party seeking to obtain a water right cannot identify a specific end use, as long as the storage would serve a demonstrated public purpose such as recharging groundwater basins (legislative action).⁵¹ The water board could place appropriate conditions on the diversion, storage, and subsequent extraction of the stored water.⁵² The board should also expedite granting water rights for excess flood flows that can be captured and stored (water board action). Some junior right-holders have voiced objections to this idea, out of concern that this might reduce the volume of water available to them. But such concerns can be addressed with adequate conditions and monitoring. Collaborative groundwater banking operations—such as those now operated by Kern County water agencies that store water for offsite parties—should be encouraged more widely.

Improve information about trading opportunities

There is little publicly available information about water trading opportunities (e.g., sources, volumes, and prices) in California. This limits market access by all but the largest agencies, reduces competition, and likely also reduces the volume of water available for trading.

Suggested reform: Develop a water transfer clearinghouse (state agency action). At a minimum, this state-level clearinghouse (or collection of regional clearinghouses) would make information available about transactions that have occurred and new trading opportunities. A clearinghouse might also serve as an electronic brokerage for pre-approved trades, to reduce the cost of closing deals.⁵³

⁵⁰ In the “Delta Wetlands case,” an investor group sought a permit from the water board to divert and store water on two islands within the Delta for later transfer to parties south of the Delta. The court of appeal held that the board erred in granting the permit because the project proponent could not identify the end beneficial uses of the stored water (*Central Delta Water Agency v. SWRCB*, 124 Cal. App. 4th 245 (2004)).

⁵¹ Other purposes could include water quality enhancement, improvement of habitat for fish and wildlife, or capture of water that is surplus to all current needs (including water quality and environmental flow standards) and that otherwise would be wasted. As with all transfers, the diversion and transport of this water for storage could not cause unreasonable harm to other legal water users or the environment.

⁵² There were negotiations in 2015 among a variety of interested parties (including state officials, local water managers, and environmental organizations) to amend Water Code § 1242 to define storage as a beneficial use. Neither house of the legislature voted on the principal draft bill, AB 647.

⁵³ This clearinghouse need not be run by a government agency. One well-functioning model of an electronic clearinghouse for pre-approved trades is the privately owned Australian service WaterFind™.

Conclusion

The reforms outlined here—streamlining the administration of water rights, bringing clarity to the allocation of water for environmental uses, and facilitating regional water trading—will go a long way toward improving California’s ability to manage droughts and address changing climate conditions for the benefit of the economy, society, and the environment. Complementary efforts will be needed to consolidate recent progress in groundwater management. The assignment of pumping rights, for example, would help to improve the management of groundwater as a critical drought reserve.

Enhancing the quality and transparency of information on water availability and use is central to all these efforts. Additional staffing for the water board’s division of water rights will also be needed to enable timely implementation of these reforms, with funding either from higher fees on water right-holders or from the state General Fund.⁵⁴

Implementing these reforms will require some adaptation. But it will not require a complete overhaul of the state’s water rights system or a change in the underlying seniority of existing rights. Indeed, by increasing flexibility and transparency while also reducing uncertainty, these reforms should strengthen water rights and improve the ability to transfer water and to invest in groundwater replenishment.

California also needs to consider investments in its infrastructure grid—including conveyance and storage—to improve the state’s ability to adapt to future droughts and a warming climate.⁵⁵

In addition, the state must improve environmental water management during droughts. This drought has highlighted the vulnerability of the state’s riverine and wetland ecosystems to prolonged, warm droughts—the type of drought California is increasingly likely to experience. Protecting the state’s iconic biodiversity will require developing and implementing plans to build environmental drought resilience. This may also require making explicit tradeoffs on the use of some water and land resources to protect biodiversity, as well as changes in the administration of some environmental laws (Hanak et al. 2011, chapter 5).

This drought has provided valuable lessons on weaknesses and pressure points in how California allocates water. By heeding these lessons, California will be able to more efficiently allocate scarce water resources and be better prepared for the next drought.

⁵⁴ As a point of comparison, the division of water rights has roughly 125 staff members, while regional water quality control boards operating at the level of the state’s nine hydrologic regions each have an average of roughly 100 staff members. To implement the proposals outlined here, staffing for the five northern hydrologic regions (North Coast, Lahontan, San Francisco Bay, Central Valley, and Central Coast) would need to be increased to be roughly on par with the water quality functions in those regions, requiring roughly a quadrupling of water rights division staffing. This would entail a budget increase from the current \$13 –\$14 million to roughly \$50 million. This is a small increment relative to overall spending on California water supply of nearly \$17 billion annually (Hanak et al. 2014a, Table 1).

