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California Water Myths

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CALIFORNIA DEPARTMENT OF WATER RESOURCES

SUMMARY

California has a complex, highly interconnected, and decentralized water system. Although local operations draw on considerable expertise and analysis, broad public policy and planning discussions about water often involve a variety of misperceptions—or myths—about how the system works and the options available for improving its performance.

The prevalence of myth and folklore makes for lively rhetoric but hinders the development of effective policy and raises environmental and economic costs. Moving beyond myth toward a water policy based on facts and science is essential if California is to meet the multiple, sometimes competing, goals for sustainable management in the 21st century: satisfying agricultural, environmental, and urban demands for water supply and quality and ensuring adequate protection from floods.

We focus on eight common water myths, involving water supply, ecosystems, and the legal and political aspects of governing California's water system. These are not the only California water myths, but they are ones we find to be particularly distracting and disruptive to public policy discussions.

Often, myths serve the rhetorical purposes of particular stakeholders. And they persist because our public policy debates are not sufficiently grounded in solid technical and scientific information about how we use and manage water. In combating these myths, we hope to set the stage for a more rational and informed approach to water policy and management in the state.

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This report seeks to rebuild public policy discussions on myth-free foundations. Improving the collection, analysis, synthesis, and use of accurate information about the state's water system is also necessary to encouraging fact-based policies.

Of course, information alone will not dispel California's water myths. But better information can fashion more effective responses to California's many ongoing and future water challenges. In the months and years ahead, policymakers and voters will be involved in crucial decisions regarding one of California's most precious and controversial resources. Let's be sure those decisions are based on reality, not myth.

Myth	Reality
1. California is running out of water.	California has run out of abundant water and will need to adapt to increasing water scarcity.
2. [Insert villain here] is responsible for California's water problems.	There is no true villain in California water policy, but opportunities exist for all sectors to better use and manage water.
3. We can build our way out of California's water problems.	New infrastructure can contribute to California's water supply solutions, but it is not a cure-all.
4. We can conserve our way out of California's water problems.	Water conservation is important, but its effectiveness is often overstated.
5. Healthy aquatic ecosystems conflict with a healthy economy.	Healthy ecosystems provide significant value to the California economy, and many opportunities exist for mutually beneficial water management.
6. More water will lead to healthy fish populations.	Fish need more than water to thrive.
7. California's water rights laws impede reform and sustainable management.	The legal tools for reform are already present in California's water rights laws; we just need to start using them.
8. We can find a consensus that will keep all parties happy.	Tough tradeoffs mean that consensus is not achievable on all water issues; higher levels of government will need to assert leadership.

Please visit the report's publication page
http://www.ppic.org/main/publication.asp?i=890
to find related resources.

Introduction

California is once again in the throes of intense debates about how to manage one of its most important natural resources, water. Several years of dry weather have depleted reservoirs and groundwater basins. New environmental restrictions on shipping water through the fragile Sacramento–San Joaquin Delta have intensified water supply concerns in cities and farming regions that rely on these shipments, and proposals to bypass the Delta with a peripheral canal have many worried about the consequences of enacting them.

These may be the most visible and vocal issues of the moment, but a virtual tour around the state reveals significant water management concerns at every turn. To the west, cities and farms in the Russian River watershed have been ordered to reduce their water use to help restore flows for steelhead trout. To the south, some Imperial Valley residents are still smarting over requirements to fallow some irrigated acreage as part of a long-term transfer of Colorado River water to San Diego. To the east, the success of a hard-won deal to restore salmon on the San Joaquin River depends on continued cooperation among fractious stakeholder groups and improvements in conditions further downstream. To the north, water allocations for salmon are a recurring source of conflict on the Klamath River.

Some summary statistics highlight why the environmental conditions of California's water resources have become a major management concern in recent decades. Twenty-two percent of the state's 122 remaining native fish species are already listed as threatened or endangered under the state and federal Endangered Species Acts, and another 45 percent are imperiled or qualified for listing.[1] More than 90 percent of California's lakes, rivers, and streams are listed as "impaired," meaning that they cannot be used for one or more of their intended uses—e.g., drinking, irrigation, fishing, swimming (U.S. Environmental Protection Agency, 2004).

The challenges and conflicts of water management are likely to intensify as population growth and climate change increase pressure on California's resources. The state is projected to gain roughly half a million residents a year over the coming decades (Department of Finance, 2007), and warming temperatures and accelerating sea level rise will make it increasingly difficult to satisfy agricultural, urban, and environmental water demands and to ensure adequate protection from floods (Cayan et al., 2009).

Policy decisions will be most effective in addressing water management goals if they are based on an accurate understanding of the state's water problems and potential solutions. Unfortunately, there is a shortage of systematic technical knowledge and coordinated research capability to support and advance policy discussions and decisions.

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This information deficit stems in part from the highly decentralized nature of water management. More than a thousand local and regional water agencies are responsible for water delivery, wastewater treatment, and flood control, alongside many state and federal agencies. Decentralized management has facilitated considerable innovation and responsiveness to local problems, but it has also fragmented much of the detailed knowledge and strategic perspectives on California's vast water system. And the state, with few resources and many competing pressures, requires little reporting of information from the field and devotes few resources to technical decision support and synthesis, monitoring of water use, or enforcement of water rights.

As a result, misperceptions—or myths—about California's water problems and solutions abound among the public, policymakers, and even many water professionals. These myths—which often support particular stakeholder interests—make public policy discussions, legislative debates, and water management decisions less productive and useful than they need to be if California's water system is to respond effectively to mounting challenges.

This report explores eight prominent myths about California water supply, ecosystem management, and legal and policy processes for water governance. (See the text box below for links to some additional myths.) We bring together perspectives from ecology, economics, engineering, law, and the physical sciences to examine the origins of these myths, how they influence policy, and where they fall short in their assessment of water problems and solutions. For each myth, we then suggest a replacement that would better guide policy. A concluding section summarizes key elements of a myth-free policy platform for California and highlights actions to strengthen the information and analysis needed for sound policy decisions.

Additional water myths

A related article (Hanak et al., 2009), available at **http://www.ppic.org/main/publication.asp?i=918**, expands on this report and discusses several additional water myths and realities:

Myth: Water markets can solve California's water problems.
Reality: Water markets work best in a coordinated portfolio of water management activities.

Myth: Restoring native ecosystems is essential for native species recovery.
Reality: We must find ways to restore native species within altered ecosystems.

Myth: Current flood protection standards keep communities safe.
Reality: Current standards increase flood risk in many locations.

Myth: Groundwater is separate from surface water.
Reality: Despite some legal distinctions, California's groundwater and surface water are often closely interconnected and sometimes managed jointly.

Myth 1: California Is Running Out of Water

The Myth

The popular press often propagates the myth that California is running out of water. As a recent example: "Have you seen Lake Oroville lately? If so, you know California is running out of water" (Speer, 2008). This myth stems from rigid notions that there is no flexibility in water management and that the economy will grind to a halt if shortages occur. It persists despite ample historical evidence and numerous economic and technical studies showing that Californians can adapt successfully (albeit at some cost and inconvenience) to living in an arid region with variable and changing water conditions. By implying that Californians cannot adapt, the "running out of water" myth discourages efforts to manage water resources more efficiently.

How the Myth Drives Debate

The notion that California is running out of water is effective in raising alarm about serious water problems but encourages a simplistic and sometimes counterproductive attitude toward solving them. If we are "running out of water," we have to "get more." The assumption underlying this myth is that California's water use and management are more or less fixed. So new water demands from population growth can be addressed only by developing additional supplies, whatever the cost. This view assumes that California's water users have little ability to stretch existing supplies through improvements in operations, gains in water use efficiency, or reallocation across sectors.

The Reality

There is a kernel of truth in this myth: California's available water supplies are limited. Most of California's river flows have already been allocated (sometimes several times over), and groundwater resources have been overdrawn in many places.[2] Water users often experience shortages relative to these allocations and to past use, as a result of drought and environmental protection measures. With climate change, shortages could increase, as warming temperatures reduce water supplies currently stored in the Sierra Nevada snowpack (Cayan et al., 2009).

But it is not true that California is "running out of water." Given California's Mediterranean-type climate, with variable rainfall and a dry growing season, water has always been scarce, and adaptation has always been an important feature of water use (Hundley, 2001).

