

# Policy Priorities for Managing Drought

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## SUMMARY

State, federal, and local water managers have worked diligently to reduce the economic, social, and environmental harm from the current drought. But as the drought continues, the challenges will grow more acute. California can learn from experiences to date—and from Australia’s response to its Millennium Drought—to better prepare both for the year ahead and for future droughts. State leaders should address weaknesses in four areas of drought preparation and response, by: 1) improving water use information, 2) setting clear goals and priorities for public health and the environment, 3) promoting water conservation and more resilient water supplies, and 4) strengthening environmental management.

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## INTRODUCTION

California is entering a fourth year of severe drought, with water scarcity affecting urban and agricultural water users throughout the state. Low flows and high temperatures are also stressing wetland and river ecosystems and the fish and wildlife that depend on them. Drought emergencies of this magnitude test California’s water management systems, revealing both strengths and weaknesses in infrastructure, operations, and policies. California needs to harvest lessons for both the coming year and the next drought.

This report summarizes some of these lessons and provides near-term policy recommendations for strengthening drought management. It builds on discussions held at the January 2015 Managing Drought conference with legislators and leaders from state and local agencies and stakeholder groups.<sup>1</sup> Conference participants examined institutional responses to the drought in the urban, agricultural, and environmental sectors and considered areas for improvement. The discussions were informed by experiences in Australia, which has a similar climate and economy and endured a decade-long “Millennium Drought” at the beginning of this century.<sup>2</sup>

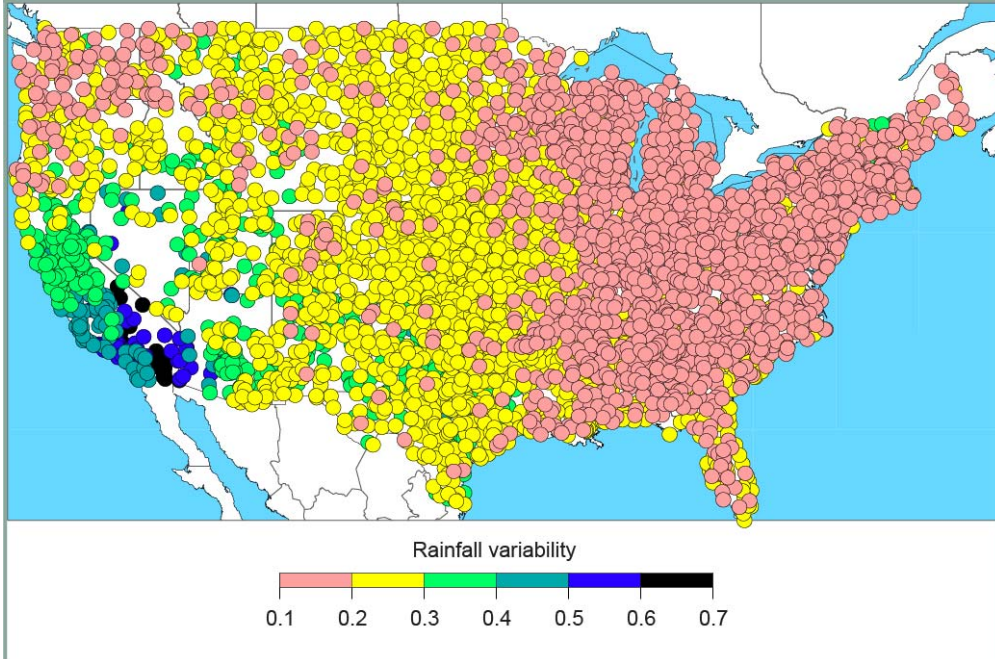
## THE DROUGHT SO FAR

California has the most variable rainfall in the nation, with a few large storms making the difference between a wet and a dry year (Figure 1). As a result, severe droughts are a regular feature of the state’s climate, occurring every 15 to 40 years. The current drought began in 2012 and has covered the entire state.<sup>3</sup> Recent record-high temperatures have amplified its effects by reducing both snowpack—a critical source of stored water—and soil moisture.

