California WATER COMMISSION

Long-term Drought in California: Overview and Global Context

Introduction

California's Water Resilience (Portfolio) Action 26.3 directs the State to develop strategies to protect communities and fish and wildlife in the event of drought lasting at least six years. A December 14, 2021 letter from the Secretaries for Agriculture, Environmental Protection, and Natural Resources asked the Commission to use its public forum to investigate potential strategies for managing long-term drought while coordinating with State agencies to develop a framework to advance this work without disrupting immediate drought response efforts. The Commission developed a high level workplan outlining its engagement on this topic, and has completed Step 1 of its workplan. This document captures information gathered by Commission staff to date.

During this first phase of work, Commission staff conducted outreach to thought leaders and practitioners about drought preparedness and response and reviewed relevant resources to create an Annotated Bibliography of Drought Resources. Over the course of four months, Commission staff spoke with more than 50 professionals about drought in the American West, including academic, agricultural, community-based organization, state government, environmental non-profit, think tank, Tribal, and water management representatives. Commission staff also spoke with multiple representatives from Australia, Israel, and Chile about how they have confronted prolonged drought.

Overarching Themes

The Commission's initial investigative work on long-term drought yielded several overarching themes. Two guiding themes that came up repeatedly in conversations with diverse parties provide dual tenets for framing drought considerations:

1. Drought crisis can and should be leveraged to take bold action to improve water management.
2. Being able to endure a severe drought is dependent upon making smart, preemptive water management decisions during non-drought years.

These guiding themes capture the opportunity to move forward boldly during drought, and to continue to plan and prepare for drought during non-drought times.

The Commission's interviews and reading also illuminated the following overarching themes.

- California must adapt to the new reality brought about by climate change by managing infrastructure, water rights, reservoirs, watersheds, and groundwater to reflect current and projected changes in hydrology.
- California must advance a portfolio approach to whole systems solutions, acting at a system-scale and taking multiple actions simultaneously, starting with the lowest hanging fruit.
- California must ensure robust measuring, monitoring, and reporting on water availability and use to be able to manage water during times of constrained supply.
- California's water managers and decision-makers must also use data as an irrefutable foundation for engaging people and shifting cultural norms and values, focusing on a holistic, collective, collaborative approach to drought response that breaks down the "us versus them" dichotomy and stresses that we are all in this together.
- California must foment a fundamental understanding of the ecological impacts of drought, and the connections between natural systems, ecosystem services, and societal values to successfully incorporate species and the environment into drought preparedness and response.

California Context

The Commission's work on long-term drought is based on Action 26.3 in the Water Resilience Portfolio, which refers to droughts lasting six years or longer. The duration of a drought, however, is not necessarily related to its severity or impact: in some places in California, drought impacts will be severe after just a year or two; other places may be able to weather a much longer drought. In general, drought is a period of constrained supply when demand for water outstrips its availability and is usually aligned with months or years of minimal precipitation. In parts of California that have invested in water supply reliability, a six-year drought may not be cause for great concern. California's aquatic species, on the other hand, are subject to near-permanent drought conditions because of water management decisions that leave insufficient water for species to thrive.

Currently, California is immersed in a third consecutive year of extreme drought. Governor Newsom issued a statewide drought emergency proclamation in October of 2021. This formal proclamation allows the State to respond to water supply shortfalls where conditions are extremely dry. On-the-ground drought conditions may extend beyond an officially declared drought emergency.

California is a drought-prone state. Tree ring studies indicate that historic droughts may have extended for 20 or more years. While droughts are not directly caused by climate change, climate change worsens droughts: hotter and drier conditions – which *are* caused by climate change – lead to less water availability in non-drought years and to more intense droughts. These modern "hot droughts" are particularly notable for creating conditions that lead to large wildfires. Periods of drought will continue *on top* of shifts in California's hydrologic baseline wrought by climate change: as the climate changes, droughts will change, and drought management, in turn, will need to evolve.