⁵⁵ For instance, moving (and trading) water from the wetter north to the drier southern and western regions of the state will become increasingly valuable as the state’s climate warms and as farming regions implement the new groundwater law. Both of these changes increase the value of moving water through the Delta. See Ragatz 2013 on climate change and Delta exports and Dogan 2015 on SGMA and Delta exports. Also see Schwabe and Connor 2012.

REFERENCES

- Association of California Water Agencies. 2015. *Developing an Effective Water Market in California*. Sacramento, CA.
- Baily, Ronald. 2014. "How to slake California's thirst." Reason.com. September 5.
- Chappelle, Caitrin and Henry McCann. 2015. "New Water Laws Address Groundwater, Marijuana." *PPIC Blog*. October 15.
- Department of Water Resources. 2013. *Initial Study/Proposed Negative Declaration. State Water Project Supply Allocation Settlement Agreement*. Prepared for the Department of Water Resources, State Water Project Analysis Office by AECOM. July.
- Diffenbaugh, Noah, Daniel Swain, and Danielle Touma. 2015. "Anthropogenic warming has increased drought risk in California." *PNAS*. 112(13): 3931–3936, doi: 10.1073/pnas.1422385112
- Dogon, Mustafa. 2015. "Integrated Water Operations in California: Hydropower, Overdraft, and Climate Change." MS thesis, Center for Watershed Sciences, University of California, Davis.
- Georgakakos, Aris, Paul Fleming, Michael Dettinger, Christa Peters-Lidard, Terese (T.C.) Richmond, Ken Reckhow, Kathleen White, and David Yates. 2014. Ch. 3: Water Resources: in *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., US Global Change Research Program, 69-112.
- Gray, Brian. 1996. "The Shape of Transfers to Come: A Model Water Transfer Act for California." *Hastings West-Northwest Journal of Environmental Law & Policy*, 4(1): 23-61.
- Gray, Brian, 2012. "Ensuring the Public Trust." *UC Davis Law Review* 45(3): 973-1019.
- Gray, Brian. 2015. "The Reasonable Use Doctrine in California Water Law and Policy," in A. Lassiter (ed.), *Sustainable Water: Challenges and Solutions from California*. University of California Press.
- Gray, Brian, Richard Howitt, Lawrence MacDonnell, Barton ("Buzz") Thompson, Jr. and Henry Vaux, Jr. 1996. "A Model Water Transfer Act for California." *Hastings West-Northwest Journal of Environmental Law & Policy*, 4(1): 3-23.
- Gray, Brian, Barton "Buzz" Thompson, Ellen Hanak, Jay Lund, and Jeffrey Mount. 2013. *Integrated Management of Delta Stressors: Institutional and Legal Options*. PPIC.
- Hanak, Ellen, Brian Gray, Jay Lund, David Mitchell, Caitrin Chappelle, Andrew Fahlund, Katrina Jessoe, Josué Medellín-Azuara, Dean Misczynski, James Nachbaur, and Robyn Suddeth. 2014a. *Paying for Water in California*. PPIC.
- Hanak, Ellen, Jay Lund, Ariel Dinar, Brian Gray, Richard Howitt, Jeffrey Mount, Peter Moyle, and Barton "Buzz" Thompson. 2011. *Managing California's Water: From Conflict to Reconciliation*. PPIC.
- Hanak, Ellen and Elizabeth Stryjewski. 2012. *California's Water Market, By the Numbers: Update 2012*. PPIC.
- Hanak, Ellen, Jeffrey Mount, Jay Lund, Greg Gartrell, Brian Gray, Richard Frank and Peter Moyle. 2014b. "Modernizing Drought Water Allocations." *California WaterBlog*. October 16.
- Hanak, Ellen, Jeffrey Mount, Caitrin Chappelle, Jay Lund, Josué Medellín-Azuara, Peter Moyle, and Nathaniel Seavy. 2015. *What If California's Drought Continues?* PPIC.
- Howitt, Richard, Duncan MacEwan, Josué Medellín-Azuara, Jay R. Lund, and Daniel A. Sumner. 2015. *Economic Analysis of the 2015 Drought for California Agriculture*. Center for Watershed Sciences, University of California, Davis.
- Kahn, Debra. 2015. "Calif.'s quirky water rights system is showing its age." E&E Publishing LLC. June 25.
- Los Angeles Daily News Editorial Board. 2015. "It's time to reform California's inherited water rights," *Los Angeles Daily News*. May 8.
- Lund, Jay, Ellen Hanak, Barton "Buzz" Thompson, Brian Gray, Jeffrey Mount, and Katrina Jessoe. 2014. "Why Give Away Fish Flows for Free during a Drought?" *California Water Blog*. February 11.
- Morin, Monte. 2015. "As California drought worsens, experts urge water reforms." *Los Angeles Times*. June 1.
- Mount, Jeffrey. 2015. "Better Reservoir Management Would Take the Heat Off Salmon." *PPIC blog*. June 23.
- Mount, Jeffrey and Ellen Hanak. 2015. "Set Water Priorities to Prepare for Drought." *San Francisco Chronicle*. February 5.
- Pottinger, Lori. 2015. "The Challenges of Getting More Crop Per Drop." *PPIC Blog*. July 28.
- Ragatz, Rachel. 2013. "California's Water Futures: How Water Conservation and Varying Delta Exports Affect Water Supply in the Face of Climate Change." MS thesis. Center for Watershed Sciences, University of California, Davis.
- Schwabe, Kurt and Jeff Connor. 2012. "Drought Issues and Semi-arid and Arid Environments." *Choices* 27(3): 1-5.