It is difficult to attribute this drought—or any specific weather pattern—to climate change, which generally is a long-term shift in conditions. Yet this drought’s characteristics are consistent with projections that California’s climate is becoming warmer and more variable, with wetter wet periods and drier dry periods. Climate projections also suggest that droughts will become more frequent.<sup>4</sup>



**FIGURE 1. CALIFORNIA'S PRECIPITATION IS HIGHLY VARIABLE COMPARED TO THE REST OF THE NATION**

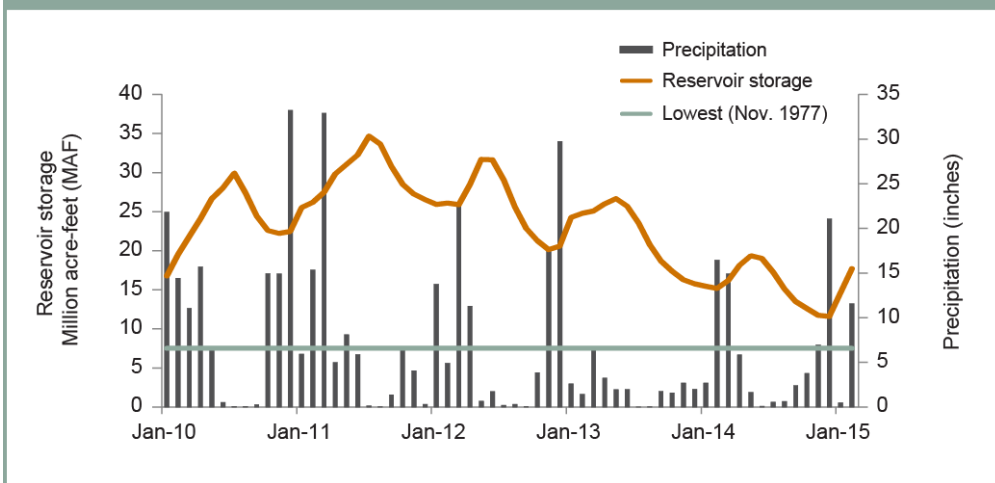


SOURCE: Michael Dettinger, 2011. "Climate Change, Atmospheric Rivers, and Floods in California—A Multimodel Analysis of Storm Frequency and Magnitude Changes." *Journal of the American Water Resources Association* 47(3):514-523.

NOTES: Dots represent the variation of total annual precipitation at weather stations for 1951-2008, as measured by the coefficient of variation. The larger the value, the greater the year-to-year variability.

Three consecutive dry years reduced water held in the state's reservoirs (Figure 2). As a result, two of the largest water providers—the State Water Project (SWP) and the Central Valley Project (CVP)—dramatically reduced water deliveries. Surface deliveries from many local projects also decreased. By 2014—so far the worst year of the drought—many areas experienced severe shortages, especially the southern Central Valley and the Central Coast. Hydropower generation, which usually provides 10–15 percent of California's electricity supply, was cut in half.<sup>5</sup>