The current drought is the third statewide drought declared in California during this century (2007 through 2009, 2012 through 2016, 2020 to present). A growing body of evidence is starting to show that our current drought situation is an extension of the 2012 through 2016 drought, interrupted by just a few wet years. That said, what California is experiencing now is not the "new normal": wet periods will return, and California will need to be ready for those periods, too.

More recent droughts in California, including the current drought, have given rise to new impacts. The 2012 through 2016 drought saw extreme shortages of cold water for salmon, alarming rates of land subsidence and drinking water shortages in the San Joaquin Valley, in addition to an explosion of wildfires. Programmatic efforts to better manage groundwater and improve the resilience of small water systems in the Central Valley have left the State better positioned to manage the current drought. However, improved lead times, forecasting, monitoring, and enforcement – particularly of water diversions – are still needed; salmon and other aquatic species are still struggling; and certain places – such as the North and Central Coast – remain vulnerable to water shortages.

In modern California history, droughts have been treated as episodic emergencies; decision-makers, practitioners, and the public have been reactive instead of proactive. As illustrated by the two guiding themes noted in the section above, there are two timeframes for considering drought: in advance of (drought preparedness) and during drought (drought response); taken together, "drought management." The main approaches to drought management include demand management, supply management, and planning.

Demand management refers to urban water efficiency (such as installing more efficient appliances and repairing leaks), urban water conservation (such as foregoing water landscaping), agricultural water efficiency (such as installing drip irrigation), and agricultural water conservation (such as fallowing

crops). Demand management strategies are considered low-hanging fruit because they are fast and inexpensive ways to "free up" water during times of constrained supply. Managing the water that is "freed up" is more difficult and raises questions: How can water be stored for future drought use? When should it be drawn on during drought? How can sectors share in that use? Should it be used to protect vulnerable species or communities? Can it be moved to the places where it is needed most? Further, when efficiency measures are implemented outside of drought periods, water demand is hardened, making water use reductions in times of drought a less effective tool. Some interviewees stressed the importance of implementing water efficiency measures outside of drought, noting that California can do more with less by drastically changing the way it grows food, primarily, and improving how it uses water in an urban setting. Others feel that, unless water conservation and efficiency during non-drought times are paired with a mechanism to support vulnerable water users during drought, California will use the extra water to plant more crops or build more houses, failing to prepare itself for future droughts.

Supply management refers to surface water and groundwater storage and management, wastewater reclamation and recycling, stormwater and flood water capture, and brackish water and seawater desalination. Many of these approaches require the use of infrastructure to develop and move water supplies, and generally take much longer and much more money to develop. Built solutions may create additional environmental impacts through habitat conversion, water quality degradation, or by using a water supply – such as wastewater – that is currently a reliable source of water for wildlife. Desalination, in particular, is costly to implement and requires a long timeline, in part because of the controversy it inspires. Proponents of desalination see it as the best way to secure drought-proof water supplies for California. Opponents object to the environmental and community impacts of proposed projects. A surprisingly diverse array of interested parties occupies a middle ground, expressing concern about positioning desalination as a silver bullet, but recognizing that, in some instances and locations, desalination may be a viable approach to secure an area's water supply. In general, interviewees acknowledged the need to pursue other, less costly approaches first, such as demand management, coordinated reservoir management, collaborative management of the State Water Project and Central Valley Water Project, conjunctive groundwater management, and water transfers and markets. The most cost-effective and least impactful solutions to drought challenges will depend on local characteristics. Notably, most new water supply projects – such as water recycling, stormwater capture, and brackish water desalination – are less energy intensive than importing water to Southern California, making Southern California a good candidate for localized water supply investments.

