california water impact network

April 8, 2019

Undersecretary Tom Gibson
California Natural Resources Agency
1416 Ninth Street, Suite 1311
Sacramento, CA 95814

Dear Mr. Gibson,

Thank you for the opportunity to share our work with you.

We believe we share the common goal of equitable and sustainable water policy for all Californians: ratepayers, agriculture, business and the environment. We also believe that Governor Newsom now has the unprecedented opportunity to correct the course of California history and create lasting positive change. We are well-positioned to help the Newsom Administration realize that goal.

Our research has shown that there's enough water to meet the needs of our growing state if it is managed equitably. Partnering with many groups and stakeholders around the state, C-WIN has developed the road map to California's new water future. A road-map that is realistic, thoughtful and achievable.

Your time is very valuable to the people of California. In the interest of efficiency, we're forwarding some background information on the most pressing issues regarding California's water. We will bring hard copies of this document to leave with you and your staff after our meeting.

Thank you again for meeting with us, and for your efforts toward a beneficial water future for all Californians.

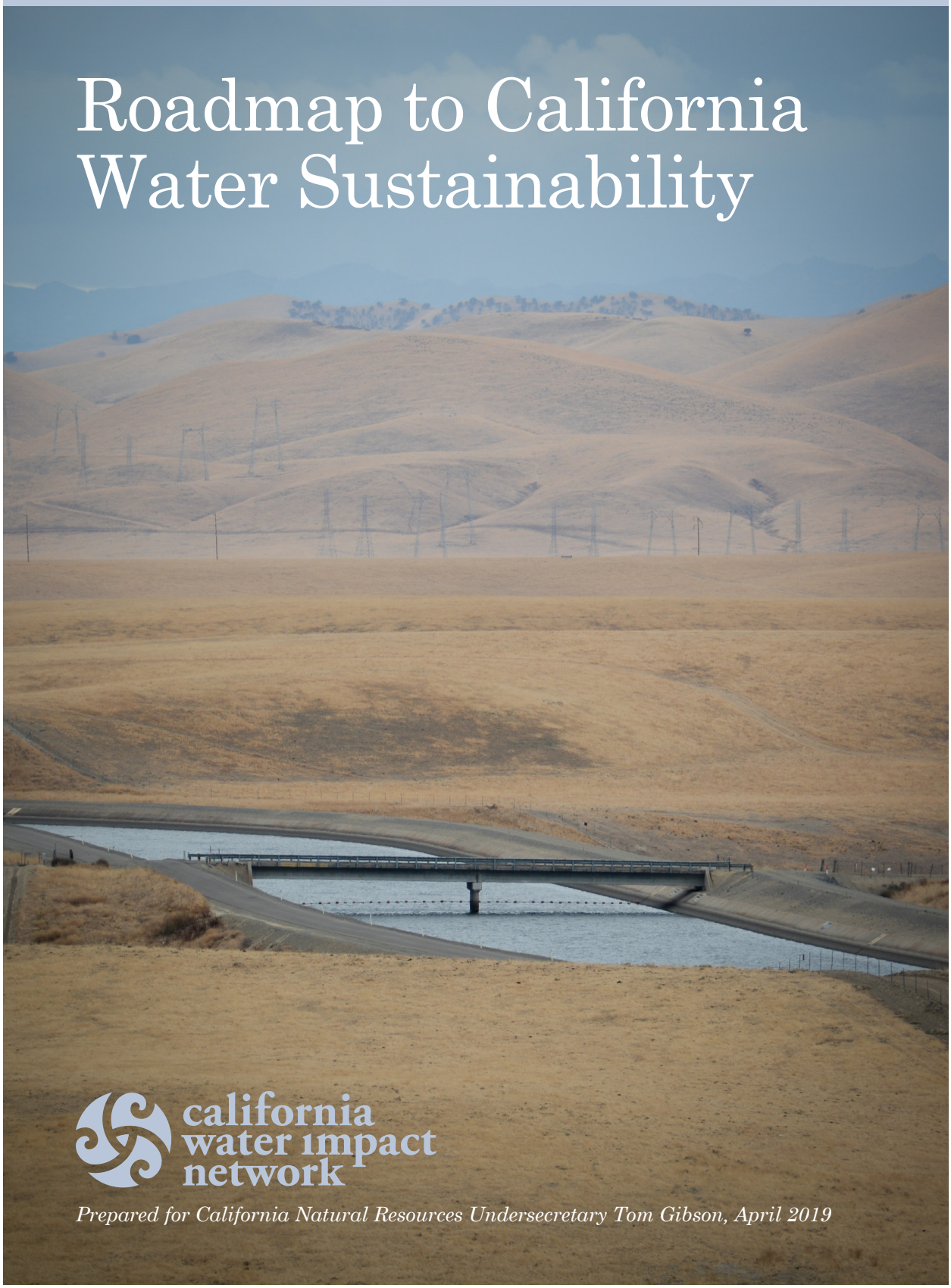
Sincerely,

Carolee Krieger

Carolee Krieger, Executive Director, C-WIN

808 Romero Canyon Rd., Santa Barbara, CA 93108, caroleekrieger7@gmail.com, phone: (805) 969-0824, fax: (805) 565-3394, **www.c-win.org**

Roadmap to California Water Sustainability



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Prepared for California Natural Resources Undersecretary Tom Gibson, April 2019

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Solutions to Equitable Water Management

The Roadmap to Success

Drought or not, there's enough water to meet the needs of all Californians and the environment if it's managed equitably. Mismanagement of public water is undermining the economic stability and well-being of California's communities and environment.

Step 1. Quantify how much water is available for export from the Delta.
The State Water Resources Control Board has never quantified the amount of water available for export from the Delta watershed. California planning is based on "paper water."

Step 2. Initiate a Public Trust Analysis.
As the steward of California's Public Trust resources, the State is obligated to perform this analysis, which will determine the needs of all stakeholders and the impacts of proposed solutions on communities and the environment.

Step 3. Implement the standards of the 2009 Delta Reform Act.
Determine how much new water is available from south of the Delta regional supplies, including reclamation, storm water capture and environmentally responsible desalination. Money spent here is more productive than tunnels and dams that supply no new water.

This plan has been developed over time by a large consortium of water stakeholders, of which the California Water Impact Network (C-WIN) is a key player. Until California understands how much real water there is to manage, it's irresponsible to spend billions on tunnels and dams that produce no new water.

Step 1:

Quantify how much water is safely available for export from the California Delta