**FIGURE 2. WATER STORED IN SURFACE RESERVOIRS HAS FALLEN**

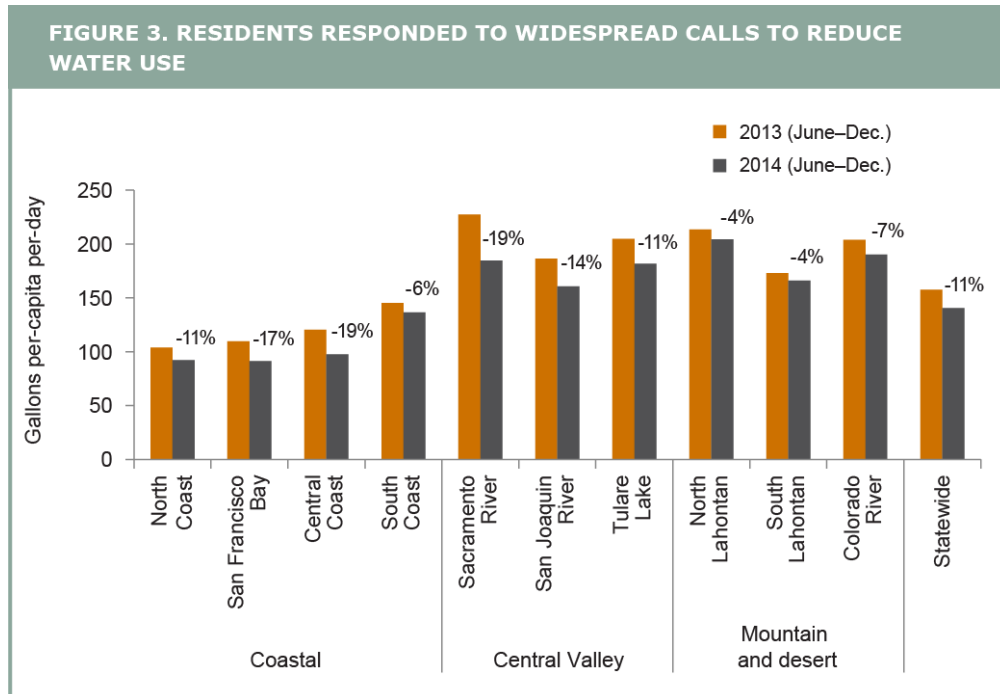


SOURCE: California Department of Water Resources

NOTES: Precipitation is measured by summing the Northern Sierra 8-station and San Joaquin 5-station precipitation indices to account for most rainfall available for reservoir storage.

Many cities and farms relied on additional groundwater pumping to meet demands. In a typical year, groundwater contributes about a third of total urban and farm water supply, and in 2014 this share likely exceeded 50 percent.<sup>6</sup> In some basins, the high rates of groundwater pumping have exacerbated problems of chronic overdraft—or excessive pumping: sinking lands, drying up of wells, and drying of some rivers and wetlands fed by groundwater reserves.<sup>7</sup>

Californians’ awareness of the drought increased dramatically in 2014, and they responded to widespread calls to reduce water use (Figure 3).<sup>8</sup>



SOURCE: Monthly Urban Water Supplier Data, State Water Resources Control Board.

NOTES: These estimates exclude commercial, institutional, and industrial water uses. The North Lahontan region covers most of the northeastern Sierras; South Lahontan covers the eastern Sierras and high desert including Mono, Inyo, and parts of Kern, Los Angeles, and San Bernardino Counties; and the Colorado River region covers the southeastern portion of the state including Imperial and parts of Riverside, San Bernardino, and San Diego Counties.

In January 2014, Governor Brown declared a statewide drought emergency and set up an Interagency Drought Task Force of agency heads to coordinate drought management and response.<sup>9</sup> The California Legislature and the federal government funded disaster relief.<sup>10</sup>

The State Water Resources Control Board (“the board”), which administers water rights and water quality standards, played a pivotal role. To allow increased diversions to cities and farms, board staff approved water allocation plans that relaxed environmental standards. For the first time since 1977, the board also ordered curtailment of water diversions for many junior water-rights holders. (In California’s “first-in-time, first-in-right” system of surface water rights, those with more recent—or junior—rights generally have lower priority in times of shortage.)

