Myths of California Water - Implications and Reality

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Fallacies do not cease to be fallacies because they become fashions.
-G. K. *Chesterton*

I. Summary

> The great enemy of the truth is very often not the lie - deliberate, contrived and dishonest - but the myth - persistent, persuasive and unrealistic.
>
> *-John F. Kennedy*

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, raising environmental and economic costs and sometimes placing lives at risk. Moving beyond myth toward more factual, scientifically based water policy is essential if California is to meet the multiple, sometimes competing, goals for sustainable management in the twenty-first century: supplying agricultural, environmental, and urban demands for water supply and quality and ensuring adequate protection from floods.

We focus on twelve common water myths, involving water supply, ecosystems, flood management, and the legal and political aspects of governing California's water system. These are not the only California water myths - and they are not all unique to California - but they are ones we find to be particularly distracting and disruptive to public policy discussions. For each myth, we provide a brief assessment of how the myth misleads, and we point to a more accurate characterization of the issue that would provide a better foundation for policymaking.

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. Most water myths have their origins in at least a kernel of truth. But that kernel of truth has become distorted through exaggeration, oversimplification, or uncritical acceptance. Often, myths serve the rhetorical purposes of particular interest groups. But myths are able to persist because our public policy debates are not sufficiently grounded in solid technical and scientific information about how we use and manage water.

With the information presented here we seek to begin rebuilding public policy discussions on more myth-free foundations. Improving the collection, analysis, synthesis, dissemination, and discussion of accurate information about the state's water system is also necessary to encourage fact-based policies. Of course, information alone will not dispel California's water myths, but it can fashion more effective responses to California's many ongoing and future water challenges.

The Myth	The Reality
Water Supply Myths	
California is running out of water.	California has run out of abundant water and will need to adapt to increasing water scarcity.
[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.
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 in either economic or environmental terms.
We can conserve our way out of California's water problems.	Water conservation is important, but its effectiveness is often overstated.
Water markets can solve California's water problems	Water markets provide important incentives for cooperation and coordination of a portfolio of water management activities.
Ecosystem Myths	
Healthy aquatic ecosystems conflict with a healthy economy.	Healthy ecosystems provide significant value to the California economy. Although some tradeoffs exist among water uses, there are many opportunities for mutually beneficial water management.
More water will lead to healthy fish populations	Fish need more than water to thrive.
Restoring native ecosystems is essential for native species recovery.	California's ecosystems are irreversibly altered and constantly changing. We must find ways to restore native species within such altered ecosystems.

Flood Management Myth	
Current flood protection standards keep communities safe	Current standards increase flood risk in many locations.
Governance and Legal Myths	
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.
Groundwater is separate from surface water.	Despite some legal distinctions, California groundwater and surface water are often closely interconnected and managed jointly.
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.

II. Introduction

> The difficulty ain't that we know so much, but that we know so much that ain't so.
>
> *-Josh Billings, as quoted by* Mark Twain

California is again in the throes of intense public policy debates about how to manage 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 Delta residents and others worried about consequences for their regions and interests.

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 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-fought deal to restore salmon on the San Joaquin River depends on continued cooperation among fractious stakeholder groups and improvements in conditions downstream. To the north, water allocations for salmon remain a recurring source of conflict on the Klamath River. And across the state, flood-prone communities have petitioned the federal government for reprieves from stricter floodplain designations, so property can be developed and residents can avoid costly flood insurance.

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 forty-five percent are imperiled or qualified for listing.[1] More than ninety percent of California's lakes, rivers and streams are listed as "impaired," meaning they cannot be used for one or more of their intended uses (e.g., drinking, irrigation, fishing, swimming) (US Environmental Protection Agency, 2004).

Looking ahead, 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 per year over the coming decades (Department of Finance, 2007), and warming temperatures and accelerating sea level rise

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

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, California currently possesses little systematic technical knowledge and coordinated research capability to support and advance policy discussions and decisions. In part, this information deficit stems 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 responsiveness to local problems, but it also has fragmented much of the detailed knowledge and strategic perspectives on California's vast water system. The state, for its part, 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, and 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 - often used to support particular stakeholder interests - confuse public policy discussions, legislative debates, and water management decisions, making them less productive and useful than they need to be for California's water system to respond effectively to its mounting challenges.

This paper explores twelve prominent myths about California water supply, ecosystem management, flood control, and the legal and policy process for water governance. 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.

III. Water Supply Myths

Myth: California is Running Out of Water

> Is California running out of water? Or are we just running out of political will?
>
> -*Paul Shigley* (2008)

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). The myth stems from a rigid notion that there is no flexibility in water management and that the economy will grind to a halt if shortages occur. The myth 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 and use water resources more efficiently.

How the Myth Drives Debate

The notion that "California is running out of water" is commonly employed to raise alarm about serious water problems, but it encourages a simplistic and sometimes counter-productive attitude towards solving them. If we are "running out of water," then we have to "get more." The underlying assumption of this myth is that California's water use and management are more or less fixed. So new water demands from population growth can only be addressed by developing additional supplies, at any cost. In this view, California's water users have little ability to better use and stretch existing supplies through improvements in operations, gains in water use efficiency, or reallocation among users.

The Reality

This myth has a kernel of truth, in the sense that 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 areas.[2] The myth persists because water users often experience shortages, relative to water contracts and rights amounts

2. Isenberg, et al., (2008b) report estimates from the State Water Resources Control Board 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.

and past use, due to drought and environmental restrictions. With climate change, shortages could increase as warming temperatures reduce supplies currently stored in the Sierra Nevada snowpack (Cayan, et al., 2009).

However, water scarcity does not mean that we are "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. Even in the state's earliest days, appropriative water rights evolved to allow gold miners to move water to new locations when the original mines were played out. Changes in the economic value of water were the original drivers for shifting water between sectors, with water moving from gold mining to farming in the early part of the twentieth century, and more recently from farming to urban uses. California water allocations also have shifted (though not without fierce debates) in response to changing social values, particularly as the rise of environmental concerns has led to reallocations of more flows to aquatic habitat.

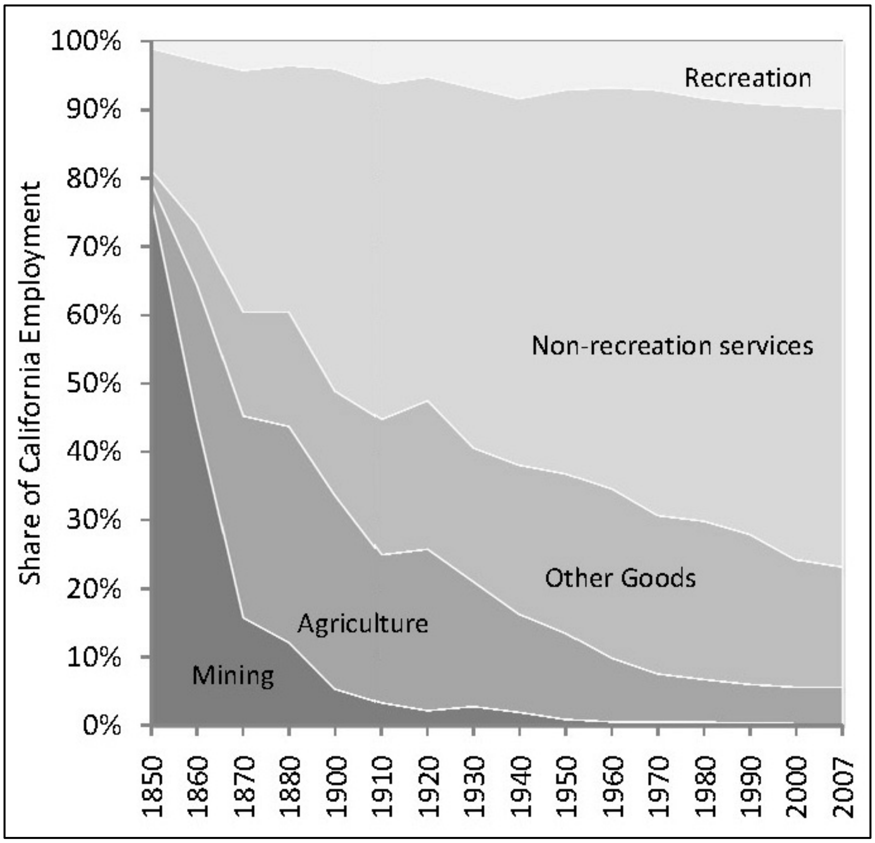
Figure 1 highlights the long-term shifts in California's economy, progressing from mining, to agriculture and manufacturing, to services, which now account for roughly three-quarters of all jobs. Figure 2 shows more recent water use trends for the agricultural and urban (non-farm business and residential) sector. Agriculture and related activities now account for about five percent of California employment, and a large, but declining share of non-environmental water use – seventy-seven percent in 2005, down from ninety percent in 1960. Consistent long-term data on dedicated environmental flows are not available, but there is consensus that environmental uses of water have increased during this time with the rise of environmental concerns and regulations. Statewide water availability for all purposes has diminished somewhat during this period due to reductions in water available from the Colorado River and groundwater overdraft in some areas.

In response to scarcity, Californians have made considerable gains in water use efficiency. A driving force for 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% 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] Thanks to yield increases and a shift to higher value crops, the real dollar value per acre-foot of irrigation water has

3. Orang, Matyac, and Snyder (2008) report surface irrigation use decreased by about thirty percent from 1972 to 2001 and drip/microsystem use increase by about thirty-one 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 data on applied water use and irrigated acreage, we estimate 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.

increased considerably.[4]

FIGURE 1:
Shifts in the California Economy, 1850 - 2007 (percentage of employment)



Source: Author calculations using Census data (IPUMS, 1950 industry basis).

Note: Agriculture includes farm-related wholesale trade and manufacturing, as well as forestry (which never exceeded 0.2% of employment and now accounts for less than 0.1%). "Other Goods" includes non-food manufacturing and construction. Recreation includes fisheries (which never exceeded 0.5% of employment and now accounts for less than 0.1%).