Fundamental to the water problems of California is the lack of understanding about the amount of water available for export from northern California to southern California by the State Water Project (SWP) and the Central Valley Project (CVP). The State Water Resources Control Board has never quantified the amount of water available for export from the Delta watershed.

C-WIN determined that the water of the 20 rivers of the Delta watershed has been **oversubscribed by 5 1/2 times what is available.** Our researchers worked for 3 years to gather the relevant information, including water rights claims, to reach this conclusion.[1] Our thorough analysis has been corroborated by an independent U.C. Davis study.[2]

C-WIN found that the State has an average of **29 million acre-feet of annual unimpaired flows of water, and that there are 153.7 million acre-feet of consumptive claims for that water**. This predicament resulted from the over-estimation of the amount of water that the State Water Project (SWP) and the Central Valley Project (CVP) could deliver. The amount of water promised in the original contracts is not sustainable, and in fact, most years the amount of water delivered to contractors is less, or much less, than pledged. Contractors in the SWP are left with the dilemma that in dry years, when the water is needed most, there is very little available. In wet years, when local supplies might suffice, the water is not needed. Yet contractors must continue to pay for large SWP infrastructure costs regardless of how much they receive.

Paper Water is the name given to the water available on paper in water rights permits and contracts, but not in reality. The court recognized this, saying "Paper water is just a wish and a prayer," in its judgment in the case Planning and Conservation League v. Department of Water Resources 2000 83 CAL.APP 4th 892. Through the years the State Water Resources Control Board (SWRCB), the Department of Water Resources (DWR) and the Bureau of Reclamation have continued to operate the State and Federal systems as if the water existed, resulting in a significant decline in the Bay/Delta ecosystem and political infighting among agriculture, fisheries, recreation, and urban users. Development has continued apace by claiming paper water as a source for expansion.

The State should conduct its own quantification study as it's first step toward future planning and development of realistic solutions.

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1 https://www.c-win.org/quantification-summary

2 https://www.c-win.org/ucdavis-quantification

Step 2:

The Public Trust Analysis

When a public resource is in jeopardy and disagreement over its use and allocation is interfering with the interests of the State and its citizens, the logical next step is to complete a *Public Trust Analysis*. As the steward of California's Public Trust resources, the State is obligated to perform this analysis, which will determine the water needs and value for all stakeholders. C-WIN is working with the economic experts who can perform a Public Trust analysis. We hired them to prepare a Public Trust Overview of a SWP/CVP analysis and what it would involve. EcoNorthwest is the highest court-designated economics consulting firm in the Exxon Valdez, Hudson River PCB and BP Gulf oil spill cases — world-class economists with years of experience quantifying the financial value of natural resources and the impacts of policy and infrastructure on communities and the environment. Ed Whitelaw leads this team.