- Solano County Water Agency. 2015. [Annual Report to the California State Legislature](#). February.
- State Water Resources Control Board. 2015. [Clarification of Notice of Curtailment for Sacramento-San Joaquin Delta Diverters Claiming Both a Pre-1914 and Riparian Water Right](#). June 16.
- Szeptycki, Leon, Julia Forgie, Elizabeth Hook, Kori Lorick, and Philip Womble. 2015. [Environmental Water Transfers: A Review of State Laws](#). Stanford Woods Institute.
- The Nature Conservancy. 2014. [Assessment of Surface Water and Groundwater Conditions and Interaction in California's Central Valley: Insights to Inform Sustainable Water Management](#). San Francisco, CA. October.
- Water Education Foundation. 2015. [The 2014 Sustainable Groundwater Management Act: A Handbook to Understanding and Implementing the Law](#).
- Water Transfer Workgroup. 2002. [Water Transfer Issues in California](#). State Water Resources Control Board.

ABOUT THE AUTHORS

Brian Gray is an adjunct fellow at the [PPIC Water Policy Center](#) and professor emeritus at the University of California, Hastings College of the Law in San Francisco. He has published numerous articles on environmental and water resources law and coauthored a variety of PPIC reports, including the 2011 interdisciplinary book on California water policy, *Managing California's Water: From Conflict to Reconciliation*. He has argued before the California Supreme Court and the US Court of Appeals in cases involving wild and scenic rivers, water pricing reform, takings, and water rights and environmental quality. He is a recipient of the William Rutter Award for Excellence in Teaching and the UC Hastings Outstanding Professor Award. He holds a JD from the University of California, Berkeley, and a BA in economics from Pomona College.

Ellen Hanak is director of the [PPIC Water Policy Center](#) and a senior fellow at the Public Policy Institute of California. Under her leadership, the center has become a critical source of information and guidance for natural resource management in California. She has authored dozens of reports, articles, and books on water policy, including *What If California's Drought Continues?* and *Managing California's Water*. Her research is frequently profiled in the national media, and she participates in briefings, conferences, and interviews throughout the nation and around the world. Her other areas of expertise include climate change and infrastructure finance. Previously, she served as research director at PPIC. Before joining PPIC, she held positions with the French agricultural research system, the President's Council of Economic Advisers, and the World Bank. She holds a PhD in economics from the University of Maryland.

Richard Frank is a professor of Environmental Practice and director of the [California Environmental Law & Policy Center](#) (CELPC). He was formerly the executive director of the Center for Law, Energy, & the Environment (CLEE) at the University of California, Berkeley School of Law. He has served on a number of state bodies working on water and environmental issues, including the Delta Vision Task Force, an advisory body that develops policy recommendations for the governor and legislature to address environmental problems confronting the Sacramento-San Joaquin Delta; and a Blue Ribbon Citizens Commission to develop a new strategic vision for California's Department of Fish and Wildlife and the California Fish and Game Commission.

Richard Howitt is an adjunct fellow at the [PPIC Water Policy Center](#) and professor emeritus of agricultural and resource economics at the University of California, Davis. He has published widely on agricultural and environmental resource allocation, with special emphasis on agricultural land use, water markets, and the application of optimization models to resource allocation questions. In addition to serving as a reviewer for seven scholarly journals, he is a member of the Western Agricultural Economics Association of Environmental and Resource Economics and the UC Davis Center for Watershed Sciences' Delta Solutions Group. He holds a PhD from the University of California, Davis.

Jay Lund is an adjunct fellow at the [PPIC Water Policy Center](#) and director of the [Center for Watershed Sciences](#) at the University of California, Davis. As a professor in the Civil and Environmental Engineering Department, he has conducted system optimization studies for California's water supply, as well as modeling studies of flood control, climate change adaptation, water marketing, water utility planning, and integrated water resources management. In addition to authoring or coauthoring more than 300 publications, he has served on the advisory committee for the 1998 and 2005 California Water Plan Updates, as president of the Universities Council on Water Resources, and on the Delta Independent Science Board. He holds a PhD in civil engineering from the University of Washington, Seattle.