**Cities**

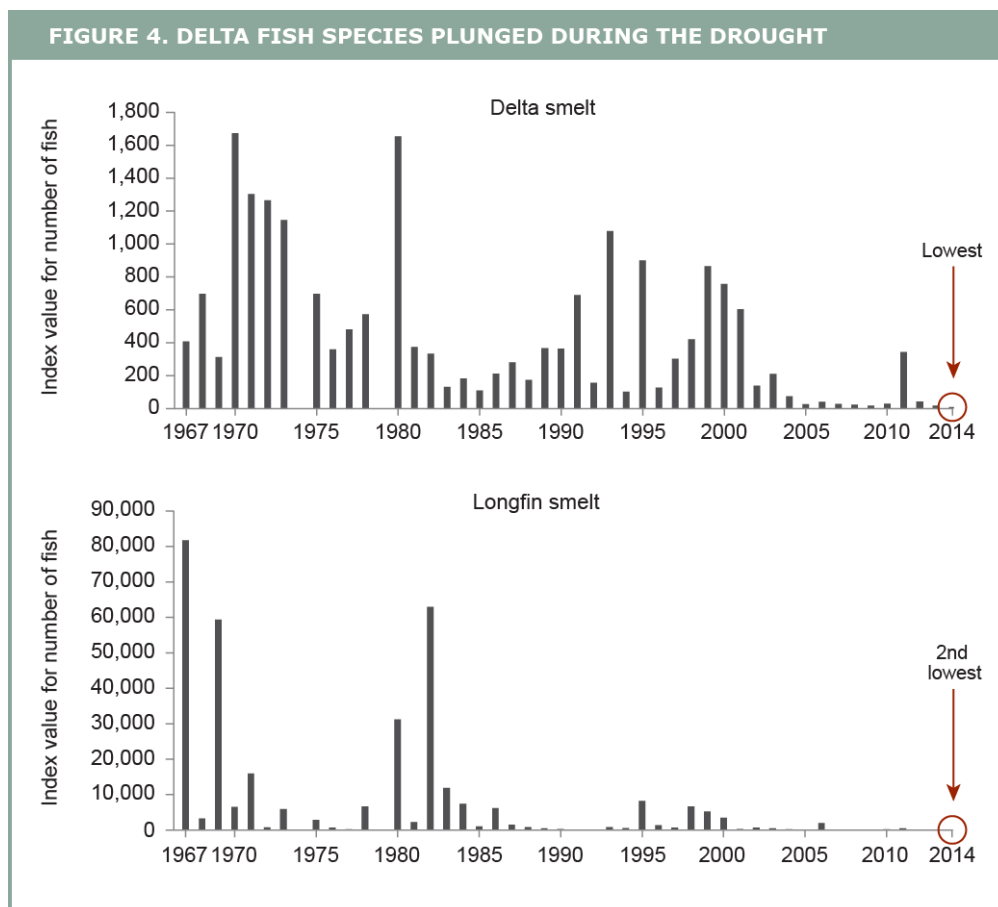
Thanks to substantial investments following the 1987–92 drought—and despite the addition of more than 8 million new residents since that time—most large urban areas have experienced only modest water shortages so far. Drought resilience improvements included new surface and underground storage, new interconnections that enable supply sharing with neighboring agencies, expanded use of recycled wastewater and stormwater, and water purchases. In addition, low-flow plumbing fixtures and appliances and changing behavior have reduced per-capita water use in most urban areas.<sup>11</sup> In contrast, several large communities and numerous small, rural communities relying on a single source (often groundwater) experienced severe shortages.<sup>12</sup> Some required emergency aid from the state.

## Farms

California's productive agricultural sector requires large volumes of water for irrigation during the dry summer months, typically using roughly four times as much water as cities.<sup>13</sup> Over the past few decades, farmers have also adapted to growing water scarcity through major investments in irrigation efficiency and shifts toward crops that generate higher revenues per unit of water used.<sup>14</sup> However, these adaptations have not generally increased drought resilience. In most of California's farming regions, irrigation efficiency improves crop yields and quality, but it does not increase overall water availability.<sup>15</sup> That is because irrigation water in less efficient systems generally is not wasted; water not consumed by crops either returns to streams where it is reused by others or else percolates through soils to recharge groundwater basins. Meanwhile, the long-term shift to high-revenue perennial nuts, fruits, and vines has made agricultural water demands more rigid, because it is more expensive to fallow this land during drought. As a result, the drought hit agriculture particularly hard. Statewide, approximately 5 percent of cropland—mainly used for lower-revenue annual crops—was fallowed, with total economic losses of more than \$2 billion and 17,000 full- or part-time jobs.<sup>16</sup>

## Ecosystems

California's aquatic ecosystems and the species that depend on them were also hit hard. Many salmon- and steelhead-bearing rivers and streams on the North Coast and in the Central Valley had record-low flows and high temperatures. Unusually low flows into the Sacramento–San Joaquin Delta led to poor water quality. Surveys in fall 2014 found some fish species—including the protected delta smelt—at record or near-record lows (Figure 4), and 95 percent of the 2014 offspring from spawning winter-run Chinook salmon perished because of warm water.<sup>17</sup> Fish rescue operations were needed for some native fish species.<sup>18</sup> Finally, water for wildlife refuges was significantly cut back, reducing critical winter feeding habitat for birds during an unusually large Pacific Flyway migration.<sup>19</sup>



SOURCE: California Department of Fish and Wildlife

NOTES: The graphs report indices for the fall midwater trawl.