Planning for drought in California takes many forms. The Office of Emergency Services' 2018 California State Hazard Mitigation Plan[1] describes the State's drought vulnerabilities – including agricultural, social, physical, mental, and financial vulnerabilities – and lists other drought-related plans that have been developed by various agencies. In response to the 2007 through 2009 drought, the State drafted a 2010 Drought Contingency Plan that was appended to the 2013 California Water Plan Update[2] and includes a table of drought preparedness and response actions to take before, during, and after drought. During

[1] California Governor's Office of Emergency Services. (2018). *2018 state of California hazard mitigation plan.* https://www.caloes.ca.gov/wp-content/uploads/002-2018-SHMP_FINAL_ENTIRE-PLAN.pdf

[2] California Department of Water Resources. (2014). *California water plan update 2013.* https://water.ca.gov/Programs/California-Water-Plan/Previous-Updates

the previous drought, from 2012 through 2016, the State developed a 2016 Drought Contingency Plan[3] that directed the operations of the State Water Project and Central Valley Project. Following the previous drought, the Department of Water Resources and the California Natural Resources Agency both produced post-mortems that detail the State's myriad drought response efforts, capture lessons learned, and propose needed actions and investments to be ready for the next drought,[4,5] and the State Water Resources Control Board produced a Water Rights Drought Effort Review,[6] which captures recommendations for priorities during a future drought, such as improved communication and relationship-building, clear drought protocols, better water data, and more collaboration between State agencies. Urban and agricultural water districts are required to address drought in their Urban Water Management Plans and Agricultural Water Management Plans, respectively, and counties and small water systems are working to develop Water Shortage Contingency Plans. Many other plans intersect with drought: Groundwater Sustainability Plans, the California Water Plan, the California Climate Change Assessment, the California Climate Adaptation Strategy, and the California Drinking Water Needs Assessment – all of which are updated regularly. What California lacks is a comprehensive, state-level drought plan that contains identified timelines and triggers for specific drought-related actions. California does not have a universally applied, regularly updated plan that governs its drought preparedness and response efforts.

While the impacts of severe and/or prolonged drought will undoubtedly be felt across all sectors of California, small, rural communities and the environment are particularly ill-prepared for drought. Small, rural communities suffer from insecure water systems and wells that go dry or are at increased risk of contamination during drought. Most of the water systems impacted during the last drought were small systems, serving 1,000 connections or fewer, and were concentrated in the San Joaquin Valley, North Coast and Central Coast. Interviewees pointed to several community-related drought needs: increased, expedited, and more flexible funding, capacity, and technical assistance during drought; systemic water resilience support to better prepare for drought; and smart land repurposing to help manage overall demand. Drought is also linked to food and energy insecurity, which impacts communities, can impair commercial fisheries, and interferes with the cultural traditions of California's Tribes.

Lack of water during drought threatens to push fish and wildlife species to the brink. During non-drought years, water for species and the environment is already severely limited compared to historical levels. During periods of drought, water for the environment is even more drastically constrained due to less overall supply, to changing use patterns that leave less run-off or effluent in streams for environmental uses, and to emergency exceptions to regulations that are intended to protect species. Frequently, due to how water is managed both during and outside of drought, species do not have time

[3] California Department of Water Resources & United States Bureau of Reclamation. (2016). *Central Valley Project and State Water Project 2016 drought contingency plan for water project operations: February - November 2016.* https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/plans/2016dcpfebnov.pdf

[4] California Department of Water Resources. (2021). *California's drought of 2012-2016: An overview.* https://water.ca.gov/-/media/DWR-Website/Web-Pages/Water-Basics/Drought/Files/Publications-And-Reports/033021_2012-16-Drought-Report_v4_ay11.pdf

[5] California Natural Resources Agency. (2021). *Report to the legislature on the 2012–2016 drought: As required by chapter 340 of 2016.* https://water.ca.gov/-/media/DWR-Website/Web-Pages/Water-Basics/Drought/Files/Publications-And-Reports/CNRA-Drought-Report-final-March-2021.pdf