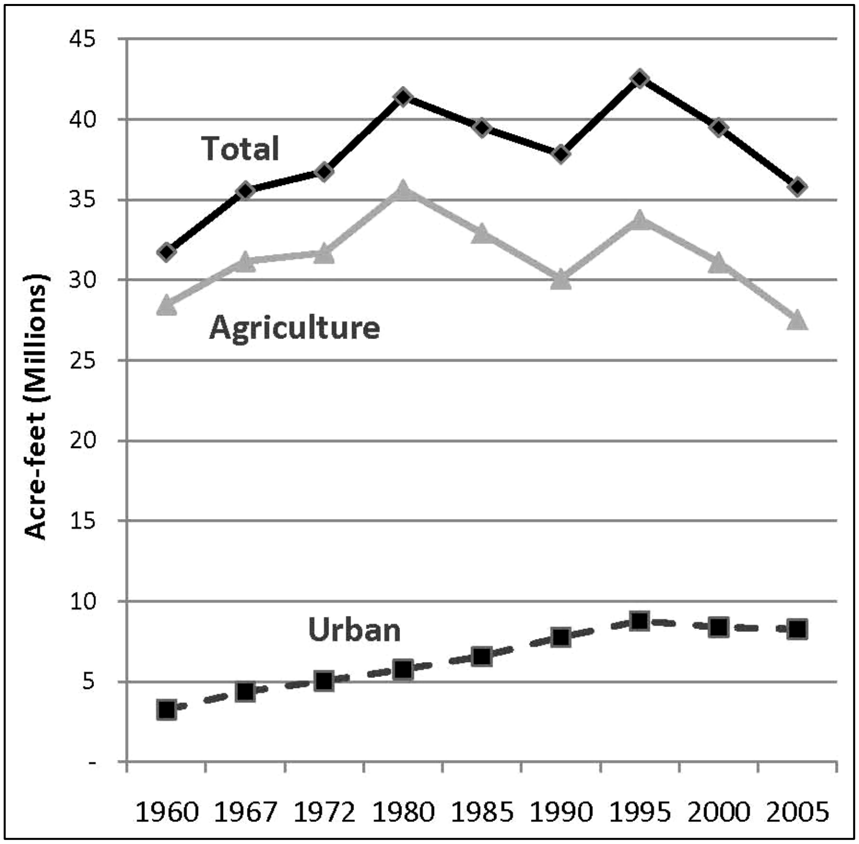
Urban dwellers also have been adapting. Following several decades of increases in per capita use spurred by rising incomes and increased home and lot sizes, many urban water agencies began implementing conservation programs during the early 1990s drought. These have reduced per capita use in both coastal and inland regions of California (Figure 3). (Inland

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 (GDP) deflator to measure inflation, and by 92.6 percent when deflated using US Department of Agriculture index of prices received by farmers (Brunke, et al., 2005).

California is shown with and without the low-desert Colorado River region, where per capita use is particularly high). Further use reductions are occurring from the recent drought and new environmental restrictions on pumping water to users south and west of the Delta.

FIGURE 2:

Trends in Agricultural and Urban Water Use, 1960 - 2005 (millions of acre-feet)



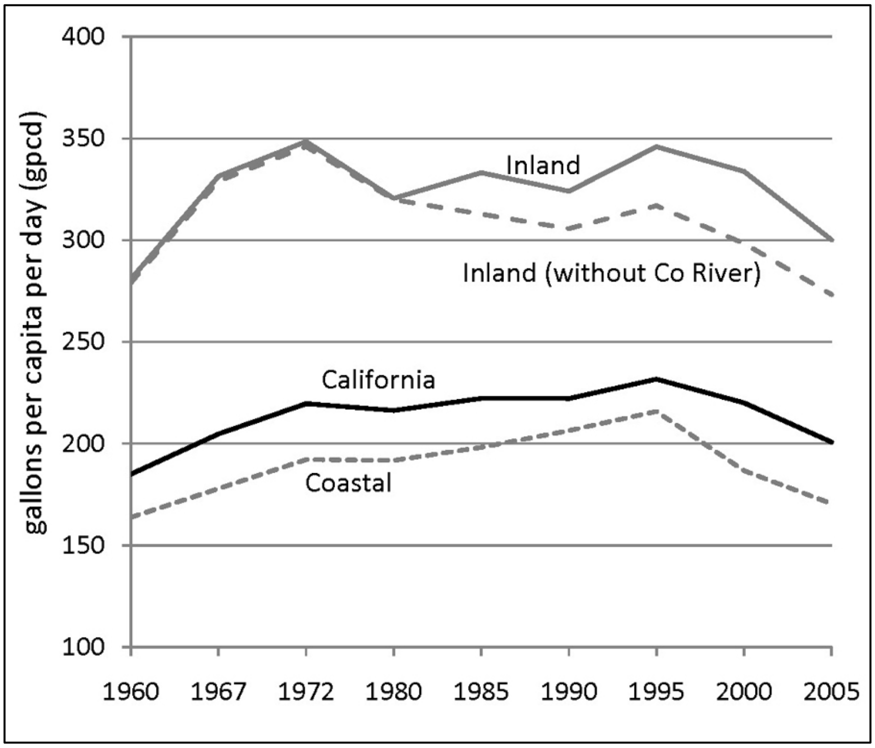
Source: Author calculations using data from California Water Plan Updates (Department of Water Resources, various years).

Note: Data for 2005 are provisional. Figure shows applied water use (for a definition, see the "conserve our way out" myth). "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, which is six percent to nine percent of the total.

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 wastewater and stormwater for reuse, and the marketing and trading of water, all of which have expanded greatly since the 1990s.[5]

FIGURE 3:

Trends in Per Capita Urban Water Use, 1960 - 2005 (gallons per capita per day).



Source: Author calculations using Department of Water Resources (DWR) data (2005 numbers are provisional)

Note: Figure shows applied water use (for a definition, see the "conserve our way out" myth). 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.

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"), improvements in conjunctive use and recycling, and some additional reallocation across sectors through water marketing (Department of Water Resources, 2009a; Jenkins, et al., 2003; Tanaka, et al., 2006; Zilberman, et al., 1993). Although climate change may significantly reduce water availability and growth in farm revenues, California agriculture

5. Department of Water Resources, 2003, 2005a; http://www.semitropic.com/; www.kwb.org.

appears able to adapt without declines in revenues from today's levels, thanks to projected improvements in irrigation and crop production technology and demand growth for higher value crops.[6]

Considerable potential remains for continued adaptation to water scarcity. California agriculture still applies more water per acre to irrigate crops than countries with similar climates and export-oriented agricultural sectors.[7] Likewise, per capita urban use in California remains quite high among developed economies with similar climates.[8] In many of these countries, water users have moved more aggressively to adopt more efficient irrigation technology, modify cropping patterns, limit outdoor landscaping use in the residential sector, recharge groundwater basins, capture stormwater, and increase use of recycled wastewater.

In short, this myth is true only if California's 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, "There is not a shortage of water, only a shortage of cheap water."

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

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6. To assess the scope for adaptation, we simulated conditions in 2050 using the Statewide Agricultural Production Model ("SWAP") as presented in Howitt, et al. (2009a). The simulation assumes a warm-dry scenario of climate change (twenty-eight percent decline in water supply from all sources), assuming a modest increase in crop productivity relative to past trends (an average twenty-nine percent cumulative increase for all crops, following Brunke, et al., 2005 and Howitt, et al., 2009a) and continued demand growth for high value fruits and nuts. Irrigated acreage falls twenty percent statewide but statewide revenues from agriculture increase by twenty-five 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.

7. California's average since 1990 has been around 3.2 acre-feet per acre. Recent application rates (in acre-feet per acre) are estimated at 2.48 in Australia, 2.11 in Spain, 1.70 in Italy, and 1.65 in Israel (Food and Agricultural Organization of the United Nations, n.d.). In contrast, other western states that rely heavily on irrigation have application rates similar to or higher than California's (Hutson, et al., 2004). Crop consumptive use of water is often directly linked to crop yield.

8. Urban per capita use (in gallons per person per day) in the early 2000s is estimated at 130 in Australia, 100 in Italy, 84 in Spain, and 76 in Israel (Food and Agricultural Organization of the United Nations, n.d.), versus roughly 210 in California.

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

As for an authentic villain, the real thing, the absolute, the artist, one rarely meets him or her even once in a lifetime. The ordinary bad hat is always in part a decent fellow.

-Colette

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 is preventing the state from meeting its water demands. Eliminating or reforming that villain would solve California's water problems. Call it the "Chinatown Myth" in honor of the evil Noah Cross who was stealing the water from beneath people's noses, creating artificial shortages. A good villain is always rhetorically useful and makes problems seem easier to solve.

Everyone in California has a favorite real-world water villain. Common favorites are the wasteful Southern California homeowner, the farmer who receives federally subsidized water, and the state and federal Endangered Species Acts. The danger with villains is that they can lead to inaction. Everyone points the 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 wash leaves from their driveways. In 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 rather than on supplying them with water. Imported water almost always comes from alternative environmental or local water uses, and there is no reason to incur those costs if the water is not truly needed.

Moreover, other water users often argue that it is unjust and unfair to force them to reduce their water use given profligate use by Southern Californians. Farmers, for example, have argued that the State should not impose conservation measures on them or permit agriculture-to-urban water transfers when Southern Californians continue to waste water.

The Reality

If Southern Californians are truly wasting water, water imports to the region should be reduced - and the water reallocated to areas of origin or other uses. But the image of Southern Californians as water villains is based on misperception of actual water use 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 4). This stems partly from a cooler climate and denser land use than inland areas. Statewide, outdoor water use averages over forty 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).

South Coast water utilities have also been among the most aggressive in reducing per capita water use. An effective way to reduce water use is to charge consumers higher rates for higher quantities consumed - known as "increasing block rates." In 2003, almost two-third of the population of California's southern coast paid increasing block rates. Only half of all Californians paid such rates, including a mere thirteen percent of San Joaquin Valley residents (Hanak, 2005). Water utilities in the South Coast 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 water customers to install water-efficient appliances, plant drought-resistant landscapes, and reduce overall water use. In places like Los Angeles, reductions in manufacturing in the early 1990s also reduced per capita use. Overall, the South Coast used nearly 450,000 acre-feet less water in 2005 than a decade earlier, despite having 2 million additional residents.[9] The region also leads in reclaimed water use.