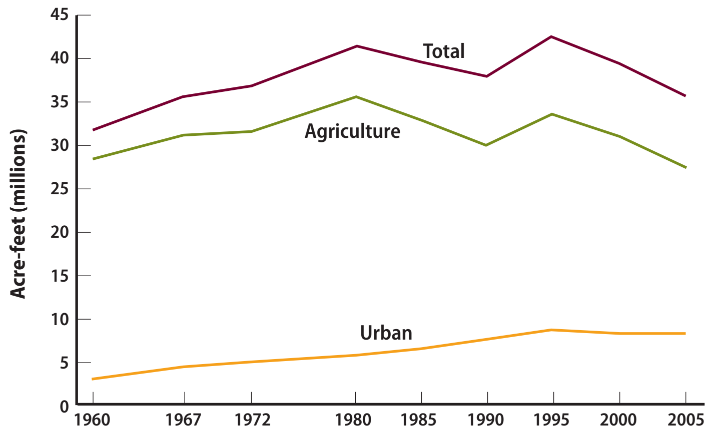
In recent decades, increasing water use efficiency has helped California adapt to population growth and higher allocations of water for the environment. Agriculture and related activities account for a large but declining share of non-environmental water use—77 percent in 2005, down from 90 percent in 1960 (Figure 1). A driving force in improving the economic efficiency of irrigation is the steady increase in crop yields per acre. Over the last four decades, California's crop yields have increased at an average rate of 1.42 percent per year (Brunke, Howitt, and Sumner, 2005). As farmers have shifted to higher value horticultural and orchard crops, they have adopted more efficient irrigation technologies.[3] These yield increases and shifts to higher value crops have greatly increased the real dollar value per acre-foot of irrigation water.[4]

Urban dwellers also have been adapting. Following several decades of increases in per capita use spurred by rising incomes and increased home and lot sizes, many urban water agencies began implementing conservation programs during the early 1990s drought. The result has been per capita declines in both coastal and inland regions of California (see Figure 2, which shows inland California's water use with and without the low-desert Colorado River region, where per capita use is particularly high). Further use reductions are being spurred by the recent drought and new environmental restrictions on pumping water to users south and west of the Delta.

Water managers also have improved the management of developed water supplies, which has enhanced water supply reliability and flexibility. Tools include banking excess surface water from wet years in groundwater basins for use in dry years ("conjunctive use"), treating waste-water and stormwater for reuse, and the marketing and trading of water, all of which have expanded greatly since the 1990s.[5]

Various studies suggest considerable scope for future adaptations to scarcity, including further gains in water use efficiency, changing operating schedules for water stored and released from reservoirs (reservoir "reoperation"),

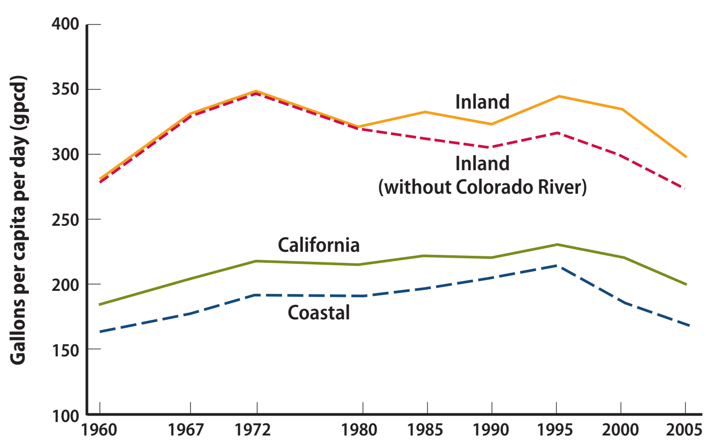
Figure 1. Total water use is now decreasing



SOURCE: Authors' calculations using data from *California Water Plan Updates* (Department of Water Resources, various years).

NOTES: Data for 2005 are provisional. The figure shows applied water use (for a definition, see Myth 4). "Urban" includes residential and non-agricultural business uses. Pre-2000 estimates are adjusted to levels that would have been used in a year of normal rainfall. Estimates for 2000 and 2005 are for actual use; both years had near-normal precipitation. Estimates omit conveyance losses (6% to 9% of the total).

Figure 2. Per capita urban water use is now declining



SOURCE: Authors' calculations using Department of Water Resources (DWR) data (2005 numbers are provisional).

NOTES: The figure shows applied water use (for a definition, see Myth 4). Outdoor water use is much higher in inland areas because of hotter temperatures and larger lot sizes (Hanak and Davis, 2006). The low-desert Colorado River region, including areas such as Palm Springs, has especially high per capita use from golf-based tourism.

improvements in conjunctive use and recycling, and some additional reallocation across sectors through water marketing (Department of Water Resources, 2009a; Jenkins et al., 2004; Tanaka et al., 2006; Zilberman et al., 1993).[6] Although climate change may significantly reduce water availability and growth in farm revenues, California agriculture appears able to adapt without declines in revenues from today's levels, thanks to projected improvements in irrigation and crop production technology and growth in demand for higher value crops.[7]

In short, California will run out of water only if its water sector does not muster the incentives, technology, and political capacity to adapt to changing demands and preferences for water use—as it has in the past.

Replacing the Myth

California is not running out of water, but the state will face increasing water scarcity. It is often said that there is not a shortage of water, only a shortage of cheap water.

Institutions and technologies must continue to change to meet future demand. Public education can help Californians realize that they reside in an arid region. With continued attention and adaptation, California will have sufficient water resources to sustain prosperous social and economic development into the indefinite future.

Myth 2: [Insert Villain Here] Is Responsible for California's Water Problems

The Myth

California's water system would work well if it were not for _________ [fill in the blank].

One of the most common myths about California water is that some villain or other is preventing the state from meeting its water demands and that eliminating or reforming that villain would solve California's water problems. Call it the "*Chinatown* Myth," in honor of that movie's villain, Noah Cross, who created artificial water shortages by stealing water from right under people's noses. A good villain is always rhetorically useful and makes problems seem easier to solve.

It is often said that there is not a shortage of water, only a shortage of cheap water.

Everyone in California has a favorite real-world water villain. Common favorites are: (1) wasteful Southern California homeowners, (2) farmers who receive federally subsidized water, and (3) the state and federal Endangered Species Acts. The danger with this myth is that it can lead to inaction. Everyone points a finger at someone else, rather than recognizing that we all need to change our water ways.

Villain 1: Wasteful Homeowners in Southern California

The favorite villains of many Northern Californians are the profligate homeowners of Southern California who use water to grow luscious lawns, fill and refill their swimming pools, and remove leaves from their driveways. According to this myth, water misuse is common in the Southland, where people forget that they are living in a former desert and import vast amounts of water, including water from Northern California.

How the Myth Drives Debate

If Southern California homeowners are the problem, state policy should focus on limiting their water use. Imported water is almost always diverted from alternative environmental or local water uses, and there is no reason to incur those costs if the water is not truly needed.

The Reality

The myth of Southern Californians as water villains is based on misperceptions of actual water use practices across the state.

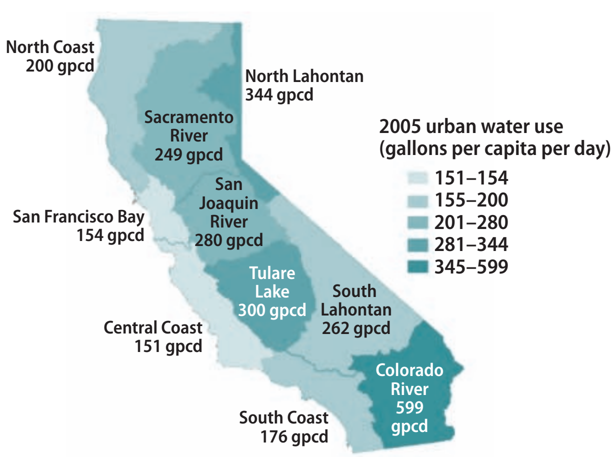
Average water use per person in the South Coast—where the majority of Southern Californians live—is, in fact, among the lowest in California (Figure 3). This stems partly from a cooler climate and denser land use than in inland areas. Statewide, outdoor water use averages over 40 percent of residential water use and increases with hotter climates, larger lot sizes, and a greater proportion of single-family homes. The Southern California coast has the highest percentage of multifamily homes in the state, and its home lots tend to be smaller (Hanak and Davis, 2006).

Moreover, South Coast water agencies have been among the most aggressive in reducing per capita water use. An effective way to reduce water use is to charge higher rates—known as "increasing block rates"—for greater quantities consumed. In 2003, almost two-thirds of the population of California's South Coast paid increasing block rates. Only half of all Californians paid such rates, including a mere 13 percent of San Joaquin Valley residents (Hanak, 2005).

South Coast water utilities also provide significant incentives for conservation. For instance, the Metropolitan Water District of Southern California has spent more than $185 million over the last decade encouraging adoption of water efficient appliances, drought resistant landscaping, and other conservation practices. Shifts out of manufacturing in the early 1990s also reduced per capita urban use. Overall, the South Coast used nearly 450,000 acre-feet less water in 2005 than a decade earlier, despite having 2.4 million additional residents.[8] The region also leads in reclaimed water use.

It might be tempting to simply change the villain in California water policy from pool-loving residents of the South Coast to urban and suburban residents of Sacramento, the San Joaquin Valley, and other inland areas. But the urban sector as a whole accounts for just over 20 percent of water use in California, and utilities in virtually every region are working to reduce per capita use.[9] Making one region into a villain oversimplifies the complex water demands in California and suggests that water conservation is a bigger issue in one region or one sector than in the state as a whole.