What follows here is EcoNorthwest's overview of what a Public Trust Assessment can and should accomplish. A fully annotated version is included as an attachment to this packet. We urge the Governor to consider this next step.

Public Trust Assessment and Methodology

Ed Whitelaw, EcoNorthwest

THE ECONOMICS OF PUBLIC TRUST

What is the Public Trust Doctrine?

The Public Trust Doctrine (PTD) provides that government entities hold certain natural resources "in trust" to safeguard them for the long-term benefit of the general public. In California, PTD responsibilities for water resources include protecting instream flows—and the ecological, habitat and recreational benefits these flows provide—along with municipal, industrial and agricultural water uses.

Why is the Public Trust Doctrine relevant to managing Bay Delta flows?

Water is a scarce resource. There's not enough of it to go around. That means allocating water to one use, e.g., irrigated agriculture, will likely have negative implications for other users, e.g., instream flows. And vice versa. The PTD requires that the relevant government entities, e.g., the State Water Resources Control Board (SWRCB), take the public trust into account when balancing competing demands for water. What's known as the Mono Lake decision is one of the most cited applications of the PTD to protecting instream flows. In that case the court stated that government entities have an, "affirmative duty to take the public trust into account in the planning and allocation of water resources, and to protect public trust uses whenever feasible." According to this ruling, the SWRCB and other state agencies must take the public trust of instream flows and other water uses into account when allocating Bay Delta flows to competing uses.

What role does economics play in Public Trust deliberations?

Using the Mono Lake case as a model for how balancing decisions for Bay Delta flows may play out, the SWRCB and others will make these decisions after considering the impacts of a range of

allocation alternatives. This information will likely include descriptions of the consequences of alternatives on biophysical factors affected by changes in instream flows including flow volumes, water quality and temperature, status of threatened or endangered species, and riparian habitats. Other relevant factors include impacts on recreation demand, and water use by agriculture, industry and municipalities. Benefit cost analysis (BCA) is a commonly used method of evaluating the impacts of these types of allocation alternatives. BCA is simple in concept: identify the user groups affected by the water allocation alternatives; calculate the costs to each group for each alternative; calculate the benefits to each group for each alternative; compare costs and benefits; select an alternative.

Applying BCA, however, can be complex. This is especially true when some of the trust resources at issue, e.g., instream flow and riparian habitats, are not traded in markets and so have no market prices with which to compare with other trust resources that are traded in markets, e.g., agricultural production. That is, some trust resources have values but no prices. Economists and others refer to these as "non-market values." As the name implies, resources traded in markets have market values. The economic analysis in the Mono Lake case concluded that the economic benefits of preserving the public trust of instream flows for Mono Lake—the non-market values—outweighed the cost to Los Angeles of finding an alternative water source to Mono Lake—a market value—by a factor of 50.

How do economists conduct economic analyses for Public Trust deliberations?

The economic analysis portion of a Public Trust deliberation should answer the general question: What are the costs and benefits of increasing/decreasing water allocations to instream flow, recreation, industry, municipal and agricultural water uses? The major steps in answering this question include the following:

1. Identify the full range of trust resources at issue. Instream flow resources provide a range of services that benefit society. These services, known as ecosystem services, may include: habitat for aquatic and riparian species; water-related amenities including scenic vistas and recreation; and water quality benefits. Many of these services have non-market values. Other trust resources and services at issue include water use by municipalities, businesses and, irrigators. These services are traded in markets and so have market values. It's important to include all trust resources and the services they provide in the economic analysis. Failing to do so can lead to underestimating or overestimating the affected benefits and costs. Incomplete analyses typically ignore or underestimate the affected non-market values.

2. Develop economic measures of the relevant benefits and costs of alternative water allocations. As noted above, such a description will likely include a mix of market and non-market values. A complete analysis would include all relevant costs, prices or payments in the analysis. For example, an alternative that reduces water allocation to agricultural production may reduce agricultural jobs and incomes. It may also, however, reduce subsidy payments that would normally support the affected agricultural production. The economic analysis should count both the negative impacts on agricultural producers and the beneficial impacts of reduced subsidy payments. That is, the analysis should describe the net effect on this economic sector.