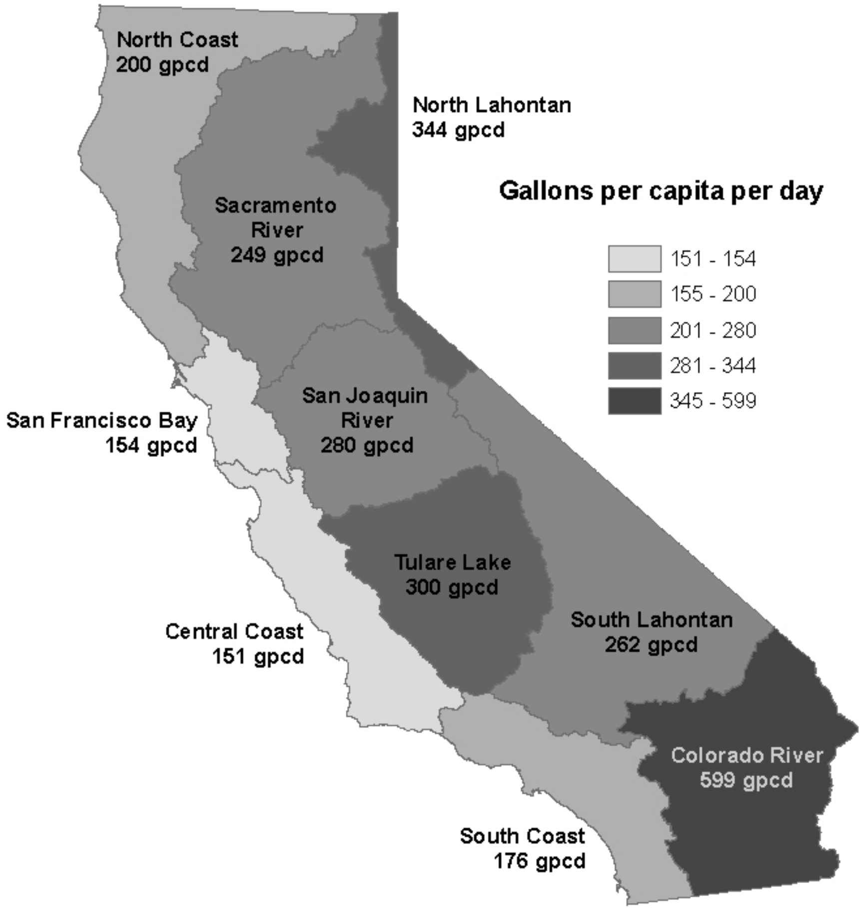
The temptation is to simply change the villain in California water policy from pool-loving residents of the South Coast to the urban and suburban residents of Sacramento, the San Joaquin Valley, and other inland areas. But the urban sector as a whole accounts for just over twenty percent of water use in California, and utilities in virtually every region are working to reduce per capita use.[10] 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 rather than for the state as a whole.

FIGURE 4:

Average per capita urban water use by hydrologic region, 2005

9. Author calculations using Department of Water Resources data.

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



Source: Department of Water Resources (provisional data).

Note: Figure shows applied water use (for a definition, see the "conserve our way out" myth). The high per capita use in the Colorado River region stems in part from the golf tourism industry.

Villain #2: Subsidized Agriculture

The chief villains for many urban water users and environmental advocates are the agricultural 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 some urban water users) (Sax, et al., 2006). The federal government subsidizes these supplies by allowing farmers to reimburse project construction costs interest-free over a span of decades, shifting to other users (such as hydroelectric projects) costs that exceed an irrigator's "ability to pay," and charging below-cost energy rates for moving the water. 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 the subsidies have undermined irrigators' incentive to conserve and encouraged them to grow lower-value crops such as wheat, grain, cotton, and rice that they believe should be grown elsewhere.[11]

How the Myth Drives Debate

If federal reclamation subsidies are unfair and undermine agricultural conservation, the most obvious solution is to eliminate them. In this spirit, Congress has increased 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). To comply with these laws, prices for federal agricultural water are likely to increase by more than sixty-five 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 and eliminate the subsidy entirely.

The Reality

The view of subsidized farmers as water villains is based on misunderstandings of the role of these subsidies 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).[12] Although the windfall to original landowners might have been unfair, current owners are receiving what the United States government led them to expect they would receive when they purchased this land. Fairness might imply locating the original landowners and stripping them of their windfall, but it is difficult to argue that stripping current farmers of the subsidy is "fair."[13]

11. There is a separate issue of 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.

12. Most farmers in California pay the actual operating cost of bringing the 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 were already receiving the water prior to the CVP, at very low (but not subsidized) prices.

13. 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,

Second, eliminating water subsidies is not the only way to encourage farmers to conserve water. As noted above (Running out of water myth), the economic efficiency of agricultural water use in California has increased steadily due to gains in crop yields, switches to higher value crops, and increases in irrigation efficiency. 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.[14] Water markets also are encouraging more efficient use. Farmers who can earn more than the cost of conserving water by selling the volume conserved to other parties have an incentive to do so, even if they currently pay little for water. For this reason, the Central Valley Project Improvement Act includes broad authorizations for CVP contractors to transfer water. Since the early 1990s, there has been an active farm-to-farm market to move 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, 2005a).

Villain #3: The Endangered Species Acts

To many users and commentators, particularly in the Central Valley and Southern California, 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.

Many water users have been predicting that the Endangered Species

environmental damages and undesirable effects of that policy are apparent and many reclamation projects have ultimately benefitted large rather than yeoman farmers that Congress originally envisioned (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.

14. 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 provide more flows for salmon. Recent regulatory actions to protect the delta smelt have led to further reductions (see Villain #3 and Figure 5). Many of these farmers are now making cropping decisions based on the (much higher) price of water they can obtain on the water market, rather than 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, when cutbacks were severe, some farmers on the west side of the San Joaquin Valley were paying as much as $500 per acre-foot for supplemental water (authors' communications with farmers and water brokers). In contrast, contract prices for CVP water on the west side run from $25 to $65 per acre-foot.

Acts would lead to water shortages since the federal government listed the Sacramento winter-run Chinook salmon as threatened in 1989, followed by the delta smelt in 1993. Since 2008, those predictions have seemed to become reality, as pumping has been reduced following a federal judge ruling that state and federal water managers were not adequately considering the needs of fish species in the Delta in managing water exports.

How the Myth Drives Debate

Seeing the Endangered Species Acts as villains has led some water users to call for reducing legal protections for native species. The federal Endangered Species Act of 1973 is currently one of the world's strongest environmental laws. Having concluded that species are of inestimable value, Congress prohibited the "taking" of endangered species under the Endangered Species Act, 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 that either the Committee be convened to allow more water to be exported from the Delta or that Congress amend the Act.

The Reality

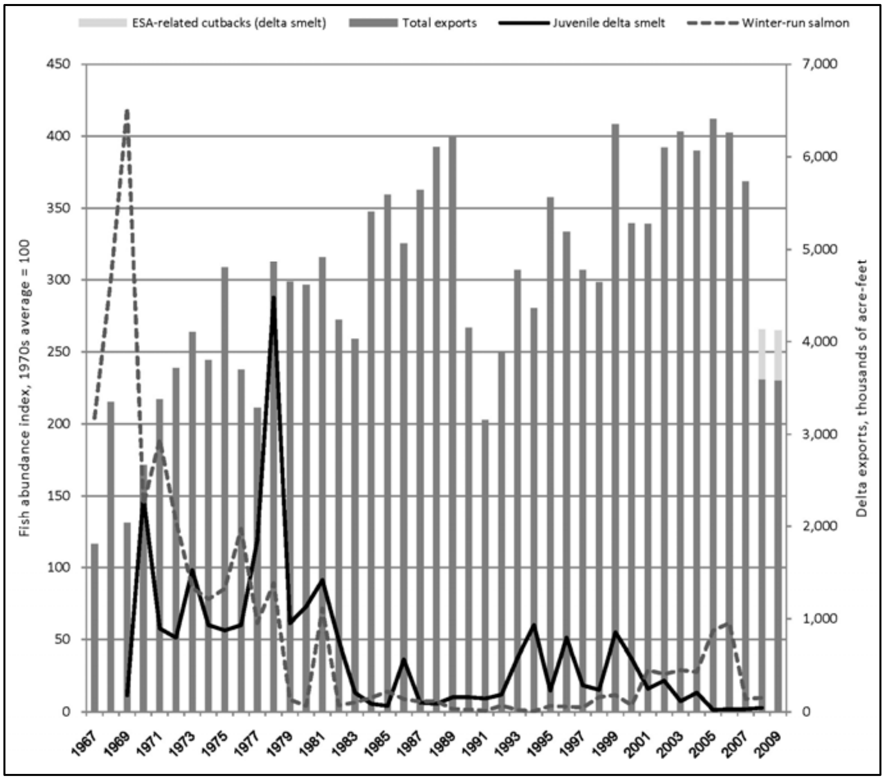
The recent Endangered Species Act restrictions have reduced water supplies available for some water users.

However, the effects are often overstated. Recent delta smelt restrictions come following a time of high sustained water exports and coincide with the ongoing hydrologic drought. In all, they account for fifteen to twenty percent of the recent declines in exports (Figure 5). Over the longer term, delta smelt restrictions are likely to reduce Delta exports by twenty percent to thirty percent on average (Department of Water Resources, 2008a, 2009b; Carlton, 2009) unless the smelt respond to large-scale habitat improvements.

Even if the Endangered Species Acts did not exist, other federal and state laws designed to protect the environment would restrict water withdrawals from California's rivers and streams. High withdrawals threaten not only fish species, but also water quality, recreation, and aesthetics. As a result, the federal Clean Water Act, state water quality laws, the public trust doctrine, and various provisions of the California Fish and Game Code all limit water operations to favor a variety of public purposes (e.g., Moyle, et al., 1998, Craig, 2007; Sax, et al., 2006). State water law, moreover, requires the State Water Resources Control Board to consider all beneficial uses, including the maintenance of fish populations, in managing the State's surface water (Sax, et al., 2006). Removing the Endangered Species Acts' restrictions on water diversions would be unlikely to provide much additional water for non-environmental uses, especially in the long run.