Figure 3. South Coast urban water use is among the lowest in the state



SOURCE: Department of Water Resources (provisional data).

NOTES: The figure shows 2005 applied water use (for a definition, see Myth 4). The high per capita use in the Colorado River region is partly from golf-based tourism.

Villain 2: Subsidized Agriculture

The chief villains for many urban water users and environmental advocates are the recipients of federally subsidized irrigation water. The largest federal reclamation project in the United States is the Central Valley Project (CVP), which supplies water to thousands of Central Valley farms—as well as to some urban water users (Sax et al., 2006). The estimated yearly subsidy to farmers receiving CVP water, relative to the full-cost rate, is roughly $60 million (Environmental Working Group, 2004).

In the minds of California's urban water users and environmental reformers, subsidized rates paid by farmers in the CVP are unjustified and unfair. Critics claim that these subsidies have undermined irrigators' incentive to conserve and encouraged them to grow lower value crops such as wheat, grain, cotton, and rice, which critics believe should be grown elsewhere.[10]

How the Myth Drives Debate

If federal reclamation subsidies are unfair and undermine agricultural conservation, the most obvious solution is to eliminate them. And Congress did increase CVP prices to farmers under both the Reclamation Reform Act of 1982 (96 Stat. 1261) and the Central Valley Project Improvement Act (CVPIA) of 1992 (106 Stat. 4600, 4706). As a result of these laws, prices for federal agricultural water are likely to increase by more than 65 percent from 2000 to 2030. But in the meantime, CVP farmers continue to receive a significant subsidy. Many argue that it would be fairer and more efficient to speed up this process by eliminating the subsidy entirely.

The Reality

The view of subsidized farmers as water villains is based on misunderstandings of the role these subsidies play in today's farm economy.

First, the claims of unfairness are unjustified, because most of today's farmers have already paid for the subsidy through higher land prices; land eligible for subsidized water is more expensive (Huffaker and Gardner, 1986).[11] Although the windfall for original landowners might have been unfair, current owners are receiving what the U.S. government led them to expect they would receive when they purchased this land.[12]

Second, eliminating water subsidies is not the only way to encourage farmers to conserve water. As noted above, the economic efficiency of agricultural water use in California has increased steadily. Since the early 1990s, water scarcity has driven efficiency improvements among CVP farmers south of the Delta, as they seek to adjust to shortages from drought and regulatory changes.[13] Water markets also are encouraging more efficient use. Farmers who can earn more by selling water than using it themselves have an incentive to do so, even if they pay little for the water.[14] Since the early 1990s, active farm-to-farm markets have moved water to water-short areas with higher value output (Hanak, 2003).

In sum, continued scarcity, along with higher water prices and other market forces, is likely to further encourage both conservation and conversion of land to less water intensive crops and an overall decline in agricultural water use (Department of Water Resources, 2005).

Villain 3: The Endangered Species Acts

To many water users and commentators, the true villains are the federal and state Endangered Species Acts (ESA) (*Wall Street Journal*, 2009). In this view, environmentalists use these laws to force unreasonable reductions in agriculture and urban water deliveries to protect a few species of worthless bait fish. As some critics have put it, the problem plaguing California's water system is not a natural drought but a "regulatory drought" from environmental flow restrictions. Since 2008, this myth seems to have gained validity, as water exports have been reduced following a federal judge's ruling that state and federal water managers were not adequately considering the needs of fish species in the Delta.[15]

How the Myth Drives Debate

This myth has led some water users to call for reducing legal protections for native species. The federal Endangered Species Act of 1973 is one of the world's strongest environmental laws. Congress concluded that species are of inestimable value and prohibited the "taking" of endangered species, regardless of the costs. Only the Endangered Species Committee, a federal cabinet-level group sometimes referred to as the "God Squad," can grant an exemption to the act's proscriptions—an action taken only twice to date. Some California water users now demand either that the committee be convened to allow more water to be exported from the Delta or that Congress amend the act.

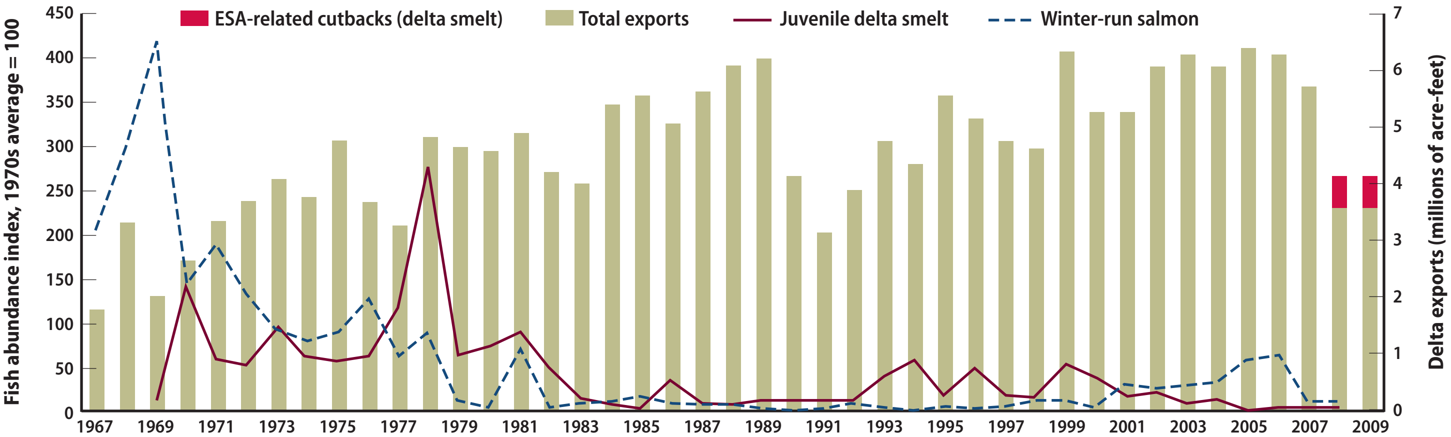
The Reality

It is true that recent Endangered Species Act restrictions have reduced water supplies available for some water users.

However, the effects are often overstated. Recent delta smelt restrictions follow a time of high sustained water exports and coincide with an ongoing drought—in all, these restrictions account for 15–20 percent of the recent declines in exports (Figure 4). Over the longer term, delta smelt restrictions are likely to reduce Delta exports by 20 to 30 percent on average (Department of Water Resources, 2008a, 2009b; Carlton, 2009) unless the smelt respond to large scale habitat improvements.

Moreover, many other federal and state laws designed to protect public health and the environment also restrict water withdrawals from California's rivers and streams.[16] High withdrawals threaten not only fish species but also various

Figure 4. Environmental restrictions account for 15–20 percent of recent Delta cutbacks



SOURCES: Authors' calculations using Department of Water Resources data on exports (DAYFLOW and CDEC) and Department of Fish and Game fish survey data.

NOTES: ESA-related cutbacks are estimated at roughly 0.5 million acre-feet in 2008 and 2009, based on Department of Water Resources (2008a, 2008b). The winter-run Chinook salmon has been listed under the federal ESA since 1989, and the delta smelt since 1993.

water quality and recreational uses. Simply removing the Endangered Species Act restrictions on water diversions would be unlikely to provide much additional water for non-environmental uses, especially in the long run.

The Endangered Species Acts and other environmental laws reflect public concern over the serious effects of human actions on the natural environment and the costs of those actions to all California residents.

Replacing the Myth

There are no true villains in California water policy. Responsibility for water problems must be shared by all water users; the problems fundamentally result from having a vibrant economy and society in an arid climate. Although rhetorically convenient, attempts to vilify one group of water users for California's diverse water problems are factually incorrect and get in the way of more productive policy discussions.

Despite inevitable water scarcity, both urban and agricultural water users throughout the state have considerable opportunities to use and manage water more efficiently (see Myth 1). It is also possible to manage water for the environment more effectively by taking habitat and the quality and timing of flows into account (Myth 6).

Myth 3: We Can Build Our Way Out of California's Water Problems

The Myth

We would solve California's water problems if we only built more __________ [fill in the blank].

All too often, California's water management challenges are attributed to a lack of infrastructure, be it (1) new surface storage, (2) a peripheral canal to convey water around the Delta, or (3) desalination plants. The myth that we can build our way out of water scarcity tends to appeal to politicians and the general public because of its simplicity; it is often promoted by special interest groups that stand to gain from a particular investment, especially if someone else will pay for it. The danger of focusing on technological silver bullets is that it deflects attention from potentially more effective and less costly alternatives (such as water markets, underground storage, and conservation), from the benefits of coordinating many water management options, and from actions required to improve environmental conditions.

Solution 1: New Surface Storage

Calls for new surface storage frequently accompany the "running out of water" myth (Myth 1). Advocates often note that California's population has nearly doubled since the state built the last major on-stream reservoir in the early 1980s and argue that new surface storage is needed to supply this growth and replace losses of Sierra Nevada snowpack storage predicted with global warming.