## FOUR AREAS FOR POLICY REFORM

Despite the difficulties posed by this severe drought, there have been some positive takeaways. “Managing Drought” conference participants noted several of these, including successful pre-drought planning and investments in urban areas, modest reductions in per-capita water use statewide, more effective coordination between state agencies, and timely response to drinking water shortages for some small communities.<sup>20</sup> In addition, 2014 saw major legislation enacted, including the landmark Sustainable Groundwater Management Act<sup>21</sup> and the approval of Proposition 1, a new \$7.5 billion water bond.<sup>22</sup> Yet despite these advances, new policies will be needed to address both ongoing and future droughts. Four areas merit close attention.

### Manage Water More Tightly, with Better Information

Australia’s Millennium Drought offers a useful case study for California. Before and during that drought, Australians invested significantly in tracking water, including accurate measurements of flow, quality, storage, diversions, discharges, and uses.<sup>23</sup> This allowed water managers to tightly manage water allocation and delivery in fair, transparent, and flexible ways. By comparison, California’s water monitoring systems are primitive, with significant gaps in critical information. The resulting uncertainty creates inefficiencies, reduces transparency, and fosters conflict.

California urgently needs to modernize water accounting to support transparent decisionmaking, both for drought curtailments and for water trading. Adopting new technologies (e.g., automated gaging, remote sensing, and improved hydrologic models) to monitor and predict water flow and quality is one piece of the equation. The other piece is requiring more accurate measurement and timely reporting of water diversions and discharges by major water-right-holders. Today, senior surface water-rights holders and those with riparian<sup>24</sup> water rights must only report diversions—the amount of water they use on farms or deliver to urban customers—every three years. (Junior rights holders report diversions each year.) And outside of urban areas, no water diverters are required to report discharges—or the amount of water returned to streams after use—even though this constitutes a significant share of supplies on some rivers.

The State Water Resources Control Board, working closely with the Department of Water Resources and the legislature, could enact meaningful reforms in water use reporting. Additional state funds are likely to be needed to improve water monitoring networks—from Proposition 1 or other sources. Federal funds also could help modernize these networks.

### Set Clear Priorities, Objectives, and Expectations

The water board’s water curtailment actions in 2014 were highly controversial. Many water users questioned the fairness of curtailments, which relied solely on the seniority of water rights and failed to consider the efficiency of use and other factors. Critics also argued that the board did not identify amounts required to meet urgent public health and safety needs or the needs of the environment. By law these factors must be considered along with seniority, and in some circumstances they may take precedence over water rights.<sup>25</sup>

During the Millennium Drought, some Australian states developed processes that greatly reduced uncertainty and controversy by clearly identifying priorities for public health and safety and giving due consideration to environmental impacts.<sup>26</sup> The board could modify its curtailment processes to explicitly identify the magnitudes and priorities of these values in advance of a drought, and exercise these procedures in “dry runs” that simulate droughts, just as agencies have drills for earthquakes, floods, and fires.

### Promote Reasonable Use and Robust Supplies

California cities and farms must also make further progress in managing demand and developing reliable supplies. Significant improvements are possible in the following areas:

- **Reduce urban landscape irrigation.** Landscape irrigation accounts for roughly half of urban water use.<sup>27</sup> In Australia, changes in urban landscaping significantly reduced urban demand. Local agencies can use financial incentives (e.g., rebates) and conservation-oriented water rates to encourage customers to install more efficient irrigation systems and to replace thirsty lawns with more California-friendly plants. Conference participants also highlighted the value of state action, to help

local agencies withstand political pressures from residents. For instance, the legislature or the water board could set landscaping water use standards to be implemented by local agencies.<sup>28</sup>