FIGURE 5:

Annual water exports through the Delta and fish population indices, water years 1980-2009



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

Note: ESA-related cutbacks are estimated at roughly 500,000 acre-feet of exports in 2008 and 2009, based on Department of Water Resources (2008a, b). The winter-run Chinook salmon has been listed under the federal ESA since 1989 and the delta smelt since 1993.

The restrictions of 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 impacts to all California residents. As discussed below (value of ecosystems myth), healthy ecosystems provide economically valuable services, such as water purification, fisheries sustenance, recreation, and aesthetic value (Daily, 1997).

Replacing the Myth

There are no true villains in California water policy. Responsibility for water problems must be shared by all water users, and fundamentally results from having a vibrant economy and society in an arid climate. Villains are always someone else. Though 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 the "running out of water" myth). It is also possible to manage water for the environment more effectively, by taking into account habitat and the quality and timing of flows (see the "more water for fish" myth).

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

People are always looking for the single magic bullet that will totally change everything. There is no single magic bullet.

-Temple Grandin

The Myth

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

All too often, solutions to California's water management challenges are summed up as a problem of insufficient construction of some form of infrastructure, be it new surface storage, a peripheral canal to convey water around the Delta, or desalination plants (or larger levees for flood control - see the "safe from flooding" myth). The myth that we can build our way out of the problem tends to appeal to politicians and the general public for its simplicity; it is often promoted by special interests who stand to gain from a particular investment, especially if someone else is paying for it. The danger with focusing on these technological silver bullets is that they deflect 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 complementary actions required to improve environmental conditions.

Infrastructure Solution #1: New Surface Water Storage

Calls for "new surface storage" frequently accompany the "running out of water" myth. 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 the loss of Sierra Nevada snowpack storage predicted to occur from global warming.

How the Myth Drives Debate

This myth assumes 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 provides great flexibility to California's water system, 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 when employed in concert with other water management actions, such as groundwater, water conservation, water markets, and other actions. Reoperation of largely-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, et al., 2008; Carpenter and Georgakakos, 2001; Fissekis, 2008).

However, the myth is founded on the erroneous notion that large unregulated flows will be available for new storage at an economically reasonable cost. The myth persists because most people do not recognize this technical limitation, 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 largest and most frequently advocated surface storage expansions would add 3.1 million acre-feet to the roughly 41 million acre-feet of existing surface water storage capacity and increase water deliveries by one percent, at an estimated cost of $6.4 billion.[15] Surface storage is a costly way to expand water supplies in part because most favorable reservoir locations already have large dams.[16] Early cost estimates from the Department of Water Resources range from roughly $340 per acre-foot (Sites Reservoir in Colusa County) to over $1,000 per acre-foot (Temperance Flat on the Upper San Joaquin River) (Table 1). The actual cost for Sites Reservoir seems likely to be considerably higher, and even a projected cost of $340 per acre-foot is likely to be prohibitively expensive for most farmers.[17] This explains why most recent surface projects have been built (and financed) by urban water agencies, and why some

15. Information from CALFED Surface Storage Investigations as reported in Department of Water Resources (2009a) and USBR (2008a, b) for Sites and Temperance Flat reservoirs. Increased percent of agricultural and urban deliveries are by authors' calculations (0.33 million acre-feet per year, relative to average deliveries of 38 million acre-feet per year from 1980-2005 (see Figure 2).

16. 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.

17. 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. (Author calculations using US Bureau of Reclamation, 2008). Even a projected cost of $340 per acre-foot is likely to be too expensive for most farmers.

farmers have been strong proponents of public subsidies.[18]

TABLE 1

Costs of new water supply sources in California ($ per acre-foot per year)

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	1300
Surface storage (state projects)	340	1070
Desalination, brackish	500	900
Desalination, seawater	900	2500

Sources: Department of Water Resources, 2009a; Department of Water Resources, 2007: low estimate for surface storage; Department of Water Resources, 2005a: conjunctive use; author estimates: water transfers.

Note: For conjunctive use, 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 the "conserve our way out" myth.

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 provides little additional water supply because there is less surplus water to store (Tanaka, et al., 2006; Connell, 2009; Madani and Lund, in press). More active coordination between existing surface reservoirs and groundwater basins - with increased drought (over-year) storage kept underground - could augment overall storage capabilities less expensively, especially with climate change (Tanaka, et al., 2006; Connell, 2009).[19]

18. Diamond Valley Lake in Southern California and Los Vaqueros reservoir in Contra Costa County, both of which came on line in 1999 (Diamond Valley Lake, n.d.; Contra Costa Water District, n.d.).

19. 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

Surface storage operations become much more effective when employed in concert with other water management actions, such as groundwater, water conservation, water markets, and other actions. 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, et al., 2008; Carpenter and Georgakakos, 2001; Fissekis, 2008).

Infrastructure 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 to address these problems is to build 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, allowing water exports to return immediately to their pre-2008 levels or higher. This thinking has misled some water users to believe that Delta conveyance is the only impediment to expanding water deliveries and has distracted 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, 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

enhance fish habitat, particularly to support cold water releases and flows during droughts. However, such environmental enhancements have yet to be analyzed. For environmental purposes, it would also be relevant to compare reoperation of existing or expanded dams with the removal of some dams to allow fish to move upstream to colder water and spawning grounds.

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 to climate change (Tanaka, et al., 2006, 2008; Connell, 2009).

However, a peripheral canal alone will fix neither the Delta nor California's water supplies and is unlikely to improve native fish populations enough to immediately allow increases in exports above currently restricted levels. A favorable outcome for native fishes depends on careful attention to 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 5), some reduction in water exports would likely be required with a canal, at least until fish populations recover (Isenberg, et al., 2008a).[20]

Infrastructure Solution #3: Seawater Desalination

To the general public, seawater desalination is often seen as the ultimate technological fix for California's water supply. California appears to be well positioned to harness desalination, with more than 2,000 miles of ocean and bay coastline, a large coastal population, and a cutting edge technology sector. Some expect this new technology to become so inexpensive that it will soon banish most water shortages and controversies, almost reminiscent of the "too cheap to meter" hopes for nuclear power in the 1950s.[21]

How the Myth Drives Debate

People point to declining desalination costs and examples from the Middle East and Australia where desalination is now used and wonder why California isn't pursuing this solution more aggressively. As with surface storage, they argue for public subsidies to jumpstart desalination investments.

20. 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.

21. Lewis L. Strauss, Speech to the National Association of Science Writers (Sept. 16, 1954) ("Our children will enjoy in their homes electrical energy too cheap to meter. . . .").

The Reality

Desalination of brackish water (less than thirty percent as salty as seawater) is already a proven technology in inland Southern California. Seawater desalination might become useful in some situations: (1) isolated coastal urban areas cut off 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 dependant 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 faces several obstacles which make it unlikely to become a major water source for California in the near future. The technology remains expensive and poses some major environmental challenges, including trapping (or "entraining") marine life at intakes, safe disposal of brine by-product, and high energy use. For decades, technologists have speculated that inexpensive commercial-scale desalination technology would become affordable and commonplace soon (White, 1966; Wiener, 1972). Recent reviews find widely variable desalination costs, with desalination of brackish water costing about $400 per acre-foot to $600 per acre-foot and seawater desalination costing about $600 per acre-foot $1000 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 greater costs of brine disposal and environmental mitigation for seawater plant location.[22] Even with continued technological advances, seawater desalination is likely to remain relatively costly for urban uses, and is unlikely to become viable for directly supplying irrigation water for agriculture (Table 1).

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

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

of actions and includes new infrastructure along with water markets, underground storage, reuse, and conservation.

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

> Contrary to the expectations of policy makers, on-farm efficiency improvements have failed to consistently conserve water on a broader geographic scale in real-world practice. Worse yet, they sometimes result in the further depletion of scarce water supplies.
>
> -*Ray Huffaker* (2008)

The Myth

The water conservation myth implies that California can adapt to changing conditions by focusing primarily on water use efficiency to the exclusion of other alternatives. Examples of countries such as Australia, where daily residential water use is reported to have fallen to roughly 40 gallons per capita ("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 that can be achieved through conservation. Adherence to the myth distracts discussions 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 other water users (the "villain" myth) while providing a silver bullet solution.

Environmentalists often promote conservation as an alternative to new infrastructure (see the "build our way out" myth). Following more than a decade of financial support to urban water utilities implementing conservations measures, California policymakers have recently proposed requiring reductions in per capita urban water use by twenty 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

23. Residential use is a component of total urban use (estimated at 201 gallons per capita per day in California in 2005 - see Figure 3), which also includes commercial and industrial uses.

24. State Water Resources Control Board (2009b) addresses the governor's call for a 20 percent reduction by 2020. This goal is also addressed in legislation proposed in 2009.

already helped California adapt to scarcity, and continued reductions in water use can help California cope with droughts and shortages (see the "running out of water" myth). Reducing water withdrawals from streams and groundwater basins can yield environmental benefits, including improved streamflow,[25] reduced pollution run-off into rivers, streams, and beaches (Noble, et al., 2003), and reduced energy use for acquiring and treating water (California Energy Commission, 2005).

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, two measures that 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 low-water using plants (a crop switch) can greatly reduce net water use. But reducing landscape overwatering (a reduction in gross water use) will only generate net savings if the excess water had not previously been recaptured in a stream or a groundwater basin.

Opportunities for net savings from indoor water conservation depend

25. Streamflow improvements can be significant locally even if there are no 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 normally needed - can reduce consumptive use (creating net savings) by ten percent to fifteen 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, et al., 2006; Ward and Pulido-Velazquez, 2008; Huffaker, 2008; Evans and Sadler, 2008; Clemmens, et al., 2008; Pfeiffer and Lin, 2009.

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 twenty percent by 2020 (State Water Resources Control Board, 2009); though useful, it would produce significantly less than a twenty percent reduction in net urban water use.