How the Myth Drives Debate

This myth assumes that water supply is linked directly to surface water storage capacity. Proponents often advocate large public subsidies for this additional storage and insist on delaying other policy changes until substantial funds are committed for surface storage expansion.

The Reality

Surface storage does afford California's water system great flexibility, making it possible to carry water over to the dry season and to smooth out year-to-year variations in precipitation. Surface storage operations can be especially effective in coordination with other water management actions, such as groundwater storage, water conservation, and water markets. Reoperation of existing surface water storage will play an essential role in improving California's water system and adapting it to changes in climate and water demands (Medellin-Azuara et al., 2008; Carpenter and Georgakakos, 2001; Fissekis, 2008).

However, the idea that surface storage is a silver bullet for the state's water problems is a myth founded on the erroneous notion that large, unregulated amounts of water are available to fill new storage at a reasonable cost. It persists because most people do not recognize the technical limitations and because a few local interests stand to gain from state subsidies for new facilities.

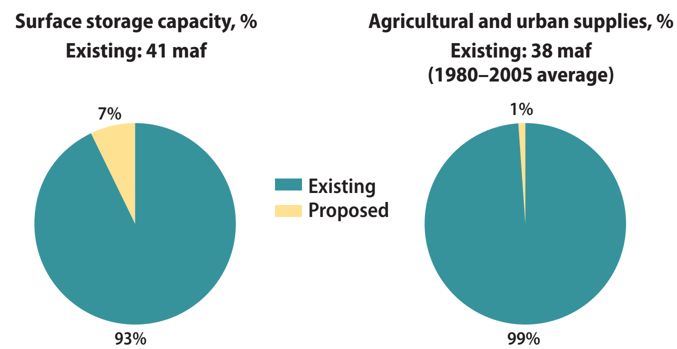
Because large reservoirs already exist on most major streams in California, expanding storage capacity has less potential to increase water deliveries than it did in the past. The two frontrunners under consideration, Sites Reservoir in Colusa County and Temperance Flat on the Upper San Joaquin River, would add 3.1 million acre-feet to the roughly 41 million acre-feet of existing surface water storage capacity and increase agricultural and urban water supplies by just 1 percent, at an estimated cost of $6.4 billion (Figure 5; Department of Water Resources, 2009a).[17] Surface storage is a costly way to expand water supplies in part because most favorable reservoir locations already have large dams.[18] Early cost estimates from the Department of Water Resources range from roughly $340 per acre-foot for Sites to over $1,000 per acre-foot for Temperance Flat (see the table).[19]

Moreover, the value of surface storage as a replacement for the snowpack is far from certain. If California's overall climate becomes drier (as predicted by some models, e.g., Barnett et al., 2008, Cayan et al., 2009), new surface storage will provide little additional water supply because there will be less surplus water to store (Tanaka et al., 2006; Connell, 2009). More active coordination between existing surface reservoirs and groundwater basins—with increased drought (multiyear) storage kept underground—could augment overall storage capabilities at lower cost, especially with climate change (Tanaka et al., 2006; Connell, 2009).[20]

Solution 2: A Peripheral Canal

The Sacramento–San Joaquin Delta has long been at the center of environmental, water supply, and land use conflicts, and its prominence in public discussions has been heightened in recent years by concerns over fragile levees and the fate of native fish species. One recurring proposal is to build

Figure 5. New surface storage will add little to existing water supplies



SOURCE: Authors' calculations using Department of Water Resources and U.S. Bureau of Reclamation data for Temperance Flat and Sites Reservoirs.

NOTE: maf = millions of acre-feet.

Surface storage is a costly source of new water supplies

	Annual cost per acre-foot ($)	
Method	**Low**	**High**
Conjunctive use and groundwater storage	10	600
Water transfers	50	550
Agricultural water use efficiency (net)	145	240
Urban water use efficiency (gross)	230	635
Recycled municipal water	300	1,300
Surface storage (state projects)	340	1,070
Desalination, brackish	500	900
Desalination, seawater	900	2,500

SOURCES: Department of Water Resources (2009a); Department of Water Resources (2007)—low estimate for surface storage; Department of Water Resources (2005)—conjunctive use; authors' estimates—water transfers.

NOTES: For conjunctive use, the costs of water for banking may be additional. For most options (except water use efficiency), estimates do not include delivery costs, which can be substantial. For a definition of gross and net water use efficiency, see Myth 4.

a peripheral canal to convey export water around, rather than through, the Delta. To many, particularly in areas that depend on water exports, the peripheral canal has become the silver bullet for addressing the Delta's woes.

How the Myth Drives Debate

The implication is that a peripheral canal should be built without delay, which would allow water exports to return immediately to their pre-2008 levels or higher. This thinking has led some water users to believe that Delta conveyance is the only impediment to expanding water deliveries and has diverted attention from many additional actions required to improve environmental conditions in the Delta and California's water system as a whole.

The Reality

If carefully designed and managed, a peripheral canal seems to be the best strategy for balancing environmental and economic goals for water management in the Delta (Lund et al., 2008). The current through-Delta system is unsustainable for the Delta's native fishes and for human water users (Lund et al., 2008). By taking export water around the Delta, a canal makes it possible to more separately manage water for exports and for the environment. Flows within the Delta could return to a more natural, variable regime to benefit the Delta's native fishes.

A canal would also provide urban and farm water users with a more reliable and cleaner source of water, while allowing water management within the Delta to be tailored to the needs of fish and other desirable aquatic organisms. By making it possible to continue moving water from Northern California to regions dependent on Delta exports, a canal would support other water management actions, such as underground water storage, reservoir reoperation, and water markets, and would make water supplies more resilient in the face of climate change (Tanaka et al., 2006, 2008; Connell, 2009).

However, a peripheral canal alone will fix neither the Delta nor California's water supply issues, and it is unlikely to improve native fish populations enough to allow immediate increases in exports above currently restricted levels. A favorable outcome for native fishes depends on careful attention to the environmental aspects of the project, as well as complementary investments in fish habitat (Moyle and Bennett, 2008).

To succeed, the canal would need to be accompanied by a robust governance package that establishes legal and procedural safeguards against extracting too much water and that ties achievement of ecosystem management goals to water diversions. Since recent fish population declines occurred during a period of high water exports (see Figure 4), some reduction in water exports would likely be required with a canal, at least until fish populations recover (Isenberg et al., 2008a).[21]

Solution 3: Seawater Desalination

To the general public, seawater desalination often seems like the ultimate technological fix for California's water supply. With more than 2,000 miles of ocean and bay coastline, a large coastal population, and a cutting edge technology sector, California appears well positioned to harness desalination. Some expect this new technology to become so inexpensive that it will soon banish most water shortages and controversies.

CALIFORNIA DEPARTMENT OF WATER RESOURCES

California already has substantial surface reservoir capacity, including Lake Oroville.

How the Myth Drives Debate

People point to declining costs and examples in the Middle East and Australia, where desalination is now used, and wonder why California is not pursuing this solution more aggressively. As with surface storage, they argue for public subsidies to jump-start desalination investments.

The Reality

Desalination of brackish water (less than 30% as salty as seawater) is already a proven technology in inland Southern California. Seawater desalination might become useful in some situations: (1) in coastal urban areas isolated from the state's wider supply network, such as the Central Coast (Cooley, Gleick, and Wolff, 2006), and (2) as a reliable partial supply for urban areas dependent on imported water. Reliability is the primary motivation for planned desalination facilities in San Diego and Orange Counties, as well as preliminary investigations in the San Francisco Bay Area.

However, seawater desalination is unlikely to become a major California water source for several reasons. The technology poses some major environmental challenges, including trapping marine life at intakes, disposal of brine by-product, and high energy use. It is also expensive: recent reviews find widely variable desalination costs, with desalination of brackish water costing about $400 to $600 per acre-foot and seawater desalination costing about $600 to $1,000 per acre-foot for large units without unusual brine disposal costs (Karagiannis and Soldatos, 2008; Texas Water Development Board, n.d.). For California, current cost estimates are somewhat higher, likely reflecting the greater costs of brine disposal and environmental mitigation for seawater plant location (see the table).[22] Even with continued technological advances, seawater desalination is likely to remain relatively costly for urban uses and unlikely to become viable for directly supplying irrigation water for agriculture.

Replacing the Myth

Although new infrastructure can contribute to California's water supply solutions, it is not a panacea in terms of costs or environmental benefits.

Billions of dollars of infrastructure investments are urgently needed but mostly for maintaining or rehabilitating aging facilities (Hanak and Barbour, 2005), refurbishing major storage and conveyance systems to reduce their environmental impacts (temperature controls on dam outlets and more fish-friendly diversions), and improving connections within the water system to improve flexibility in operations. Infrastructure investments are usually best financed by local beneficiaries and best employed within a portfolio approach to water management, which orchestrates a wide range of actions and includes new infrastructure along with water markets, underground storage, reuse, and conservation.