3. Take account of relevant trends including scarcity of resources and changing patterns of demand. For example, species or habitats close to the extinction tipping point

will likely have greater biophysical and economic value than species or habitats in abundance. In another example, to the extent that recreation demand is projected to increase faster than other resource uses, the economic analysis should take this into account by considering the likely future consequences of decisions made today.

4. Identify measures that could mitigate economic costs. Economies are dynamic. Business and industries constantly adjust and react to shifting economic conditions including things like changing interest rates, competitive forces, supply and demand conditions. The BCA analysis of alternative Bay Delta allocations should acknowledge this dynamic nature. For example, the analysis could describe the extent to which water users have alternatives to Bay-Delta water, what those alternatives cost, and how these costs compare to the non-market and market values of the benefits of instream flows.

Through BCA, economists offer a rigorous, legally and academically validated set of tools to help the SWRCB adopt a plan for managing Bay-Delta flows that balances protecting instream flows with other trust resources.

Ed Whitelaw of EcoNorthwest specializes in economics, planning, and finance. Founded in 1974, it's one of the oldest independent economic consulting firms in the Pacific Northwest. EcoNorthwest has extensive experience applying rigorous analytical methods to examine the benefits, costs, and other economic effects of environmental and natural resource topics for a diverse array of public and private clients worldwide.

Step 3:

Implement the Standards of the Delta Reform Act

In 2009 the State Legislature passed the Delta Reform Act and established the Delta Stewardship Council. The Council's charge was to create new rules and recommendations to further the state's coequal goals for the Delta: Improve statewide water supply reliability, and protect and restore vibrant and healthy Delta ecosystems, all in a manner that preserves, protects and enhances the unique agricultural, cultural, and recreational characteristics of the Delta.[3]

The Delta Reform Act demands, as part of its mandate, a reduction in South of the Delta reliance on the Delta and its tributaries for water.

In 2012, the Delta Stewardship Council published its Plan for managing Delta flows as required by State law. This woefully inadequate Plan was rejected by the court as having no quantifiable standards or benchmarks for protecting the Delta. The Council has yet to meet the requirement of producing an acceptable plan.

California currently uses about 36 million-acre feet of water a year. Fifteen to twenty percent of this water is delivered via the State Water Project and the federally operated Central Valley Project. Much of the Bay Area, the Central Coast, the San Joaquin Valley and southern California have come to rely on the five to six million acre-feet of water delivered by these conveyance projects, which employ a vast system of reservoirs, aqueducts and pumps to deliver water from the Sacramento/San Joaquin Delta to the South State. Currently, these gigantic projects are an antiquated, expensive, environmentally destructive and ultimately unsustainable means of distributing water. These systems cannot be abandoned, but we can – we must – change the way they operate, augmenting their deliveries with more reliable sources.

How We Reduce Reliance on The Delta

The Environmental Water Caucus (EWC), of which C-WIN is a member, is a consortium of water stakeholders and environmental organizations from throughout California. EWC has written a comprehensive *Sustainable Water Plan for California*.[4] The value of this Plan lies in the detail with which it describes strategies and documents water savings as developed by a broad cross-section of businesses and environmental organizations.

Overwhelming evidence shows that a suite of aggressive conservation and water efficiency actions will reduce overall demand and provide reliable and cost-effective increases in available water supplies. These measures will satisfy California's water needs well into the future and at far less financial and environmental cost than the construction of additional storage dams, reservoirs, canals, and tunnels. *State Water Plan (Bulletin 160-13)*, reinforces this conclusion, and it is further refined by the Bay Institute's *Collateral Damage*[5] report, by the Pacific Institute's publications, and by actual experience in urban areas and farms.

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3 CA Water Code §85054

4 http://www.ewccalifornia.org/reports/ewcwaterplan9-1-2015.pdf

5 https://bayecotarium.org/wp-content/uploads/collateraldamage.pdf

Urban Water Conservation

Southern California, with its huge urban population, can provide the major urban conservation impetus for water savings and demand reduction, as highlighted by the report released by the Los Angeles Economic Development Corporation, *Where Will We Get the Water?*[6] This study shows a combined potential savings and demand reduction of approximately 1.7 million acre-feet. These savings can be achieved through three main measures: urban conservation, recycling, and storm water capture. The potential recycling savings are larger with more investment in recycling facilities and regulations related to outdoor urban usage.

Here are other measured savings cited in the EWC Plan:

- State Water Plan — total urban water demand can be reduced by as much as 3.1 million acre-feet with above cited measures.[7]

- The Los Angeles Economic Development Corporation report found that in 7 urban southern California counties, water conservation could have an impact equivalent to adding more than 1 million acre-feet of water to the regional supply (about 25 percent of current annual use). At $210 per acre-foot, the LAEDC report shows that urban conservation is by far the most economical approach available, especially compared to new surface storage at $760 to $1,400 per acre-foot.