Public discussions also frequently fail to acknowledge that water conservation has implementation and operating costs, just like other actions (Table 1). Some conservation quickly pays for itself (e.g., reducing hot water use through low-flow fixtures saves on both energy and applied water) (Gleick, et al., 2003). But other actions can be quite costly (e.g., replacing lawns with low-water landscapes) (Hanak and Davis, 2006). Conservation also can reduce the flexibility of urban areas to cope with droughts because the greater efficiency of use often reduces the potential for inexpensive conservation in times of shortage.

Replacing the Myth

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

Substantial reductions in *net* water use are essential for California. Such reductions are likely to arise from increases in the economic efficiency of irrigation (where less net water use provides a similar or greater level of service, e.g., "more crop per drop") combined with reductions in water use and service levels (e.g., from fallowing irrigated land or seasonally drying lawns), and from reductions in applied water use by residents and businesses in coastal communities. 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: Water Markets Can Resolve California's Water Problems

When the well is dry, we know the worth of water.

-*Benjamin Franklin*, Poor Richard's Almanac, 1746

The Myth

Water marketing is a silver bullet for many economists and businessmen (and some environmentalists) who view voluntary transfers as the ideal mechanism to redress supply and demand imbalances that result from variable water supplies and long-term shifts in demands. Markets are also the favorite tool of those who view water as a commodity, and water rights as a property right like any other. Like other silver bullet solutions (the "build our way out" and "conserve our way out" myths), the dangers of this myth lie in failing to see limitations of the approach and missing out on opportunities to combine it with other water management actions.

How the Myth Drives Debate

The implications of a markets-first approach are two-fold. First, as with conservation, there is a tendency to view other infrastructure investments and actions as unimportant. Second, there is an emphasis on removing regulatory barriers to transactions, so that buyers and sellers can maximize the movement of water. As a result, a markets-first approach risks limiting the use of other water management actions, even actions which would improve the effectiveness of water markets.

The Reality

Temporary transfers of water from lower to higher value uses often help redress shortages during droughts, and long-term or permanent transfers facilitate the evolution of water rights as the economy and climate change. Transfers also can increase environmental flows. The development of a market in California since the late 1980s has demonstrated the value of temporary, permanent, and environmental water transfers (Hanak, 2003; Howitt and Hanak, 2005; Hollinshead and Lund, 2006). Even with restrictions on Delta pumping, increased transfers within the San Joaquin Valley (which has significant disparities in water rights and agricultural productivity) and Southern California (primarily from the Colorado River to urban areas) could lessen the economic hardships of drought and water shortages (Tanaka, et al., 2008). With climate change, the ability to transfer water from wetter to dryer regions is likely to become increasingly valuable (Tanaka, et al., 2006; Connell, 2009).

However, the idea that transfers alone can redress supply and demand imbalances is mistaken; transfers only work well when appropriate infrastructure can move water from place to place. For instance, an ability to move water through the Delta is now essential for any water transfers from the Sacramento Valley (e.g., conserved water from northern California rice farms or stored groundwater or surface water) to cities and farms south of the Delta. During the summer of 2009, this market was curtailed by pumping restrictions in the Delta.

And although some regulatory flexibility is healthy, the most important restrictions on transfers are to ensure that water markets avoid major harm to other water rights holders, the environment, and the public. In particular, water transfers can cause "third party" effects - physical and financial effects on parties other than the buyer and the seller, including other water users (people and fish) and the local economy in the vicinity of the sellers. California law and local ordinances limit transfers to protect parties physically affected by transfers, including downstream water right holders and instream beneficial uses (Hanak, 2003; Gray, 1996). State law and local ordinances aim to protect local groundwater users from overdraft due to unfettered exports of groundwater. Such protections essentially prevent water from being transferred if other water users or the environment would be harmed.

Financial effects, or "pecuniary externalities," can result when sales of agricultural water reduce or eliminate farming in an area. Concern over negative impacts on the local economy (lower farm employment, agricultural input and processing sales, and lower tax receipts) runs high in many farm communities. California law does not protect against these types of impacts (though it does require disclosure of sales of more than twenty percent of the water in an area).[28] Also, water transfers that do not pay a fair

28. See Section 1745.05 of the Water Code. In addition, chapter 2.6 of the Water Code (sections 380-87) requires the State Water Resources Control Board ("SWRCB") to determine that a long-term transfer will not "unreasonably affect the overall economy of the area from which the water is being transferred." This section of the water code applies only to public agencies, which are also able to use the more general water-transfer provisions in chapter 10.5. The latter do not require the

share of the cost of use of conveyance infrastructure can mask the true environmental and infrastructure costs of transfers, and result in public subsidies for market transactions.

One of the greatest values of water markets is their role in supporting flexibility and cooperation in the management of California's highly decentralized water system (Pulido, et al., 2004). Water markets are not like most commodity markets, where buyers and sellers never meet or negotiate directly. Instead, developing deals - especially for longer-term arrangements - typically requires significant collaboration, to sort out safeguards and logistics. Water markets have greatly increased cooperation among water districts as those seeking additional water (southern California and Bay Area cities and some San Joaquin Valley farmers) pay others to voluntarily conserve water (e.g., Imperial Irrigation District), store water (e.g., Semitropic Irrigation District), operate conjunctive use programs (e.g., Glenn Colusa Irrigation District), reoperate reservoirs (e.g., Yuba County Water Authority), or fallow land (e.g., Imperial Irrigation District). In this sense, water markets allow multiple parties to "get better together," instead of fighting over water rights.

Replacing the Myth

Water markets provide important incentives for cooperation and coordination of a portfolio of water management activities. Markets alone do not produce water. Water markets often become more economically and environmentally effective when coordinated with other water management actions (Pulido, et al., 2004; Jenkins, et al., 2004) and rely on well-established property rights for water that allow for market transactions.

Instead of seeking salvation from a single solution, a portfolio approach, orchestrating a wide range of management actions including conservation, water markets, underground storage, and new infrastructure, is much more likely to be successful in addressing California's complex, locally varied, and evolving water problems (Jenkins, et al., 2004). Many water agencies have adopted a portfolio approach to long-range water planning, which can better balance cost and reliability, much in the same way that financial portfolio planning seeks to balance risk and return. Crafting such water management portfolios requires skilled use of data and analysis, which has been underdeveloped in the quest for silver bullets, be they in the form of infrastructure, water conservation, or water markets.

SWRCB to look at economic impacts on local communities. To our knowledge, the provision in chapter 2.6 has never been used.

IV. Ecosystem Myths

Myth: Healthy Aquatic Ecosystems Conflict with a Healthy Economy

Nature provides a free lunch, but only if we control our appetites.

-William Ruckelshaus

The Myth

This classic "fish versus people" argument is imbedded in 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 leads to much greater economic losses than potential benefits.

Though rhetorically convenient for individuals and regions suffering from water scarcity or facing costs of implementing water quality regulations, this myth overlooks or undervalues the real economic benefits of healthy ecosystems. The dangers are under-investing 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 inevitable conflict between economic and environmental water uses drives much recent debate over water allocation, particularly during times of scarcity (see the "villain" myth). It also fuels resistance to the regulation of polluted runoff caused by urban activities and farming operations.

The Reality

Environmental regulations often interfere with traditional economic activities. For instance, the recently imposed environmental regulations on Delta water exports cost several thousand farm jobs (Howitt, et al., 2009b), and uncertainties about Delta supplies are raising concerns in some Southern California cities about the ability to approve new development.[29]

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

29. 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.

that they provide (National Research Council, 2005a; Brauman, et al., 2007). But new tools are emerging to measure and economically value these services (see "Valuing Ecosystem Services"). For example, instream flows support recreational and commercial fisheries, enable water-based recreation, and increase water quality (Daily, et al., 1997). Wetlands and healthy watersheds also reduce flood risks. Watershed protections nationally save 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 from receiving water from the pristine Hetch Hetchy watershed (Null and Lund, 2006).[30] 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 "non-use" or "existence" value).

One consequence of the failure to put a price tag on environmental flows is that many environmental water demands remain unsatisfied.[31] 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, et al., 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 settlement on the San Joaquin River, 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

30. 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 twentith century.

31. 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 ten to twenty percent between wet and dry years, environmental water use can drop by over fifty percent during droughts (Department of Water Resources, 2009a).

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 US Environmental Protection Agency (2009) concludes that the government should better integrate ecosystem services into decision making 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 provide information about how much the voting population values particular services.

restored flows (in terms of recreation, lower treatment costs, and the "existence" value of restored flows) can far exceed farm revenue losses.[32]

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

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: More Water Will Lead to Healthy Fish Populations

It takes more than water to restore a wetland.

-J. B. *Zedler* (2000)

The Myth

Ongoing debates over the peripheral canal, rewatering the San Joaquin River, restoring steelhead runs in southern California, federal relicensing of hydropower dams in the Sierra, and restoring endangered and threatened salmon and sucker fish in the Klamath River all involve a common, contentious 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 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

32. 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 non-use value from the restoration of the river. (Hanemann, 2005)

simplifies current policy debates, making them manageable for decisionmakers and stakeholders. It is in the interest of utilities and water contractors to focus on this issue because it implies that a science-based, quantifiable solution exists with reasonable certainty. It is in the interest of the financially strapped fisheries agencies because it allows them to focus on monitoring flows using existing stream gauges, rather than expanding efforts to measure fish populations. Elected officials also focus on this issue because it is easy to communicate and understand - add more water, get more fish, and other water users get the rest. 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.[33] Streamflow diversions and groundwater pumping have significantly diminished fish numbers, with great impacts on Central Valley, Lahontan, 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 such 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." Here's why:

First, more water is *not* always better for fish. If 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.[34] 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 evolved in warmer waters tend to do poorly when water temperatures are made artificially cold by releases from dams (Clarkson and Childs, 2000).

Second, water without sufficient physical habitat does little good and

33. Californians typically divert and consume much of the flow from the state's major rivers, averaging twenty-five percent of Sacramento River flows and over half of flows in the San Joaquin River (Calculations by William Fleenor using Department of Water Resources data).

34. For instance, riparian shading and temperature control devices on dams can provide water temperatures that support fish without dedicating additional water (Null, et al., 2009; Vermeyen, 1997). See also Welsh, et al., 2001.