Myth 4: We Can Conserve Our Way Out of California's Water Problems

The Myth

The water conservation myth implies that California can adapt to changing conditions by focusing primarily on water use efficiency. Examples of countries such as Australia, where daily residential water use is reported to have fallen to roughly 40 gpcd during the recent drought (versus about 145 gpcd in California), are used to highlight the scope for savings (Whyte, 2009).[23] The danger with this myth lies in overestimating the real water savings achievable through conservation. Adherence to this myth distracts discussion from the need for more sweeping changes in water institutions, infrastructure, and management.

How the Myth Drives Debate

The idea that improvements in urban and agricultural water use efficiency could free up enough water for population growth and increased environmental use is appealing. It places blame for water problems on water users (Myth 2) while providing a silver bullet solution.

Environmentalists often promote conservation as an alternative to new infrastructure. After more than a decade of financial support to urban water utilities implementing conservations measures, a new law now requires reductions in per capita urban water use by 20 percent, in the expectation that this will free up significant supplies for other purposes.[24]

The Reality

Improvements in urban and agricultural water use efficiency have already helped California adapt to scarcity, and continued reductions in water use can help California cope with droughts and shortages (Myth 1). Reducing water withdrawals from streams and groundwater basins can yield environmental benefits, including improved streamflow, reduced pollution runoff into rivers, streams, and beaches (Noble et al., 2003), and reduced energy use for acquiring and treating water (California Energy Commission, 2005).[25]

But public policy discussions about water conservation often overestimate potential water savings by failing to distinguish between net and gross water use. Net (or "consumptive") water use refers to water consumed by people or plants, embodied in manufactured goods, evaporated, or discharged to saline waters. Once this water is used, it cannot be recaptured. Gross (or "applied") water use refers to water that runs through the taps of a home or business, or is applied to fields—not all of which is consumed. Some of it—known as "return flow"—is available for reuse, because it returns to streams and irrigation canals or recharges groundwater basins. Conservation measures often target reductions in gross water use. But because of return flow, *net* water savings are often lower (and never higher) than *gross* water savings. Only net water savings provide more water.

In agriculture, achieving significant net water savings generally requires switching to crops that consume less water or reducing irrigated land area; these two measures typically reduce farm profits and are therefore costly.[26] By contrast, irrigation efficiency investments, which can increase farm profits, may reduce gross water use per acre but increase net water use on farms by making it easier for farmers to stretch their gross supplies across additional acres of cropland.[27]

Similar issues arise for urban water conservation. Outdoors, switching from thirsty lawns to plantings that use less water (a crop switch) can greatly reduce net water use. But reducing landscape overwatering (a reduction in gross water use) will generate net savings only if the excess water has not previously been recaptured in a stream or a groundwater basin.

Only net water savings provide more water.

Opportunities for net savings from indoor water conservation depend on location. Almost all indoor water use returns to the system as treated wastewater. Thus, indoor conservation in coastal areas, which discharge wastewater to the sea, produces substantial net water savings. But indoor conservation in Sacramento—where wastewater discharges to the Sacramento River and can be reused by others before reaching the ocean—has little effect on California's net water use.

Not distinguishing between net and gross water savings in public discussions can create unrealistically high expectations for water conservation and inaccurate evaluations of the benefits of specific conservation measures. For instance, the large potential savings from urban conservation reported in the 2005 *California Water Plan Update* are gross, not net, savings (Department of Water Resources, 2005). The same is true for the governor's plan to reduce gross per capita urban water use 20 percent by 2020 (State Water Resources Control Board, 2009); although useful, the plan would produce significantly less than a 20 percent reduction in net urban water use.

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Replacing lawns with landscapes that use less water generates net water savings but can be quite costly.

Public discussions also frequently fail to acknowledge that water conservation has implementation and operating costs, just like other actions (see the table). Some conservation quickly pays for itself—for example, low-flow fixtures that reduce hot water use save both energy and applied water (Gleick et al., 2003). But other actions can be quite costly, such as replacing lawns with landscapes that use less water (Hanak and Davis, 2006).

Replacing the Myth

Water conservation is important, but its effectiveness is often overstated.

To free up supplies for other users, conservation must focus on net water reductions. As with building new infrastructure, conservation should be part of a portfolio approach to water management, which is much more likely to be successful in addressing California's complex, locally varied, and evolving water problems (Jenkins et al., 2004).

Myth 5: Healthy Aquatic Ecosystems Conflict with a Healthy Economy

The Myth

Underlying this classic "fish versus people" argument is the belief that natural resources should be used to generate economic wealth, and that any resource not so used is somehow "wasted." In this view, environmental water uses and healthy watersheds have little or no economic value, so allocating water to the environment or imposing water quality regulations involves much greater economic losses than potential benefits.

Although rhetorically convenient for individuals and regions suffering from water scarcity or facing the costs of implementing water quality regulations, this myth overlooks or undervalues the real economic benefits of healthy ecosystems. The dangers are underinvesting in environmental actions and failing to pursue water management strategies that serve both the natural environment and overall economic well-being.

How the Myth Drives Debate

The myth of an inevitable conflict between economic and environmental water uses drives much of the recent debate over water allocation, particularly during times of scarcity (see Myth 2). It also fuels resistance to the regulation of polluted runoff caused by urban activities and farming operations.

The Reality

Environmental regulations often do interfere with traditional economic activities. For instance, the recently imposed environmental restrictions on Delta water exports cost several thousand farm jobs (Howitt, Medellin-Azuara, and MacEwan, 2009b), and uncertainties about Delta supplies are raising concerns in some Southern California cities about the ability to approve new development.[28]

Yet environmental water uses also add economic value to California. This is not always readily apparent, because the market generally does not put a price on environmental flows, healthy watersheds, or the services that they provide (National Research Council, 2005a; Brauman et al., 2007). But new tools are emerging to measure and economically value these services (see the text box at right). For example, instream flows support recreational and commercial fisheries, enable water-based recreation, and increase water quality (Daily et al., 2009). Wetlands and healthy watersheds also reduce flood risks. Watershed protections save U.S. cities billions of dollars per year in avoided treatment costs (Postel and Thompson, 2005); San Francisco alone saves tens of millions of dollars per year because it receives water from the pristine Hetch Hetchy watershed (Null and Lund, 2006).[29] Sacramento Valley rice farming has developed substantial mutual benefits with wildfowl (Bird, Pettygrove, and Eadie, 2000). And most people are willing to pay for the continued existence of native species and landscapes, even if they may never see them (sometimes called a "nonuse" or "existence" value).

One consequence of the failure to put a price tag on environmental flows is that many environmental water demands remain unsatisfied.[30] In addition, public and private decisions often neglect the economic costs of environmental effects from traditional agricultural and urban water uses. For example, many groundwater basins are contaminated by accumulations of nutrients and pesticides from farming or from leaching of industrial chemicals (Oster, Vaux, and Wallace, 1994; California Department of Pesticide Regulation, 2009). Although environmental regulations have begun to hold water users, dischargers, and land use agencies responsible, others generally bear the costs of the environmental degradation—through diminished recreational opportunities, higher drinking water treatment costs, greater health risks, increased flooding, and other effects, including health risks for wildlife and plants.

The recent San Joaquin River settlement, which will decrease agricultural diversions to benefit salmon habitat, provides a good illustration of the importance of considering environmental values in water management decisions. The estimated gains in economic value from restored flows (in terms of recreation, lower treatment costs, and the "existence" value of restored flows) can far exceed farm revenue losses.[31]

As California's economy continues to shift from resource-dependent goods production to activities more dependent on environmental quality for recreation and other ecosystem services, it will become increasingly important to manage water resources for both commercial value and healthy ecosystems.

Valuing ecosystem services

Ecosystem services are benefits that ecosystems provide to humans. Healthy rivers and watersheds, for example, can provide salmon and waterfowl, whitewater for kayakers, and clean drinking water for cities. The Millennium Ecosystem Assessment (2005) gives four ecosystem services categories:

Provisioning services — providing food and water.

Regulating services — sequestering carbon and reducing soil erosion.

Cultural services — providing recreation and spiritual renewal.

Supporting services — promoting soil fertility and primary production.

It was historically difficult to measure and value these services, except for the few services (e.g., food) traded in the marketplace. Scientists today, however, are developing techniques to estimate how various actions will affect ecosystem services and to value those services in economic and non-economic terms (DeGroot, Wilson, and Boumans, 2002; Daily et al., 2009). A recent study by the Science Advisory Board for the U.S. Environmental Protection Agency (2009) concludes that the government should better integrate ecosystem services into decisionmaking and discusses a variety of methods for valuing ecosystem services. These methods include:

Measures of public attitudes — surveys and focus groups that elicit public preferences for ecosystem services.

Economic methods — methods to estimate how much people are willing to spend to avoid losing a service.