- **Improve conservation-oriented pricing in cities.** Water pricing—particularly tiered rates that charge higher per-gallon rates for greater water use—are important to promote urban conservation. Rates also need to provide revenue streams that are stable when water sales fall, so that utilities can still cover their fixed costs. Ideally, rate structures should allow per-gallon prices to increase during droughts. Unfortunately, very few of California’s urban utilities had robust drought pricing systems in place last year.<sup>29</sup> Here again, the legislature or the water board could help by setting standards for local compliance.<sup>30</sup>
- **Strengthen water markets.** Australia depended heavily on water markets to reduce the costs of the drought, and made numerous policy changes to enable water markets to function effectively in very dry years. Investments in (sometimes highly controversial) conveyance infrastructure expanded market access.<sup>31</sup> California’s water market has helped both farms and cities cope with droughts, but this market can be strengthened with a more transparent approval process and strategic investments in monitoring and conveyance infrastructure.<sup>32</sup>
- **Continue diversifying urban supplies.** Local agencies should continue to make investments in non-traditional supplies (such as recycled water and stormwater capture projects), interconnections, and storage. Proposition 1 authorizes matching funds for such projects.
- **Manage groundwater.** As this drought has shown, groundwater is California’s most important drought reserve; it is critical to the health of the agricultural economy. Yet decades of overuse—most notably in the southern Central Valley—have depleted many groundwater basins and reduced their value for drought management. The new groundwater law holds great promise for managing future droughts. But the timeline is long, giving basins more than 25 years to attain sustainability. The state could support local efforts to expedite this process through additional legislation (e.g., to facilitate the allocation of pumping rights and trading), technical assistance (particularly in areas without a history of groundwater management), help in organizing local agencies, and funding (including Proposition 1 bond funds).
- **Prevent waste and unreasonable use.** The State Water Resources Control Board should exercise its constitutional authority to ensure that California’s scarce water resources are “put to beneficial use to the fullest extent of which they are capable.” This might include encouraging changes in the timing of water diversions so that they best suit the needs of fish and wildlife – something Sacramento Valley rice growers agreed to this past year on a voluntary basis. Where appropriate, the board could also scrutinize individual users whose diversions harm other water users or the environment, and determine whether local restrictions on water trading constitute unreasonable use during severe droughts.

### **Modernize Environmental Drought Management**

State and federal fish and wildlife agencies—working closely with water managers—undertook great efforts to reduce the environmental harm of this drought. But most efforts were made without advanced planning and without strong scientific input or review. Few investments were made in advance to reduce drought impacts; there has been limited monitoring of the effectiveness of emergency measures; and no strategy has been developed for recovering species when the drought ends. Failure to protect native species during drought can have costly long-term regulatory consequences, with new restrictions that limit future water supply and hydropower.

California needs an aquatic and wetland drought management plan to improve the resilience of the state’s native biodiversity. This plan should set clear objectives for drought management, including priorities when limited water availability forces difficult trade-offs between species (for example, when storing water for late season flows to protect salmon reduces available water for delta smelt). The plan should also identify key river segments and minimum instream flows needed to maintain species of concern, guidelines for carryover

storage in reservoirs to meet environmental needs, and emergency actions (such as captive breeding programs and refuge habitats) to prevent extinction. This plan should be developed by a biodiversity task force made up of independent experts, working closely with agency personnel.

State and federal agencies should then use this plan to guide drought management. Implementation requires both a reliable source of funds and a reliable allocation of water for the environment. Proposition 1 authorizes nearly \$1.5 billion for ecosystem investments, and at least half of the \$2.7 billion authorized for storage projects must also support the environment. The legislature, which will oversee bond expenditures, could insist that agencies adopt an environmental drought plan and prioritize investments that increase the environment's drought resilience. The legislature could also identify a reliable long-term funding mechanism that outlives the current bond.