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).

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 and complex physical habitat, high water quality, and be protected 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. Fisheries 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: Restoring Native Ecosystems is Essential for the Recovery of Native Species

> Ecological restoration efforts should aim to conserve and restore historical ecosystems where viable, while simultaneously preparing to design or steer emerging novel ecosystems to ensure maintenance of ecological goods and services.
>
> -S.T. *Jackson and* R.J. H*obbes* (2009), p. 567

The Myth

As demonstrated by the durability of the Endangered Species Act and the Clean Water Act, society values native species and healthy ecosystems that provide habitat for native species. Some interpret this to mean that California's native ("natural") ecosystems must be restored to pre-European conditions. Often, this unattainable ideal has polarized discussions and hindered serious environmental management.

How the Myth Drives Debate

The notion of "restoration" was a useful guide in the early days of environmental management. Early efforts focused on attempting to discover and recreate a pre-development condition that would be suitable to support native species. This ideal is no longer attainable because California's built environment is fully integrated with the natural environment, and both are undergoing rapid change (Jackson and Hobbes, 2009). While most scientists and policymakers recognize that true restoration is not possible, "restoration" remains a flashpoint in public debates.

Rhetorical perpetuation of the myth has three potentially negative policy outcomes. First, for some water users, it becomes an excuse for not taking action to protect native species: if native ecosystems cannot be "restored," how can we save the species that depend on them? (Or, if we can't restore the Delta to its natural state, why should we waste all the money, time, and water keeping delta smelt from going extinct?) Second, for some environmental interests, the myth implies that native species can only recover if additional development is stopped and existing development is reversed to return the system to pre-development conditions. But restoration efforts based mainly on seeking a return to hypothetical pre-development conditions will, due to ever-changing conditions, prove ineffective at sustaining native species, and keep water supply management in turmoil. Third, and most importantly, the conflict between these first two views distracts attention from promising means of managing water that serve both the natural environment and societal well-being in the longer term.

The Reality

Some features of native ecosystems will be needed to support native species.

However, there are no pristine ecosystems left in California and probably not in the world. For California, pre-development conditions are usually considered to be those before the Gold Rush era, which is fairly arbitrary because the native peoples also modified the landscapes in major ways (e.g., keeping forests open by fire).

Large numbers of non-native species and changes in land and water development have irrevocably altered California's ecosystems, and will continue to effect changes in the future. Wilderness areas still retain human recreational and other uses, while supporting non-native plant and animal species. Our forests and rivers have to be continually managed to provide the high-value ecosystem services we expect from them. Indeed, many services, such as fisheries or erosion control, come from non-native species. Thus even contemporary "natural" ecosystems can be very different in species composition than they were historically, depend on human intervention, and continue to change. But the native species that are maintained in such systems are often our most sensitive indicators of the condition of the ecosystems.

Instead of aiming to restore native ecosystems, we can usefully apply our perceptions of the historical systems to set guidelines for maintaining or even recreating functional environments. There is growing recognition that ecosystems that function in more "natural" ways provide many services that are valuable to humans and native species (see the "ecosystems versus economy" myth). Thus the restoration of flows to the lower Owens River not only recreated habitat for the Owens tui chub and for a trout fishery, but reflooded alkaline Owens Lake. This reduced toxic dust blown by storms from the surface of the dry lake, which threatened human health over a wide area. However, the ecosystem that provides these services today is different in many ways from the ecosystem that once existed in the same area. The trout fishery in the Owens River, for example, is for brown trout, a species imported from Europe. Most ecosystems in California are similar in this respect.

While the restoration myth seems to exist more in rhetoric than in reality, the myth still very much colors the debate on how to manage ecosystems into the future, achieving a balance between commercial benefits to humans and benefits to wild organisms. Aesthetically, we know in a general sense what we want: unpolluted streams that flow with clear cold water through shady forests and estuaries and lakes with abundant fish and birds without mats of noxious algae or floating garbage. But the exact characteristics of such ecosystems tend to be vague both in people's minds and in policy. Rather than talking about restoration as the universal goal for ecosystem and habitat protection, it might be more useful to focus on reconciliation as the goal, where reconciled ecosystems possess the desirable aesthetic traits and wild species but are well integrated into human landscapes (Rosenzweig, 2003).

The concept of reconciliation as the underlying idea of our interactions with the environment recognizes that we humans are committed to large-scale ecosystem management for our own benefit and those of native species. It recognizes that we need healthy ecosystems but that the nature of these ecosystems will be determined largely by our actions. For California water policy, this means, for example, that we need to make decisions about how we want our aquatic ecosystems to look and work. While we talk about flows being "restored" to the San Joaquin River, for example, we are in reality creating a very different river from the historical river that once existed in the San Joaquin Valley. The reconciled river will no longer be dry and will have small salmon runs, but it will also contain many non-native species and flow through constructed channels in many places. In managing this river in the future, we will constantly be making decisions to favor different organisms and even different aesthetic values. But the basic template for the reconciled river is being laid down now. This is not a bad way to approach future "restoration" projects.

Replacing the Myth

Tomorrow's healthy ecosystems, though resembling natural systems in some ways, will depend heavily on continued human management and have different species composition than historic ecosystems.

Managing the system for the benefit of native species often works to benefit humans as well, especially from a long-term perspective. As California's economy continues to shift towards activities that demand high environmental quality for clean water, recreation, and other ecosystem services, it will become increasingly important to manage water resources for both commercial value and healthy ecosystems. But the healthy ecosystems of the future will not be identical to those of the past and many will need to be quite different.

Some of the characteristics of reconciled ecosystems would include: (i) provision of ecosystems services such a clean water, recreation, and fisheries, (ii) high aesthetic value (which can change through time; what we value highly today may not be the same as what future generations will value), (iii) resiliency - a high ability to absorb disturbance while maintaining basic ecosystem structure and function (Walker and Salt, 2006), and (iv) self-sustaining populations of desirable species, especially native species.

V. Flood Management Myth

Myth: Current Flood Protection Standards Keep Communities Safe

> Hazard always arises from the interplay of social and biological systems; disasters are generated as much or more by human actions as by physical events.
>
> -*Gilbert White* (1978)

The Myth

Federal law generally restricts urban development and requires that property owners have flood insurance within a designated "100-year" floodplain (having more than a 1-in-100 chance of flooding in any single year).[35] This policy framework has fostered the myth that current flood protection standards keep communities safe. The danger in this myth lies in encouraging new development in high risk areas and lulling existing homeowners into thinking they are safe and don't need flood insurance outside of the 100-year floodplain.

How the Myth Drives Debate

Since the introduction of new federal policies in the 1960s, communities have sought to avoid development restrictions and the need for flood insurance for their residents by making investments to meet the new minimal federal standards of protection. As a consequence, billions of dollars of flood management infrastructure - including levees, dams, by-passes, and other river modifications - have occurred under the mistaken belief that they provide safety for new development. Adhering to this myth allows public officials and land development interests to accept minimal levels of flood protection at little risk to themselves.

This policy also has also encouraged the ecological separation of floodplain land from rivers and discouraged land uses, such as farming, open space, and wildlife habitat that might be more compatible with occasional floodplain inundation. As is common in coastal hurricane areas, but so far not widely successful in California, raising and otherwise making structures resistant to flooding can sometimes reduce flood damages with less investment in flood protection infrastructure and environmental damage.

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35. In the 1960s the federal government established the National Flood Insurance Program (NFIP) and set national minimum standards for the performance of federally-supported flood control projects. To qualify for flood insurance, communities must restrict new development from the reach of floodwaters in the "100-year flood" (the flood with a 1-in-100 chance of occurring in any single year). Owners, in turn, must generally only hold flood insurance for properties within Special Flood Hazard Areas (SFHA), deemed to have a higher likelihood of flooding.

The Reality

In all but the wettest years, California's flood management systems prevent significant flood damage or loss of life. The federal requirements force communities to acknowledge the possibility of flooding, even if they have yet to experience a large, damaging flood.

But in the aggregate, traditional investments in flood infrastructure, while decreasing flood frequency, often increase flood risk by creating a false sense of security (White, 1945; Carolan, 2005; Pinter, 2005, Montz and Tobin, 2008). The underpinnings of the myth that our flood protection standards keep communities safe lie in how we manage for risk, our perceptions of risk, and the way traditional flood infrastructure increases risk (Mount, 1995; Carolan, 2005; Galloway, et al., 2008).

Federal standards provide only a uniform standard for frequency of flooding and neglect economic and social consequences from flooding. Measures of economic risk consider both the likelihood of flooding and its consequences, such as property damage, loss of life, and broader economic disruptions (Helm, 1996; Plate, 2002).[36] With uniform flood frequency standards, densely populated urban communities on a deep floodplain (with flood depths over house eaves, risking loss of life) are regulated in the same way as suburban communities on a flood terrace (flooding to the doorstep without loss of life). As an illustration, Figure 6 shows flood depths for the Sacramento area in the event of levee failure. Under the federal standards, shaded properties are considered to have the same levels of protection, even though they face flood depths ranging from just one foot to over ten feet. An economic risk calculation would account for differences in damage exposure and require higher protection in areas with higher losses from flooding (Van Dantzig, 1956; Zhu, et al., 2007).

In general, the federal minimal standards are quite low for areas with significant economic value at risk. Here it is useful to think in terms of how the residual, or remaining, flood risk[37] varies with different levels of flood protection. In an area with $1 billion of potential economic flood damages (roughly the potential damage for a community of 5,000 homes having potential losses of $200,000 per home), a 1-in-100 year level of protection has a residual risk of $10 million per year ($2,000 per year per household). Even a 1-in-500 year level of protection retains a flood risk of $2 million per year ($400 per year per household).