Civil valuation methods — public referenda or initiatives that provide information about how much the voting population values particular services.

California must find ways to manage water jointly for environmental and commercial benefits.

Replacing the Myth

Healthy ecosystems provide significant value to California's economy, partially and sometimes fully offsetting their costs to traditional economic sectors. Direct benefits include improvements in recreation, commercial fishing, and drinking and agricultural water quality, and indirect benefits include improvements in the quality of life in California.

California must find ways to manage water jointly for environmental and commercial benefits. Better accounting of water use and its economic and environmental benefits and costs can help guide policies for watershed management.

Myth 6: More Water Will Lead to Healthy Fish Populations

The Myth

Ongoing water management debates all involve a common question: "How much water do the fish need?" This question stems from the assumption that simply allocating more water will lead to healthy fish populations. Those involved in managing water resources know that this assumption is wrong. Yet it remains the primary (if not sole) focus of debate, often to the detriment of other, more important factors for species recovery.

How the Myth Drives Debate

The assumption that more water is sufficient to recover fish species oversimplifies current policy debates. Utilities and water contractors focus on this myth because it implies that a science-based, quantifiable solution exists with reasonable certainty. It allows financially strapped fishery agencies to continue monitoring flows using existing stream gauges, rather than expanding efforts to measure fish populations. Elected officials also rely on this myth because it is easy to communicate and understand. The result has been a discussion of environmental flows disconnected from other fish needs and less effective in supporting fish populations.

The Reality

The myth that more water is sufficient for healthy fish populations rests on a basic truth: To state the obvious, fish need water.[32] Streamflow diversions and groundwater pumping have significantly diminished fish numbers, with great effects on Central Valley, Lahontan, and Central Coast and South Coast rivers and streams (Moyle, 2002; Moyle et al., 2009). Perhaps the most striking example is the complete dewatering of the San Joaquin River and the resulting extirpation of spring-run Chinook salmon (Brown, 2000; Moyle, 2002). Clearly, in some cases more water is necessary for improving fish stocks.

But more water alone is rarely sufficient. The best answer to the question "How much water do the fish need?"—one that reflects the reality of allocating water to the environment—is the maddeningly vague "It depends."

First, more water is *not* always better for fish. If the water is of the wrong quality—in terms of temperature, sediment, nutrients, and contaminants—it does little good and may do harm. Less water of better quality might support larger and healthier desirable fish populations.[33] Fishes adapted to cold, clear waters, such as salmonids, do not benefit from higher releases of warm, nutrient-rich water (National Research Council, 2005b). Alternatively, fishes that evolve in warmer waters tend to do poorly when water temperatures are made artificially cold by releases from dams (Clarkson and Childs, 2000).

Second, without sufficient physical habitat, more water does little good and may cause harm. Habitat needs connectivity and complexity, along with the ability to adjust to changing conditions (Graf, 2001; Zedler, 2000). For example, increasing winter and spring flows on leveed or channelized rivers cut off from the floodplain provides little benefit and may even harm scarce in-channel habitat.

Third, poorly timed flows can be ineffective or counterproductive. Water allocations for the environment should be viewed differently from irrigation water allocations, with yearly or monthly allocations at some fixed flow rate. California's Mediterranean climate has large seasonal, annual, and spatial variations in flows, temperatures, and physical habitat. Few efforts to manage ecosystems, much less individual fish species, adequately account for this variability when prescribing increases in flow (Baron et al., 2002; Moyle et al., 2009).

The best answer to the question "How much water do the fish need?" is the maddeningly vague "It depends."

Fourth, many factors can affect wild fish populations, such as salmon and steelhead, that migrate between rivers and the ocean. These factors range from ocean conditions, to rates and timing of pumping from the South Delta pumping plants, to interactions with fish of hatchery origin (Moyle and Bennett, 2008). Thus, putting more water down a river without addressing problems at other locations may not significantly improve fish populations.

Finally, science simply cannot accurately and precisely predict how much water the fish need. Large uncertainties are unavoidable in assessing the magnitude, timing, frequency, and duration of ecological flows. To address these uncertainties, adaptive management strategies, which view all environmental flows as experimental and establish procedures for adjusting them, will be required (National Research Council, 2004). To date, no major California water projects have successfully implemented adaptive management.

Replacing the Myth

Native aquatic species need more than water to prosper. To support native fish populations, water flows must have appropriate seasonal and interannual variability, abundant

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Many factors can affect wild fish populations, such as these salmon, as they migrate between rivers and the ocean.

and complex physical habitat, high water quality, and protection from the effects of invasive species.

Effective water policy must pragmatically embrace this complexity. Solutions will need to be flexible, account for the natural variability of water and the surrounding environment, and account for the complexity of ecosystem responses. Fishery agencies will need greater resources to adequately monitor the effects of changing flows, or they will risk making serious errors in flow prescriptions. Most challenging of all, effective solutions will require greater flexibility and creativity on the part of agricultural and urban water providers and may reduce the reliability of water supplies.

Myth 7: California's Water Rights Laws Impede Reform and Sustainable Management

The Myth

This myth promotes the idea that California cannot effectively address its current and future water challenges because of its system of archaic and entrenched water rights. In this view, century-old water allocations and rules

California water law embodies far more flexibility and potential for reform than is often understood.

still dominate California water law. So, for example, inefficient water uses are insulated from regulation except in the most egregious cases of waste. Likewise, seriously degraded aquatic ecosystems cannot receive sufficient water because of longstanding water and contract rights. Belief in the rigidity of California water law has been a major impediment to improving water policy and management.

How the Myth Drives Debate

Many impartial observers of California's water rights system believe in this myth, but it is also perpetuated by those who stand to lose from changes in their water rights. Thus, many groundwater users argue that the state has no authority to regulate their actions, and senior surface water rights holders furnish legal objections to being held accountable for environmental water flows. Water rights holders and water contractors often contend that the government must pay them just compensation when it restricts their water use to protect endangered species or water quality. The difficulties of major legislative or constitutional reforms of water rights and the potential costs of compensation can appear as insurmountable obstacles to reform.

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The public trust doctrine was used to require Los Angeles to divert less water from Mono Lake to protect its ecosystem.

The Reality

California's system of water rights is a complex, often confusing, and sometimes incoherent amalgam.[34] Challenges to water use efficiency and to existing allocations of water can be problematic, both because of costs and delays of adjudication and because water and contract rights to water service are "property" under the California and federal constitutions and cannot be "taken" unless the government pays just compensation to the owners.

However, California water law embodies far more flexibility and potential for reform than is often understood. Far from being an absolute form of private property, water rights are shaped and constrained by a variety of rules designed to ensure that all water uses are reasonable and promote the public interest.

The "reasonable use" requirement of California's Constitution is the foundation of the state's water rights system and applies to all water rights.[35] The California Supreme Court has held that "no one can acquire a vested right to the unreasonable use of water" (*Barstow v. Mojave Water Agency*, 2000; *National Audubon Society v. Superior Court*, 1983). Consequently, the state may enforce the reasonable use mandate without running afoul of the constitutional ban on "taking" property.[36] Water users, as well as individual members of the public, have the authority to challenge an existing water use as unreasonable.

Reasonable use is a dynamic principle that can respond to changes in hydrology, technology, scientific information, water demand, and economic and social conditions (*Environmental Defense Fund v. East Bay Municipal Utility District*, 1980). The determination of reasonable use "depends on the entire circumstances of each case" and cannot be resolved in isolation from critical statewide considerations. As water becomes increasingly scarce, a paramount consideration is the "ever increasing need for the conservation of water" (*Barstow v. Mojave Water Agency*, 2000).

The public trust doctrine further contributes to the flexibility of California's water rights system. The state has both the authority and the "affirmative duty . . . to protect public trust uses whenever feasible" (*National Audubon Society v. Superior Court*, 1983). This means that the state "has the power to reconsider allocation decisions" even after it has awarded a water right. As with the reasonable use requirement, the public trust doctrine is dynamic and "sufficiently flexible to encompass changing public needs" (*Marks v. Whitney*, 1971).

The flexibility inherent in these fundamental rules of California water rights law has enabled the state to address inefficient or outdated water uses in a variety of settings.[37] The doctrine of reasonable use may support several necessary changes in California water policy, including:

1. **Prevention of waste and improvement in water use efficiency.** A property right in water wholly depends on its reasonable use. The state has the authority to declare a variety of water practices unreasonable, even if they were considered acceptable in the past.[38] This would not constitute a "taking" for which the state would need to pay just compensation.
2. **Creation of incentives to enhance water allocation efficiency.** The reasonable use mandate can be used to encourage the transfer of conserved water to other users through a water market.
3. **Compliance with environmental standards and protection of the public trust.** Because no constitutionally protected property right exists for an unreasonable use of water, when the state abates or reforms water practices that unreasonably harm the environment, it may do so without payment of just compensation.

Replacing the Myth

The legal tools for reform are already present in California's water rights laws. Indeed, they have been there for many decades. We just have to use them.