The Australian state of Victoria benefited greatly from this type of planning tool, which enabled environmental water managers to allocate environmental water where it was most needed during the drought.<sup>33</sup> California should also consider two additional innovations that have proved very useful for managing Australia's environment during the Millennium Drought and beyond. The first is purchase of water rights for the environment, which provides managers with a flexible tool for managing key habitats.<sup>34</sup> The "Environmental Water Holder" is able to trade its annual water allocations to get water where it is most needed, and even use revenues from water leasing for other habitat improvements.<sup>35</sup>

The second innovation is a financial contribution from water authorities. In the state of Victoria, this amounts to 5 percent of revenue from urban water services and 2 percent from rural (irrigation) water services.<sup>36</sup> The receipts are used to promote sustainable water management and address adverse water-related environmental impacts. These funds can help develop critical drought habitat, purchase water during shortages, and recover populations following drought.

## CONCLUSION

Implementing these four solutions—better water use information, clear priority-setting, stronger demand and supply management, and forward-looking environmental drought management—will improve California's ability to weather droughts, a recurring feature of the state's climate. Making these changes will be worth the effort, but it will entail some costs. And like all meaningful reforms, it will require overcoming institutional and political hurdles and objections from those who prefer the status quo. The Australians made these difficult policy changes during their long drought, leaving them better prepared for the next drought. California needs to do the same.

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## NOTES

1. For a list of speakers and event videos, see [www.ppic.org/main/event.asp?i=1623](http://www.ppic.org/main/event.asp?i=1623).
2. See van Dijk, Albert, I., M., et al. 2013. "The Millennium Drought in Southeast Australia (2001–2009): Natural and human causes and implications for water resources, ecosystems, economy and society." *Water Resources Research* 49 (2): 1040–1057.
3. For a summary of drought statistics see the *California Department of Water Resources* (accessed Jan. 22, 2015).
4. See the 2014 National Climate Assessment (accessed Jan. 22, 2015).
5. For hydropower data, see U.S. Energy Information Administration and California Energy Commission (accessed Feb. 12, 2015).
6. Chappelle, C. et al., *Reforming California's Groundwater Management* (PPIC, 2014).
7. For a discussion of land sinking, see Chapter 6 of the California Department of Water Resources November 2014 report "Public Update for Drought Response."
8. By summer 2014, large majorities of Californians said they were following the drought, and by fall more than a quarter of all residents said they thought water was the state's biggest issue—virtually on par with the economy (Baldassare et al., *PPIC Statewide Survey: Californians and Their Government*, September and October 2014). Calls to reduce water use came from Governor Brown, the State Water Resources Control Board, and local water agencies.
9. For a timeline of state drought actions see: <http://ca.gov/drought/> (accessed Jan. 22, 2015).
10. See Hanak, E. "Testimony: Funding to Promote Drought Resilience," March 27, 2014 and Figure 14 in Legislative Analyst's Office "The 2015-16 Budget: Overview of the Governor's Budget."