The focus on achieving a weak frequency standard misleads policymakers and the public into thinking that floods are adequately managed (James and Singer, 2008). This misperception often leads to

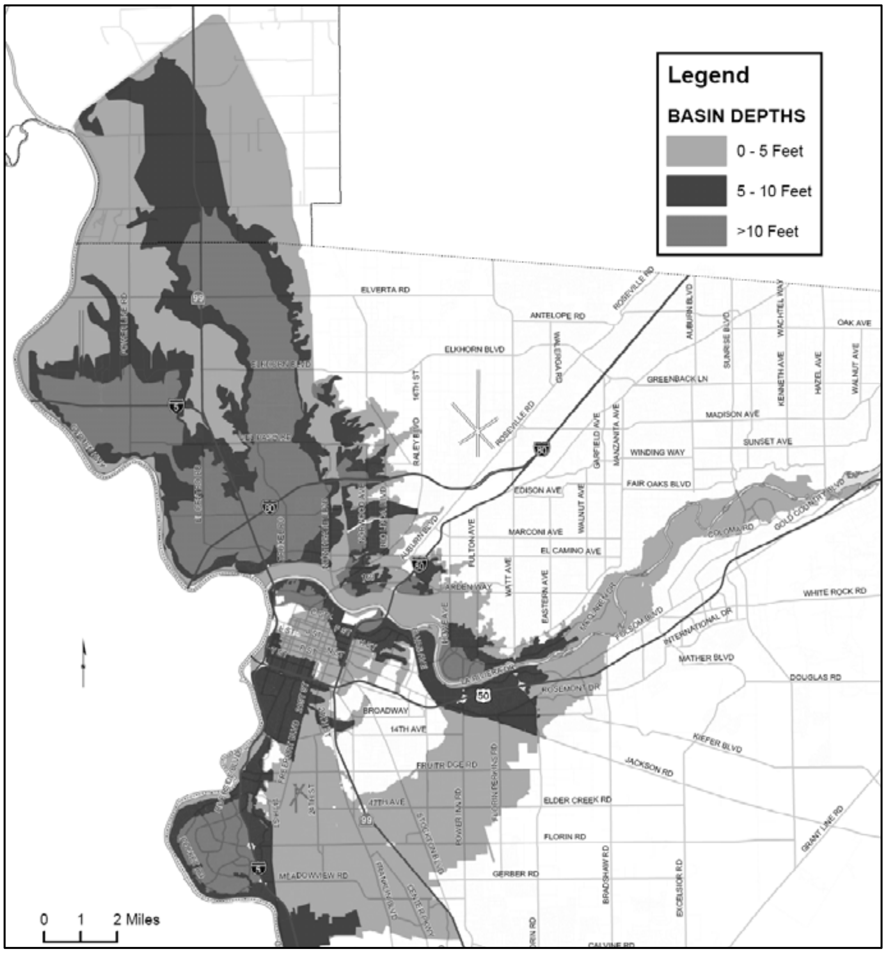
36. This risk is defined as the product of the annual probability of each flood size (the flood frequency) and the economic costs of that flood.

37. Residual risk is the risk from flows exceeding the flood design capacity or the failure of flood management infrastructure before the design capacity is reached (Green, 2004).

additional economic development on floodplains, further increasing already high residual flood risks. If raising flood protection for agricultural land (with a damage potential of $2,000 per acre) from 1-in-50 years to 1-in-200 years results in urbanization of that land (raising the damage potential to $1 million per acre), annual flood risk rises from $40 to $5,000 per acre.[38] This process has occurred time and again in the fast-growing Central Valley.

FIGURE 6:

Flood depths in the Sacramento region



Source: Sacramento Area Flood Control Agency (www.safca.org)

Financial incentives for flood infrastructure compound this problem, because state and federal governments have paid for most flood infrastructure, making it relatively affordable for communities to attain

38. $40 per acre-year = 0.02 per year*$2000 per acre;
$5,000 per acre-year = 0.005 per year * $1,000,000 per acre

minimal federal standards. In addition, local governments in the Central Valley face skewed incentives since a 2003 California appellate court decision, which holds the state liable for damages from failures of state levees, even though local governments are responsible for land use decisions and most levee maintenance (Department of Water Resources, 2005b). This encourages local agencies to promote development in flood-prone areas, with the state bearing most flood liability.

Flood-prone development also is encouraged by human tendencies to discount risk. Personal experience is the most important factor shaping both perception of and response to flood risk, but length of time since previous flooding also plays a critical role. This "flood memory half-life" problem is well illustrated by the number of California residents that purchased flood insurance following the Central Valley floods of 1997 (Hanak, 2008). Immediately afterward, per capita flood insurance purchases doubled (to four percent of properties), but largely returned to pre-flood levels by 2005, despite no notable reductions in flood risk. Similarly, politicians are most likely to push for better flood protection soon after flood events. More proactive risk communication, including public disclosure of risks in areas protected by levees, would encourage insurance purchases.[39]

Since federal standards and procedures are unlikely to change, the onus is on the state to develop a better flood policy framework. A set of bills signed into law in 2007 takes some steps in this direction, by tightening the flood frequency standard to a 200-year flood for future urban development in the Central Valley, making local governments share liability with the state, and requiring communities to incorporate flood hazard reduction in their general plans. But state policy still relies on a uniform flood frequency standard. Moreover, the new flood policy only applies to the Central Valley and not the densely populated regions of southern California and the Bay Area that remain at high risk of flooding. A more risk-based statewide flood management system, such as that used by the Netherlands, where risk-based analysis was used to establish a 1-in-10,000 year event protection level for urban areas (Woodall and Lund, 2009), would require new legislation as well as better technical data and changes in management approaches.

39. Hanak and Reed (forthcoming) find that the introduction of disclosure rules for SFHA status upon home sale increases insurance uptake by about 15 percentage points.

Replacing the Myth

No level of levee or reservoir investment can eliminate risk from floods.

Any levee can fail, no matter the design level of protection, and any historical floodplain can flood under the wrong circumstances, even when combined with upstream reservoirs and flood by-passes. California should move toward a policy focusing on risk-based management and improve the communication of risk to floodplain residents.

VI. Governance and Legal Myths

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

> It is revolting to have no better reason for a rule of law than that so it was laid down in the time of Henry IV. It is still more revolting if the grounds upon which it was laid down have vanished long since, and the rule simply persists from blind imitation of the past.
>
> *-Oliver Wendell Holmes, Jr.* (1897)

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 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 for restrictions on their water use required 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.

The Reality

California's system of water rights *is* a complex, often confusing, and sometimes incoherent amalgam.[40] 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.[41]

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.[42] 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.[43] 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 responds 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).

40. 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).

41. "Indeed, some courts that have adjudicated recent water rights takings claims have been confused by the complexities of the state's water rights system or deterred from addressing the most fundamental issue in such cases: whether the claimants have protectable rights under California law to divert or use water in situations where the exercise of the water right is harmful to water quality, fish, or other instream beneficial uses (*Casitas Municipal Water Dist. v. United States*, 2008; *Stockton East Water Dist. v. United States*, 2009).

42. 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 State Water Resources Control Board's permit and license jurisdiction (*Barstow v. Mojave Water Agency*, 2000; *National Audubon Society v. Superior Court*, 1983).

43. *Joslin v. Marin Municipal Water District*, 1967.

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. Like 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.[44] 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 authority to declare a variety of water practices unreasonable, even if they were considered acceptable in the past. 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. 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 state may wield the unreasonable use determination as an incentive for more efficient water use and allocation. One of the premises of the modern water transfer statutes is the creation of economic incentives for the reallocation of conserved water and water for which the transferor can earn more revenue in transfer than in its own use. Enforcement of the reasonable use mandate to induce these types of transfers is consistent with these statutes and should become a more prominent component of

44 To date, the State Water Resources Control Board 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 over-appropriated watershed; inefficient conveyance and production of excessive tailwater by pre-1914 appropriators that 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 jeopardizes 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, 1994b & 2002).

California's water use efficiency and reallocation strategy.

3) Compliance with environmental standards and protection of the public trust

The reasonable use doctrine also helps to implement and enforce the public trust and the other environmental laws that protect water quality, endangered species, aquatic habitat, and other in situ uses. These laws establish fundamental limitations on the amount of water that water right holders and their derivative users may impound and divert from California's rivers, lakes, and estuaries. They also restrict the quantity and types of return flow and effluent that water users may discharge back into the state's water systems. Because there is no valid property right in an unreasonable use, when the state acts to abate 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 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: Groundwater is Separate from Surface Water

> California is the only western state that still treats surface water and groundwater under separate and distinct legal regimes. . . . As the present case illustrates, classification disputes in this field quickly take on an Alice-in-Wonderland quality because the legal categories (e.g., "subterranean streams flowing through known and definite channels," "percolating water") are drawn from antiquated case law and bear little or no relationship to hydrological realities.
>
> *North Gualala Water Co. v. State Water Resources Control Board*
> 39 Cal. App. 4th 1577, 1590 (2006)

The Myth

Water pumped from the ground is a major component of California's water supplies, accounting for roughly one-third of all agricultural and urban water use in years with normal rainfall, and considerably more in dry years.[45] It is widely understood that ground and surface waters form a hydrologically connected system in much of the state.[46] Yet the conventional understanding in California water policy is that groundwater and surface water are legally distinct, with groundwater rights and regulation fundamentally separated from surface water rights and regulation. Like the myth of inflexible water rights, this understanding contains elements of truth, but also misses important aspects of current California law that would allow for more effective, integrated management of water resources.

How the Myth Drives Debate

The myth that these two types of water are legally distinct has exacerbated two central problems of contemporary California water resources management. It has prevented water managers and regulators from accounting for the effects of groundwater withdrawals on surface water supplies (and *vice versa*). It also has allowed policymakers to tolerate serious cases of groundwater overdraft and indirect withdrawal of surface waters because of the perceived difficulties of applying to aquifers rules commonly accepted as essential components of surface water regulation.

The Reality

The state's modern water code, enacted in 1913, does indeed create an artificial separation between groundwater and surface water rights. The Water Commission Act of 1913 created a permit and license system only for

45. The balance consists of surface water flowing in rivers and streams (and often stored behind dams). Recycled wastewater accounts for less than one percent of the total used by farms and urban areas.