[6] California State Water Resources Control Board. (2021). *Water rights drought effort review.* https://www.waterboards.ca.gov/board_info/agendas/2021/feb/warder_projectrpt_v2_508drft_210205.pdf

to recover between droughts. This can lead to species transformations, caused when communities of species die out, triggering new and different species to fill their ecological niche (e.g., forested habitat transitioning to scrub habitat or native fisheries transitioning to invasives-dominated fisheries). Species transformations can have cascading, detrimental impacts on native species and on ecological function. Thinking about ecosystem-based water management opens the door to managing water during dry, normal, and wet times in a flexible, adaptive manner that focuses on whole systems instead of single species. Looking to "biological strongholds" – places where natural systems are still mostly intact – may help focus drought planning and response efforts to benefit species. Interviewees indicated that species need places of refuge during drought and time to recover from drought; that water management for ecosystem purposes and protection of biological strongholds will serve species well both during and outside of drought; and that forest management is critical to protecting habitat for species while offering many other benefits to people and the environment.

While drought is not solely to blame for wildfire, it exacerbates wildfire – particularly prolonged drought – by causing dry, fire-prone conditions and tree mortality due to lack of water and insect infestations. The resulting impacts on humans and wildlife are multiple: fire impacts water quality, air quality, habitat integrity, forest economies, and recreational access. Costs from wildfires and their public health impacts could become the largest economic and public health impact of drought, enduring long after drought ends. It is impossible to protect all of California's forested landscape from wildfire, but thoughtful forest management shows promise in offsetting the worst of California's growing wildfire problem, providing near-term climate and water benefits, and it may be the best rallying cry to spur investment in and collaborative management of the State's wildlands. Forest management will require a huge commitment to targeted treatment of critical areas and ongoing maintenance of those areas. Some California Tribes are engaged in selective burning and tree removal, practices that restore mountain meadows – which are important water sinks, improve soils, augment plant vitality, create habitat for diverse insect and animal species, and improve access to traditional food sources. Tribes apply traditional ecological knowledge to forest management that is not just about managing resources, but rather about restoring the health of the whole forest.

International Context

There is no template approach to long-term drought management, but California can draw on lessons learned from other countries when responding to long-term drought. Conversations with international decision-makers and experts from Israel, Australia, and Chile provided insight into the ways that other countries have reacted to extended drought conditions through both supply and demand management efforts. While some strategies are more applicable to California, they all reveal how a portfolio approach is necessary to addressing drought impacts. They also build on the theme voiced by California thought leaders: drought crisis can be a catalyst for spurring meaningful and lasting change.

<u>Israel</u>

Israel is an arid country, naturally water-constrained with limited access to freshwater, that suffers from periodic drought. Israel's proactive water management has secured its water supplies in the face of significant population growth, allowing the country to weather droughts of varying lengths. Israel has made gradual shifts in both demand and supply management that have provided its water security over time, while at the same time utilizing crisis moments to make less palatable changes in water management, such as charging all consumers the full cost of water. One key component of Israel's streamlined water management is the fact that all water is controlled and managed by the Israeli Water Authority, whose board is comprised of high-ranking officials from relevant government ministries plus

two public representatives, for the benefit of all sectors and people. This allows for integrated decision-making across water production, storage, conveyance, supplies and pricing, as well as wastewater treatment and reuse.

Recognizing the natural water limitations within the country, Israel has long emphasized the value of water, embedding this priority in its national culture, and promoting water awareness in all its constituencies. The country's strong public education campaign includes water curriculum in schools, which has ushered in major changes in water use attitudes and behaviors. Through a sustained public engagement effort, Israel has gained the confidence of the people being served by the water system. Special efforts were devoted to gaining the confidence and strong participation of the agricultural sector in use of treated sewage effluents in return for reduction of freshwater use. Recognition of limited water has opened the door to acceptance of wastewater reclamation and reuse in agriculture, which is now standard. Water metering in both the urban and agricultural sectors, which has been conducted in Israel since the 1950s, has also been key to water management in Israel. All domestic water users have access to unlimited, clean water, and all pay the same, fully burdened rate for water, covering the next increment of water management in the country. Israel's emphasis on the value of water has engendered national reverence for the resource.