The state legislature, as well as state agencies, courts, and private water users, have significant authority under current water law to meet the myriad challenges facing California.

However, strong leadership will be required to overcome resistance to change. The State Water Resources Control Board (SWRCB) needs political support and an adequate budget to supervise and to promote the reasonable use of water. And California needs to begin requiring the full range of water rights holders to disclose their water use. Accurate and current information about surface and groundwater use is essential to the task of better managing the state's water resources.

Myth 8: We Can Find a Consensus That Will Keep All Parties Happy

The Myth

This myth is a modern-day reaction to the idea that California's water problems will always result in "water wars": hard-fought battles that result in winners and losers, most often decided by the courts or public referenda. Achieving consensus is seen as a way to balance the competing goals of different stakeholders. But when consensus processes avoid inevitable tradeoffs, they can lead to ineffective incrementalism and indecision on critical water policy issues.

How the Myth Drives Debate

Consensus-based decisionmaking was popularized during the CALFED[39] decade, from the mid-1990s to the mid-2000s, when diverse parties sought mutually compatible solutions for the environmental, water supply, and land use problems of the Delta. Although that process is widely considered to have failed in achieving its primary goals, consensus-based decisionmaking continues as the hallmark of stakeholder-driven planning and policy processes. Many stakeholders support consensus processes to be sure they get a seat at the bargaining table, where they can defend their interests.

The Reality

Consensus is most promising where incremental changes to the status quo can allow all parties to improve their position without sacrificing their fundamental interests or positions. For instance, the California Urban Water Conservation Council (a group of water utilities, agencies, and environmental organizations) has had good success in fostering urban water conservation actions across the state.

However, many major water policy choices facing California will not result in win-win outcomes and will require that some groups relinquish some of their fundamental positions or interests. For example, a peripheral canal can benefit the economy and the environment but will likely accelerate water quality losses for some Delta farmers and make it less likely that the state will provide large subsidies to shore up all of the Delta's aging levees (Lund et al., 2008). To seek consensus on such water policy matters is to run the risk of maintaining the status quo rather than making hard choices.[40]

Placing a consensus process within a legal, regulatory, or political framework and time line can motivate parties to be more earnest and timely in seeking consensus solutions. For instance, the San Joaquin River accord was reached by farmers and environmentalists under the threat of a court-ordered solution. If consensus processes fall short, some tough decisions need to be brokered by higher level authorities, with an aim to achieve significant buy-in, rather than to make all parties happy.

Acknowledging inevitable tradeoffs does not mean ignoring the consequences for affected parties. When the best overall solutions involve losses to fragile groups, side payments—in cash or in kind—can help soften the costs of adjustment. Incentive payments are likely the best option for Delta landowners facing eventual loss of some islands to flooding (Lund et al., 2007, 2008). Financial payments have softened the effects of structural changes in the economy that had severe ramifications for some industries (e.g., textiles and logging), and similar strategies have been used to address the financial effects of water transfers in some California farm communities (Hanak, 2003).

Acknowledging inevitable tradeoffs does not mean ignoring the consequences for affected parties.

Replacing the Myth

Consensus is not always feasible for achieving sustainable water policy outcomes. For some big decisions, tradeoffs are inevitable and higher level authorities need to provide direction and mediate conflict.

Although decentralized decisionmaking can be highly effective for many local and incremental water management decisions, matters of broader public importance, involving many historically confrontational interests, will require strong state or federal leadership to broker solutions and achieve significant buy-in. Finding ways to acknowledge and address consequences to affected parties—without ceding to unreasonable calls for compensation—is a central challenge for California's water future.

Moving Beyond Myth

California faces major challenges in establishing a sustainable path for water resource management in the 21st century, as continued population growth, unmet environmental demands, and climate change will pose increasing strains on the state's usable water resources, raise costs, and heighten already substantial conflicts among various interest groups. Fortunately, California's innovative water resource sector will help meet those challenges. Numerous local and regional water supply, quality, and flood control agencies actively experiment with solutions and learn from each other to adapt to changing conditions and opportunities.

Yet a significant downside of this decentralized system is the limited extent to which information is collected, shared, and analyzed on matters of statewide importance. This setting fosters the persistence of water myths—a collection of partial truths, oversimplifications, outdated notions, and misperceptions—which distort policy debates and impede the development of effective policies. Myth is often more convenient than reality, which forces society to confront hard choices.

Available, up-to-date information—such as that presented here—provides a basis for rebuilding public policy discussions on myth-free foundations. Some foundational facts include the following: First, California has passed the point where reasonably priced "new" water is available, and costly new infrastructure decisions must be weighed against alternatives that use existing infrastructure more effectively, taking into account cost, reliability, and environmental consequences. Second, there are no villains: Water users in both the urban and agricultural sectors have been making strides to improve water use efficiency for some time, and environmental water uses provide economic and social benefits. Third, improving the conditions of our degraded aquatic ecosystems will require adaptive management approaches that may reduce the reliability of supplies. And fourth, although some management solutions will provide benefits to multiple parties, many solutions will involve contentious tradeoffs.

To advance the policy process, California must improve the collection, analysis, synthesis, and dissemination of information to policymakers and the public. To help dispel the myths examined here and support a pragmatic assessment of solutions, we suggest some specific actions:

- **Improve the flow of existing information:** Establishing a common understanding among the public and elected officials requires organizing and disseminating available information, such as broad trends in water use by sector and region and the costs of water supply alternatives (Myths 1, 2, 4).
- **Collect and disseminate new information:** To provide a sounder basis for using California's water laws, e.g., ensuring reasonable use (Myth 7), California must collect and document more accurate water use information from the field. This will require changes in the law, to require reporting by all surface and groundwater users, regardless of the nature of their water rights—an unpopular move for many water users.
- **Expand analyses:** Moving forward often will require significant new analysis to develop actionable information and understanding. Expanded data collection and analysis will be particularly important for improving ecosystem management (Myth 6), integrated water management portfolios (Myths 3, 4), and other purposes. More generally, a better understanding of the value of ecosystem services (Myth 5) and the tradeoffs inherent in water policy decisions (Myth 8) can help clarify the policy choices California faces.

To advance the policy process, California must improve the collection, analysis, synthesis, and dissemination of information to policymakers and the public.

Information alone will not dispel California's water myths. In a world of scarcity and tradeoffs, myths provide convenient rhetoric for specific stakeholder interests. However, better technical and scientific information, analysis, and synthesis will be an essential support to better policy. If the state's leaders are serious about finding solutions to California's water challenges, they must not shy away from requiring better reporting and analysis, even if stakeholders resist.

Moving beyond myth will not end debate; many difficult problems and areas of legitimate disagreement will remain. But when built on solid factual foundations, policy discussions can focus on a more realistic consideration of critical, long-term water management issues. The challenges are many, and California's future depends on facing them.

Notes

[1] Moyle, Quinones, and Katz (forthcoming). Nine of the state's 131 native fish species have become extinct since California became a state.

[2] Isenberg et al. (2008b) report estimates from the SWRCB that allocations of surface water in the Sacramento and San Joaquin River watersheds amount to roughly eight times the average streamflow and three times the highest streamflow on record.

[3] Orang, Matyac, and Snyder (2008) report that surface irrigation use decreased by about 30 percent from 1972 to 2001 and drip/microsystem use increased by about 31 percent, mostly from reduced field crop and increased orchard and vineyard planting. Most of the switch occurred from the early 1990s onward. Using Department of Water Resources (DWR) data on applied water use and irrigated acreage, we estimate that water applied per acre has declined from an average of 3.5 acre-feet per acre in the 1960s–1980s to 3.2 acre-feet per acre from 1990 to 2005.

[4] From 1972 to 1995, the real value of output per acre-foot of applied irrigation water increased by 19.3 percent when using the gross domestic product deflator to measure inflation, and by 92.6 percent when deflated using the U.S. Department of Agriculture index of prices received by farmers (Brunke, Howitt, and Sumner, 2005).

[5] DWR (2003, 2005). For information on water banking in the Semitropic Water Storage District, see www.semitropic.com, and for the Kern Water Bank, see www.kwb.org.

[6] Water management practices in other countries with similar climates also suggest ample scope for continued adaptation (Hanak et al., 2009).

[7] To assess the scope for adaptation, we simulated conditions in 2050 using the Statewide Agricultural Production Model (SWAP) as presented in Howitt, Medellin-Azuara, and MacEwan (2009a). The simulation assumes a warm-dry scenario of climate change (28% decline in water supply from all sources), a modest increase in crop productivity relative to past trends (an average 29% cumulative increase for all crops, following Brunke, Howitt, and Sumner, 2005, and Howitt, Medellin-Azuara, and MacEwan, 2009a), and continued growth in demand for high value fruits and nuts. Irrigated acreage falls 20 percent statewide but statewide revenues from agriculture increase by 25 percent relative to 2005 levels. The decline in water use does lower the growth in revenues by about two-thirds relative to conditions without climate change.