46. Hydrologists, water managers, and most water users have known for decades that surface streams and underlying aquifers are physically integrated systems in most of California (Bredehoft, Papadopulos, and Cooper, 1982; Harter, 2003). Before extensive water resources development occurred in the latter half of the nineteenth century, groundwater in the Sacramento and San Joaquin Valleys was in a rough balance with surface streams. High winter and spring surface flows, especially at higher elevations, would push some stream flow into aquifers. In summer and early fall, these higher aquifer levels would increase base flows to surface streams (Harou and Lund, 2008). As development and use of these water resources increased, surface water recharge of the aquifers diminished; and as groundwater levels fell, the aquifers reduced flows to surface streams. Although increased pumping during much of the twentith century has reduced the flows between groundwater and surface water resources (Fleckenstein, et al., 2004), infiltration from surface streams remains important for groundwater recharge (Harter, 2003). Deep percolation of irrigation return flows - the amount of water in excess of plant needs - also contributes to recharge.

surface water and "subterranean streams flowing through known and definite channels."[47] The statute has been consistently interpreted as not applying to "percolating" groundwater - regardless of the hydrologic relationship between such groundwater and surface water resources. Most other states have legal and regulatory systems that provide much more integrated management of surface and underground waters.[48]

Nevertheless, integrated management of hydrologically connected groundwater and surface water is in fact a prominent feature of contemporary California water policy, recognized by all three branches of state government:

- The foundational directive of state groundwater rights law - that aggregate withdrawals not exceed the safe yield of the aquifer - recognizes that groundwater basins are recharged principally by surface water sources, including percolation from precipitation, surface streams, residual water from urban and agricultural uses, and managed recharge (e.g., *Los Angeles v. San Fernando*, 1975).
- The Legislature has created several special water management districts (in Orange, Santa Clara, and Ventura Counties) with authority to regulate groundwater extractions and impose pumping charges to reduce economic incentives to overdraft and to pay the costs of imported surface water supplies (Schneider, 1977).
- Most judicial decrees in the nineteen adjudicated groundwater basins authorize similar types of conjunctive water management

47. Although early California law and policy are often credited with ignoring the hydrologic interrelationships between groundwater and surface water, the record is more ambiguous. The California Supreme Court's first important twentith century groundwater rights decision, *Katz v. Walkinshaw* (1903) is famous for its adoption of the basic rules of groundwater rights that remain the law of the state to this day: overlying landowners have first call on the waters of aquifers beneath their lands, followed by non-overlying users in order of their priority of appropriation. Less remembered is the Court's recognition that groundwater and surface water resources most often occur as single, integrated systems. Although the Court acknowledged that it "is usual to speak of the extraction of this water from the ground as a development of a hitherto unused supply," in fact groundwater pumping may cause "an exhaustion of the underground sources from which the surface streams and other supplies previously used have been fed and supported." In a review of the legislative record for the Water Commission Act of 1913, Sax (2003) concluded that the Legislature intended to grant the Water Commission (predecessor to the State Water Resources Control Board) regulatory jurisdiction over the "pumping of groundwater that appreciably and directly affected surface stream flows."

48. Under Colorado law, for example, all groundwater is presumed to be "tributary" - i.e., hydrologically connected to surface water - unless the groundwater user can prove that its pumping will have only negligible effects on surface water sources. Arizona strictly limits the withdrawal of groundwater in areas of critical overdraft. Other states, including Montana, New Mexico, Nevada, Oregon and Utah, have permit systems governing the appropriation of groundwater and surface water (Sax, et al., 2006).

arrangements (Blomquist, 1992).

- The California Supreme Court recognized in the Los Angeles groundwater adjudication that the city's pueblo water rights in the Los Angeles River extend to all hydrologically connected groundwater (*Los Angeles v. San Fernando*, 1975).

- The legislature authorized the SWRCB and the courts to adjudicate all groundwater and surface waters of the Scott River System as a single hydrologic resource, and the decree in that case manages groundwater and surface water uses as an integrated system (Schneider, 1977; Department of Water Resources, 2003).

- The California Supreme Court adjudicated all groundwater and surface water rights in the Mojave River basin adjudication and affirmed a decree based on the importation of surface water to recharge the aquifer to support groundwater uses (*Barstow v. Mojave Water Agency*, 2000).

- In an unusual move, the SWRCB recently began limiting total withdrawals (including groundwater) to help maintain flows in the Russian River (State Water Resources Control Board, 2009a).

In addition, numerous less formal methods are employed for managing surface and groundwater resources jointly. Many water districts in the Central Valley seek to reduce groundwater overdraft by setting the price of surface water supplies to be slightly below the costs of pumping groundwater. This encourages farmers to use surface waters in wetter years, both to reduce groundwater withdrawals and to promote aquifer recharge (Vaux, 1986; Jenkins, 1991; Bredehoft, et al., 1995). In Kern County and other areas, regional water managers have established sophisticated groundwater banking projects, which store native and imported surface water for local and export uses (Thomas, 2001; Hanak, 2003).

But problems remain. Groundwater banking is hindered in basins where parties cannot agree on accounting and management protocols - a problem in much of the Central Valley. Under current state law, it is possible to transfer surface water and make up the difference by pumping groundwater, even if the additional pumping reduces stream flows - a concern in much of the Sacramento Valley (Gray, 1994b). A similar issue can arise with the regulation of environmental flows. When the SWRCB instructed surface water users along the Russian River to reduce diversions to protect endangered steelhead in 2008, increased groundwater pumping limited the effectiveness of the regulation, prompting the Board to set overall conservation targets, as noted above. More integrated legal treatment of groundwater and surface water is key to resolving these types of problems.

Reform by legislation, rather than through *ad hoc* judicial or administrative determinations, is desirable because integrated administration of groundwater and surface water rights in each hydrologic basin will require comprehensive analyses of the volume and movement of water within the aquifers, the effects of groundwater pumping on surface water supplies, the sources and rates of surface water recharge, the effects of surface water diversions on groundwater recharge, the relative contributions of native and imported surface water sources, the appropriate ordering of priorities among groundwater rights and surface water rights in the newly integrated systems, and other factors. But as noted in the preceding myth, even without new legislation, the SWRCB and the courts have authority under the reasonable use and public trust doctrines to limit groundwater withdrawals that unreasonably affect surface water resources or impair the public trust in surface streams and lakes.

Replacing the Myth

Despite the long-standing legal distinction between ground water and surface water rights, California's groundwater and surface water resources are often closely interconnected and managed conjunctively.

With population growth and increasing demands for environmental flows, California is likely to experience increasing conflicts in areas where groundwater and surface water are governed separately and continuing overdraft of aquifers as demands for water rise and usable surface supplies diminish. Although all branches of government have taken actions to integrate these water resources in various parts of the state, legislative reform is desirable to better integrate the administration of groundwater and surface water statewide.

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

> Consensus means that lots of people say collectively what nobody believes individually.
>
> -*Abba Eban*

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 between opposing parties that result in winners and losers, most often decided by the courts or public referenda. Achieving consensus is seen as an alternative way to balance the many competing interests, views, and goals of different stakeholders. But when consensus processes avoid inevitable tradeoffs in water management, they can lead to ineffective incrementalism and indecision on critical water policy issues.

How the Myth Drives Debate

Consensus-based decision-making was popularized during the

CALFED[49] 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 under the slogan "we will all get better together." Although that process is widely considered to have failed in achieving its primary goals, consensus-based decision-making continues as the hallmark of stakeholder-driven planning and policy processes. Many stakeholders support the idea of consensus processes to be sure they get a seat at the bargaining table so they can defend their interests and stall or veto unfavorable decisions.

The Reality

Consensus is most promising where incremental changes to the status quo can allow all parties to improve their position without sacrificing fundamental interests or positions. For instance, the state's new recycled water policy was developed through a collaboration of regulators, water users, and environmentalists (State Water Resources Control Board, 2009c). Similarly, 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 some groups to relinquish fundamental positions or interests. A peripheral canal can benefit the economy and the environment, but will likely accelerate water quality losses for some Delta farmers, and it makes it less likely that the state will provide large subsidies to shore up all of the Delta's aging levees (Lund, et al., 2008). Taxpayer-financed surface storage will benefit some water users and perhaps also some fish, but it will mean higher taxes or lower public spending on other programs (such as education). Some environmental actions may largely benefit future residents, at some cost to current residents. Seeking consensus on all water policy matters runs the risk of maintaining the status quo, rather than making hard choices.

Most large stakeholder-driven processes seek small incremental changes in the status quo, because large changes threaten too many interests (Lindblom, 1959, 1979). This risk avoidance is especially problematic when decisions must be made with some urgency and incremental options are decidedly inferior (Coglianese, 1999; Lomas, 1991). Such was the experience with CALFED for the Delta, and it is a commonly cited problem with decentralized decisionmaking (Little Hoover Commission, 2005; Goodhue, Simon and Stratton, 2009; Hanemann and

49. 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.

Dyckman, 2009). Within a system of decentralized interests and governance, leadership from state and/or federal authorities is often needed to chart strategic new directions.

Placing a consensus process within a legal, regulatory, or political framework and timeline can motivate parties to be more earnest and timely in seeking consensus solutions. For instance, the accord on restoring flows to the San Joaquin River 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 effects of structural changes in the economy with severe ramifications for some industries (e.g., textiles, logging), and similar strategies have been used to address the financial impacts of water transfers in some California farm communities (Hanak, 2003).

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 motivation, and to 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 and/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.

VII. Moving Beyond Myth

> People would rather live with a problem that they cannot solve than accept a solution that they cannot understand.
>
> -*Woolsey and Swanson*, 1975

California faces major challenges in establishing a sustainable path for water resource management in the twenty-first 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. Myths are 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 have not yet been widely employed in California and that may reduce the reliability of supplies. Fourth, while 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:

1) Improve flows 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 (Water Supply myths).

2) Collect and disseminate new information

To provide a sounder basis for using California's water laws for groundwater and ensuring reasonable use, California must collect and document more accurate water use information from the field (Water Rights myths). 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.

3) 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 (Ecosystem myths), flood management (Flood myth), integrated water management portfolios (Water Supply myths), and other purposes. Expanded analysis also should include lessons from other states and countries which struggle with similar problems. More generally, a better understanding of the value of ecosystem services and the tradeoffs inherent in water policy decisions (Consensus myth) can help clarify the policy choices California faces.

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.

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