Building on this cultural recognition of the value of water, Israel has invested in water monitoring to better understand its natural water sources and how water is being used – or lost – within the country. With the backing of sound data, Israeli officials can identify water waste caused by leaks and inefficiencies. As a primary step to securing its water supplies, Israel began to implement water efficiency measures in both the urban and agricultural sector. In the agricultural sector, the government promoted investments in innovative technologies to spur water efficiency and encouraged farmers to partner with water technology start-ups to further push the limits of innovation. This led to widespread adoption of drip irrigation and water-wise crop selection and breeding. In the urban sector, Israel saw a drop of close to 50% per capita domestic consumption in the 1990s. Israel also relies on market signals to help curtail urban water use: water users are charged the full cost of the water, including costs to construct and operate all infrastructure, and to collect and treat wastewater. Water supply and wastewater treatment and reuse are both part of water management.

Israel has been at the forefront of water recycling and desalination, which the country embraced to further enhance water security on top of its demand management practices. Over 80% percent of wastewater in Israel is reclaimed and reused for agriculture. The water conveyance system includes a separate system for moving adequate-quality recycled water to agricultural regions.

Since the 1990s, Israel has advanced desalination as an integral component of its water supply system. Currently, the country has five operating desalination plants with more under construction, all constructed by the private sector under build-operate-transfer contracts with the government. Israel uses its National Water Carrier, an integrated water conveyance system constructed in the 1950s and 1960s, to bring water from the north to the drier central and southern parts of the country. The National Water Carrier conveys water from the Sea of Galilee, the country's largest natural source of freshwater, and integrates local groundwater supplies and the water produced in its desalination plants along its way. In recent years, the north has been short of water; Israel has reversed parts of its north-to-south water conveyance system and has launched a plan to use desalinated water to augment the Sea of Galilee and manage its operation as a water source and ecological amenity.

Israel has prioritized food security and ensures that clean water is affordable and accessible for all. System security and safety are paramount, to ensure continuous supplies in the face of hydrological

variability and potential physical and cyber-attacks. Supporting the water needs of its neighbors is of high moral and political importance. Historically, Israel has neglected the flows and ecology of its rivers and streams; recent efforts have elevated environmental protection to address the health of rivers and watersheds in a holistic manner.

Australia

As a significantly larger country, over three hundred times the size of Israel, and with a decentralized government, Australia takes a more regionalized approach to water management. Australia's Millennium Drought started with low rainfall in 1996 and 1997, was at its worst in 2006 and 2007, ten years into the drought, and lasted through the end of the decade. The duration and magnitude of the drought was much worse than urban areas had planned for and lead to curtailment of water rights in many areas. Curtailments were used as a stopgap while other measures were enacted: demand management in urban areas, and development of alternative water supply through water recycling and reuse and construction of desalination plants. New conveyance pipelines also facilitated water transfers between catchments, complementing Australia's robust water market. For its investments in water supply infrastructure, Australia used "real options planning," identifying triggering conditions for moving forward with an investment that could be curtailed if conditions changed.

The Millennium Drought was most severe in Southern Australia, particularly in the Murray-Darling Basin, Australia's primary agricultural region. For over a decade, the Murray-Darling Basin faced serious environmental decline through low flows, decreased hydrologic connectivity, and degraded aquatic habitat. These ecological impacts caused Australia to overhaul its water governance in the Murray-Darling Basin. In response to the Millennium Drought, Australia passed Water Act 2007, establishing an independent entity, the Murray-Darling Basin Authority (MDBA), and tasking it with basin-wide planning and decision-making in the interest of the basin as a whole. The MDBA prepared a basin plan, completed in 2012, whose primary objective is to set the amount of water that can be taken from the basin each year, leaving enough in-basin to support functioning ecosystems. The plan aims to sustainably manage the Murray-Darling Basin's water resources while supporting farming and other industries. Management of the basin is done collaboratively, involving the national and state governments, as well as relevant industries and communities. Water is managed adaptively, allowing for the flexibility to respond to a dynamic system. To incorporate new information and adapt to a changing climate, the basin plan is reviewed and revised every 10 years.