[8] Authors' calculations using DWR data.

[9] For a discussion of the efforts of large urban water utilities, see California Urban Water Agencies (2008).

[10] A separate issue is whether federal crop subsidies create skewed incentives to grow certain crops. Some California crops benefit from these subsidies (notably rice, corn, about half of all cotton, and, indirectly, alfalfa, an input to the subsidized dairy industry). But most California acreage is planted to unsubsidized crops.

[11] Most farmers in California pay the operating cost of bringing water to their farms (even if they—like other water users—generally do not pay the external environmental costs from reduced steam flows). Water delivered to farmers from the State Water Project, local water projects, and the Colorado River Project is essentially unsubsidized. In addition to its subsidized contractors, the CVP also delivers over 2 million acre-feet to "settlement" and "exchange" contractors, who received water before the CVP, at very low unsubsidized prices.

[12] When Congress passed the original Reclamation Act of 1902 (32 Stat. 388), the subsidies were seen as a way to make the desert bloom. Today, the environmental damage and undesirable effects of that policy are apparent, and many reclamation projects have benefitted large rather than yeoman farmers (Pisani, 1984; Arax and Wartzman, 2003). But that does not reduce the fairness concerns of eliminating water subsidies on which CVP and other federal project farmers have long relied.

[13] Since the 1992 passage of the CVPIA, CVP contractors south of the Delta have received reduced deliveries in most years, as part of a mitigation program to better support salmon runs. Recent regulatory actions to protect delta smelt have caused further reductions (see Villain 3 and Figure 4). Many CVP farmers now base their cropping decisions on the much higher price of water in the water market, rather than on the price of water delivered by the CVP. Since the early 1990s, farmers have routinely paid more than $100 per acre-foot to purchase supplemental water, and in the 2008 and 2009 seasons, some farmers on the west side of the San Joaquin Valley paid as much as $500 per acre-foot for supplemental water (authors' communication from farmers and water brokers). In contrast, contract prices for CVP water on the west side range from $25 to $65 per acre-foot.

[14] For this reason, the Central Valley Project Improvement Act broadly authorizes CVP contractors to transfer water.

[15] For a discussion of the rulings, see Isenberg et al. (2008b).

[16] Moyle et al. (1998); Craig (2007); Sax et al. (2006).

[17] Information from CALFED Surface Storage Investigations as reported in DWR (2009a) and U.S. Bureau of Reclamation (2008a, 2008b). The increased percentage of agricultural and urban deliveries is based on the authors' calculations (0.33 million acre-feet per year, relative to average deliveries of 38 million acre-feet per year from 1980 to 2005; see Figure 1).

[18] For example, the San Joaquin River basin already has roughly 8.7 million acre-feet of storage capacity and average annual runoff of only 6 million acre-feet.

[19] The $340 per acre-foot estimate assumes very high environmental benefits and urban water quality benefits. Without these benefits, the net cost per acre-foot delivered rises to $616. (Authors' calculations using data from the U.S. Bureau of Reclamation, 2008b). Even a projected cost of $340 per acre-foot is likely to be too expensive for most farmers.

[20] Some areas (notably Sacramento) would benefit from new surface storage as part of the flood management system, especially with climate warming and earlier spring runoff (Fissekis, 2008; Zhu et al., 2007). Increased surface storage might also enhance fish habitat, particularly to support cold water releases and flows during droughts. However, the details of such environmental enhancements have yet to be analyzed. For environmental purposes, it would also be relevant to compare the reoperation of existing or expanded dams with the removal of some dams to allow fish to move upstream to colder water and spawning grounds.

[21] Even with significantly reduced exports, some form of peripheral canal is likely to be much cheaper for water users (and the state's economy) than the status quo or ending exports. The analysis on which this conclusion is based allowed for export reductions by up to 40 percent relative to a baseline of 6 million acre-feet, with costs of a canal of nearly $10 billion in 2008 dollars (Lund et al., 2008). If canal costs prove to be substantially more expensive, this would lessen the economic advantages of continuing Delta exports.

[22] These estimates are wide-ranging and uncertain because of differences in cost accounting methods (low estimates often exclude subsidies or assume 100% capacity utilization), the evolving nature of the technology, and lack of experience with large-scale desalination in California (Cooley, Gleick, and Wolff, 2006).

[23] Residential use is a component of total urban use (estimated at 201 gpcd in California in 2005—see Figure 2), which also includes commercial and industrial uses.

[24] State Water Resources Control Board (2009) addresses the governor's call for a 20 percent reduction by 2020. This goal is reflected in Senate Bill X7 7, signed into law in November 2009.

[25] Streamflow improvements can be significant locally even without net savings from conservation measures, because return flows do not generally return to the same location as diversions.

[26] Agricultural areas draining to the Salton Sea are a major exception, where any use reduction generates net water savings. For some crops (e.g., alfalfa and wine grapes), "stress irrigation"—which strategically waters crops less than is normal—can reduce consumptive use (creating net savings) by 10 to 15 percent.

[27] This issue arises because farmers pay for gross, not net, water use. Subsidizing irrigation efficiency improvements often encourages these acreage extensions. See Scheierling, Young, and Cardon (2006); Ward and Pulido-Velazquez (2008); Huffaker (2008); Evans and Sadler (2008); Clemmens, Allen, and Burt (2008); Pfeiffer and Lin (2009).

[28] See Bowles and Lee (2007, 2008) for approval delays in Riverside County and *Los Angeles Times* (2008) and Steinhauer (2008) for a more general discussion.

[29] Of course, this water quality benefit also comes with the significant environmental cost of flooding the Hetch Hetchy valley in Yosemite National Park with reservoir construction in the early 20th century.

[30] A study of environmental water uses for the 2005 State Water Plan found that, in 2000 and 2001 (normal and dry years, respectively), the state failed to meet nine important environmental flow objectives by almost a million acre-feet (Environmental Defense, 2005). And whereas urban and agricultural water use generally varies by no more than 10 to 20 percent between wet and dry years, environmental water use can drop by over 50 percent during droughts (DWR, 2009a).

[31] Annual losses in net agricultural revenues were estimated at $14.5 million to $38 million, depending on the extent of water marketing. Environmental benefits included $45 million in increased value of recreation, plus improved water quality for downstream urban and agricultural users, and nonuse value from the restoration of the river (Hanemann, 2005).

[32] Californians typically divert and consume much of the flow from the state's major rivers, averaging 25 percent of Sacramento River flows and over half of flows in the San Joaquin River (calculations by William Fleenor using DWR data).

[33] For instance, riparian shading and temperature control devices on dams can provide water temperatures that support fish without additional water (Null, Deas, and Lund, 2009; Vermeyen, 1997). See also Welsh, Hodgson, and Harvey (2001).

[34] These rights include riparian rights, pre-1914 appropriative rights, permitted and licensed water rights, prescriptive rights, pueblo rights, overlying and appropriative groundwater rights, and contract rights (Littleworth and Garner, 2007).

[35] The requirement appears in Article X, Section 2, of the Constitution and extends to groundwater and pre-1914 surface water rights that otherwise fall outside the SWRCB's permit and license jurisdiction (*Barstow v. Mojave Water Agency*, 2000; *National Audubon Society v. Superior Court*, 1983).

[36] *Joslin v. Marin Municipal Water District* (1967).

[37] To date, the SWRCB and the courts have applied Article X, Section 2, to declare unreasonable excessive use of water by riparians in light of new, competing appropriations for municipal water supply; wasteful conveyance losses to supply senior appropriative rights; simultaneous, aggregate diversions by riparians and appropriators that created critical shortages of water needed to protect wine grapes; maintenance of unexercised riparian rights at full priority in an overappropriated watershed; inefficient conveyance and production of excessive runoff by pre-1914 appropriators, which caused flooding of adjacent lands; an upstream point of diversion that threatened recreational and other instream uses downriver; the storage and diversion of water that jeopardize compliance with water quality standards, the public trust, and other in situ beneficial uses; and excessive use of groundwater by overlying landowners in an overdrafted basin (Gray, 1994, 2002).

[38] These may include excessive evaporative and conveyance losses, inefficient irrigation techniques, failure to adopt or to implement best management practices, and perhaps other profligate uses such as the irrigation of water-intensive crops and landscaping, failure to install low-flow water appliances, and continued reliance on imported water instead of using cost-effective alternatives such as demand reduction, use of recharged groundwater, and recycling of reclaimed wastewater.

[39] CALFED was a program to address the various problems facing the Delta, bringing together the various state and federal agencies overseeing water supply, water quality, and species management. Although stakeholders from various interest groups were not formally represented in the CALFED governing structure, their participation was an essential part of negotiations leading up to the development of a Record of Decision (and an investment plan) in 2000.

[40] For a discussion of the problems with CALFED, see Little Hoover Commission (2005) and Hanemann and Dyckman (2009). See Hanak et al. (2009) for broader research on this problem.

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