Leon Szeptycki is an attorney who specializes in water quality, water use and watershed restoration. He is a Professor of the Practice at [Stanford Woods Institute for the Environment](#), and executive director of its [Water in the West](#) program. His work includes issues related to streamflow restoration in the context of the western appropriative rights system and increasing human demands on water. He is the author of many publications, including most recently *Environmental Water Rights Transfers: A Review of State Laws*. From 2006–12, he taught at the University of Virginia School of Law, where he ran the Environmental Law and Conservation Clinic. Prior to that, he spent 10 years with Trout Unlimited, a national conservation organization devoted to the protection and restoration of trout and salmon rivers. He has also worked in private law practice and at the US Department of Justice. He holds a JD from Yale Law School, and a BA from the University of Kansas.

Barton "Buzz" Thompson is the Robert E. Paradise Professor in Natural Resources Law at Stanford Law School and the Perry L. McCarty Director of the [Stanford Woods Institute for the Environment](#). He also serves as Special Master for the United States Supreme Court in *Montana v. Wyoming*. His research focuses on the role of law, institutions, and markets in effective water management, as well as the law of regulatory takings and biodiversity protection. A former member of the Science Advisory Board for the US Environmental Protection Agency, he is the author of numerous books on water and the environment, including *Legal Control of Water Resources* (5th ed., 2013). He holds a JD from the Stanford Law School, an MBA from Stanford Graduate School of Business, and a BA from Stanford University.

ACKNOWLEDGEMENTS

The authors wish to thank reviewers of an earlier draft of this report for their very helpful comments: Alvar Escriva-Bou, Greg Gartrell, Jeff Mount, Tim Quinn, and Kurt Schwabe. We also thank Lori Pottinger and Lynette Ubois for expert editorial support. We alone are responsible for any remaining errors or omissions.

PUBLIC POLICY
INSTITUTE OF
CALIFORNIA

Board of Directors

Donna Lucas, Chair
Chief Executive Officer
Lucas Public Affairs

Mark Baldassare
President and CEO
Public Policy Institute of California

Ruben Barrales
President and CEO
GROW Elect

María Blanco
Executive Director
Undocumented Student Legal Services Center
University of California Office of the President

Louise Henry Bryson
Chair Emerita, Board of Trustees
J. Paul Getty Trust

A. Marisa Chun
Partner
McDermott Will & Emery LLP

Phil Isenberg
Vice Chair, Delta Stewardship Council

Mas Masumoto
Author and Farmer

Steven A. Merksamer
Senior Partner
Nielsen, Merksamer, Parrinello,
Gross & Leoni, LLP

Gerald L. Parsky
Chairman
Aurora Capital Group

Kim Polese
Chairman
ClearStreet, Inc.

Gaddi H. Vasquez
Senior Vice President
Government Affairs
Edison International
Southern California Edison

PPIC WATER
POLICY CENTER

Advisory Council

Frances Spivy-Weber, Chair
Vice Chair
State Water Resources Control Board

Timothy Quinn, Vice Chair
Executive Director
Association of California Water Agencies

Mark Baldassare
President and CEO
Public Policy Institute of California

Celeste Cantú
General Manager
Santa Ana Watershed Project Authority

Dave Cogdill
President & CEO
California Building Industry Association

Lauren B. Dachs
President and Vice Chair of the Board of
Directors
S. D. Bechtel, Jr. Foundation

Daniel M. Dooley
Principal
New Current Water and Land, LLC

Debbie Franco
Community and Rural Affairs Advisor and
Local Drought Liaison
Governor's Office of Planning and Research

Phil Isenberg
Vice Chair
Delta Stewardship Council

Debra C. Man
Assistant General Manager and Chief
Operating Officer
Metropolitan Water District of Southern
California

David Puglia
Senior Vice President, Government Affairs
and Communications
Western Growers Association

Lester Snow
Executive Director
California Water Foundation

Mike Sweeney
Executive Director
The Nature Conservancy California Chapter



PPIC

PUBLIC POLICY
INSTITUTE OF CALIFORNIA

The Public Policy Institute of California is dedicated to informing and improving public policy in California through independent, objective, nonpartisan research.

Public Policy Institute of California
500 Washington Street, Suite 600
San Francisco, CA 94111
T: 415.291.440
F: 415.291.4401
PPIC.ORG

PPIC Sacramento Center
Senator Office Building
1121 L Street, Suite 801
Sacramento, CA 95814
T: 916.440.1120
F: 916.440.1121