Coming out of the Millennium Drought, entities tasked with managing the Murray-Darling Basin prioritized securing environmental water entitlements to maintain ecological integrity. The basin plan sets "water recovery" targets – the portion of surface water and groundwater entitlements that "should be recovered and retained in the system, to improve the health of rivers, wetlands and groundwater systems".[7] Building on existing entitlements, the national government and state governments have developed efficiency projects and applied the water savings to the environment, while also purchasing water on the water market from willing sellers. Though there are social programs in place to support communities, some claim that the government's purchase of water has undermined local agricultural economies. However, holding the environment as an equal user of water has improved drought and broader climate change resilience for the region.

Australia engages in multi-scale water planning at the state and regional level, empowered by national policy objectives. Water supply and allocation planning and environmental water planning are done at

[7] Murray-Darling Basin Authority. (2022). *Progress on water recovery.* https://www.mdba.gov.au/progress-water-recovery

different intervals and integrated to guide timely decision-making based on measured water conditions. Planning prior to drought conditions has helped improve drought resilience of native species and reduced conflicts. For instance, post-drought, water use is gradually ramped up to avoid a boom in water demand immediately following drought. A scaled planning approach was supplemented by a concerted public outreach effort which included multi-modal approaches to promotion, education, and communication that built public support and awareness around water savings, drought response, water storage, and planned supply. To augment public understanding and spur behavior change, the government created clear triggers for public water use restrictions based on drought impacts rather than precipitation levels. Drought emergency mobilized collaboration because of the severity of the situation. Strong partnerships and planning at multiple spatial scales have proven vital to an integrated water management approach.

Chile

The country of Chile has many geographic similarities with California: a long coastline, a central valley that serves as a prime agricultural region, and mountain ranges running the length of the state and bordering either side of the valley. In Chile, however, major rivers run from the mountains to the coast, crossing their central valley rather than running the length of it, as California's Sacramento and San Joaquin rivers do. Without natural or manmade north-south water conveyance, opportunities for easily moving water across the country are limited.

Currently in a 13-year megadrought, Chile is facing major water security challenges and uncertainties. Their existing institutional framework involves a privatized water market and rising social concerns over equity in the face of water scarcity. Although water is a public good, it is managed by private utilities, which are seen as exploitative. This is especially the case in rural areas of Chile, which lack water for domestic use. A recent water law, passed in 2022, prioritized water distribution for human consumption and ecological purposes, and required and enabled basin level management. However, the implementation of the new water law is yet to be determined. A recently proposed constitutional reform sought to modernize water governance and declare water as an inalienable human right. The Chilean people's rejection of the new constitution raises many questions for how Chile will continue to adapt and respond to the ongoing challenges and uncertainties posed by drought.

Conclusion

Drought in California is a given: it is part of California's past and present and, due to climate change, will only grow more intense in the future. A drought crisis can be used to promote needed changes in water management, but drought must also be a consideration during non-drought years, when it will be important to plan and prepare for the next event. The international examples above demonstrate the unique, context-specific challenges of water scarcity, which are dependent on physical constraints, political frameworks, and cultural attitudes and behaviors towards water. California is no different.

To weather long-term drought, California must continue to take steps to shore up water supply for small, rural communities and to maintain ecosystem function that ensures the survival of vulnerable fish and wildlife species. When protecting communities and species from the impacts of long-term drought, California will have to do many things, but will not be able to do them all at once: policymakers and water leaders will need to prioritize the most efficient actions with the biggest return on investment while using farsighted incrementalism to address difficult problems through a series of small, forward-thinking actions. While drought is a lived experience and a massive stressor on the human psyche, drought leadership will need to be clear-headed and strategic.