11. For a map of per-capita water use trends see: [www.ppic.org/main/mapdetail.asp?i=988](http://www.ppic.org/main/mapdetail.asp?i=988). For a general discussion of urban water conservation see: Cahill R, Lund J. 2013. Residential Water Conservation in Australia and California." *Journal of Water Resources Planning and Management* 139 (1): 117-121.
  12. For example see: [www.santacruzsentinel.com/general-news/20140225/santa-cruz-council-declares-water-shortage-emergency-rationing-anticipated-may-1](http://www.santacruzsentinel.com/general-news/20140225/santa-cruz-council-declares-water-shortage-emergency-rationing-anticipated-may-1) and [www.latimes.com/local/lanow/la-me-ln-central-california-residents-wells-go-dry-20140826-story.html](http://www.latimes.com/local/lanow/la-me-ln-central-california-residents-wells-go-dry-20140826-story.html).
  13. See Mount, J. et al., *Water Use in California* (PPIC, 2014).
  14. For shifts in crop type see Figure 3.7 in Hanak, E., et al., *Managing California's Water* (Public Policy Institute of California, 2011). For irrigation efficiency trends see Tindula, G., et al. (2013). "Survey of Irrigation Methods in California in 2010." *Journal of Irrigation Drainage Engineering* Vol. 139 (3): 233–238.
  15. See Hanak, E. et al., *California Water Myths* (PPIC, 2009).
  16. Howitt, R.E. et al. (2014). "Economic Analysis of the 2014 Drought for California Agriculture." Center for Watershed Sciences, University of California, Davis, California. (accessed Jan. 22, 2015).
  17. <https://cdfgnews.wordpress.com/2015/01/26/agencies-taking-measures-to-protect-winter-run-chinook-preparing-to-release-approximately-600000-fish/> (accessed Jan. 29, 2015).
  18. For a summary of activities by the California Department of Fish and Wildlife, see the transcript of a presentation by Director Chuck Bonham to the California Water Commission (accessed Jan. 29, 2015).
  19. See <http://ca.gov/drought/news/story-60.html> (accessed February 1, 2015).
  20. As the experience of East Porterville shows, this did not always happen as quickly as it might have.
  21. See [www.water.ca.gov/groundwater/sgm/index.cfm](http://www.water.ca.gov/groundwater/sgm/index.cfm) (accessed on Jan. 22, 2015).
  22. For a breakdown of funding, see the infographic "Breaking down the water bond" from *Water in the West*, Stanford University (accessed on Jan. 22, 2015).
  23. See the description in the Australian National Water Initiative (accessed on Jan. 22, 2015).
  24. Riparian rights are a special type of senior water right only available for use on properties bordering rivers or streams.
  25. For a summary of the legal issues, see Hanak, E. et al., "Modernizing drought water allocations," October 16, 2014 [californiawaterblog.com](http://californiawaterblog.com).
  26. This process is referred to as a "qualification" of water rights. See [www.depi.vic.gov.au/water/governing-water-resources/water-entitlements-and-trade/qualification-of-rights-to-water](http://www.depi.vic.gov.au/water/governing-water-resources/water-entitlements-and-trade/qualification-of-rights-to-water) (Accessed Jan. 30, 2015).
  27. Mount, J. et al., *Water Use in California* (PPIC, 2014).
  28. Las Vegas and some other southwestern communities have had turf restrictions for more than a decade. See Hanak, E. and M. Browne. "Linking Housing Growth to Water Supply: New Planning Frontiers in the American West." *Journal of the American Planning Association* Vol. 72 (2), 2006.
  29. Only 17 water districts (of over 270 that responded to the survey) had drought pricing in place in July 2014. See the "June/July 2014 Urban Water Supplier Report" from the State Water Resources Control Board.
  30. For a summary of water pricing issues see Hanak et al., *Paying for Water in California* (PPIC, 2014). Some courts have interpreted cost-recovery standards introduced by Proposition 218— a constitutional amendment approved by voters in 1996—in ways that impede conservation-oriented rate structures. Legislative guidance regarding conservation-oriented pricing could help utilities withstand such challenges.
  31. National Water Commission. 2011. *Water markets in Australia: a short history*. See also Crase, L., Pawsey, N. and Cooper, B. (2014). "The Closure of Melbourne's North-South Pipeline: A Case of Hydraulic Autarky." *Economic Papers*, 33(2): 115-122.
  32. For a discussion of trends and challenges in California's water market, see Hanak and Stryjewski E., *California's Water Market, By the Numbers: Update 2012* (PPIC, 2012).
  33. See, for example, the Watering Plan that the Victorian Environmental Water Holder puts out each year (accessed on Jan. 22, 2015).
  34. At the height of the drought, nearly half of all available water in the vast Murray-Darling Basin was traded. This enabled farmers with high-revenue crops to stay in business, such that total farm revenues fell by only 21%, even though water deliveries fell by more than half. See National Water Commission. 2011. *Australian Markets: Trends and Drivers 2007–08 to 2010–11*. National Water Commission, Canberra.
  35. For a description of the Environmental Water Holder in the Australian state of Victoria, see [www.environment.gov.au/water/cewo](http://www.environment.gov.au/water/cewo) (accessed Jan. 22, 2015)
  36. See [www.depi.vic.gov.au/water/governing-water-resources/environmental-contributions](http://www.depi.vic.gov.au/water/governing-water-resources/environmental-contributions) (accessed Jan. 30, 2015).
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## OTHER PUBLICATIONS

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