- The Los Angeles and San Gabriel Watershed Council has estimated that if 80 percent of the rainfall that falls on just a quarter of the urban area within the watershed (15 percent of the total watershed) was captured and reused, total runoff would be reduced by about 30 percent. That translates into a new supply of 132,000 acre-feet of water per year, or enough water to supply 800,000 people.

Agriculture Water Savings

Agriculture uses 80% of the State's developed water supplies. Therefore, agriculture **must** be part of the solution. EWC's *Sustainable Water Plan for California* outlines **in detail** numerous strategies for less water demand including incentivizing necessary measures such as the continuing trend of drip, micro sprinklers and similar higher technology irrigation, reduced deficit irrigation, transition to less water-intensive crops, ongoing farmland acreage reduction, and tiered price structures. According to Peter Glick, the elimination of about1 million acres of drainage-impaired farmland south of the Delta would result in a water savings of about 4 million acre feet of water.

Summation of EWC's Sustainable Water Plan for California

Based on data from the most recent State Water Plans (Bulletins 160-05, Bulletin160-09, and Bulletin 160-2013), the Planning and Conservation League, and the Pacific Institute[8], the savings that can be achieved from these efficiency scenarios are estimated at almost 13 million acre-feet per year. The urban water savings of approximately 5 million acre-feet a year, including recycled municipal water and urban efficiencies as

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6 Los Angeles County Economic Development Corporation (LAEDC). 2008. *Where Will We Get the Water? Assessing Southern California's Future Water Strategies*. P 6.

7 California Department of Water Resources. California Water Plan Update 2013, V-3 Resource Management Strategies, Page 1-9 Climate Change Scoping Plan Appendices Volume I. December 2008. Pursuant to AB 32 The California Global Warming Solutions Act of 2006. C-135. http://www.arb.ca.gov/cc/scopingplan/document/appendices_volume1.pdf

8 http://www.pacinst.org/reports/california_water_2030/ca_water_2030.pdf

shown in Figure 1, is enough water to support a population growth of almost 30,000,000 people.

A recent report published by a coalition of environmental organizations, *Wetter or Not*,[9] supports the 13 million AF savings and demand-reduction potential cited above.

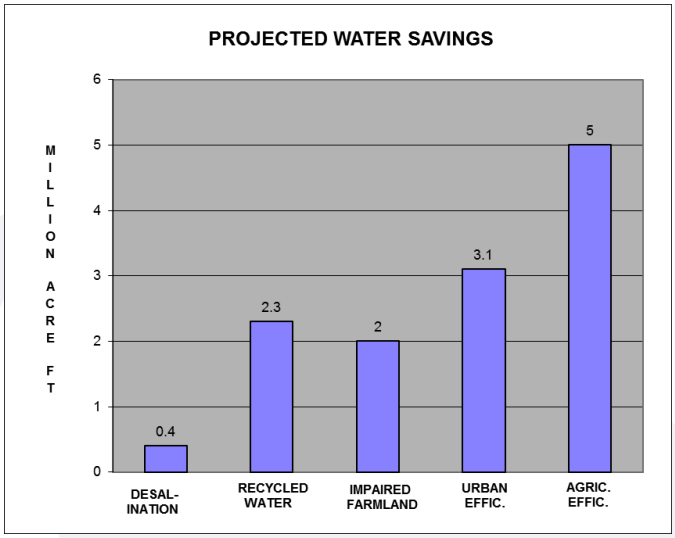

Figure 1: This graph illustrates just some of the sources for "creating" more water.

To quote from the EWC's *Sustainable Water Plan:*

"The solutions proposed in this report are demonstrably more efficient and economical than more dams and canals. The combination of water efficiency planning and implementation, and reduced reliance on the Delta obviate the need for increased surface storage and increased conveyance through the Delta."

9 National Resources Defense Council, et al. *Wetter or Not*. November 2014. https://www.nrdc.org/resources/wetter-or-not-actions-ease-current-drought-and-prepare-next

Summary

The Roadmap to California's Water Future

The road to California water sustainability is clear. The State must uphold its responsibilities and base its water policies on science and the law.

The State must initiate an **accurate measurement of water sources** for the 20 rivers of the Delta watershed that feed the State Water Project and the Central Valley Project. It cannot ignore the diminished supply portfolio in allocating those sources to urban and agricultural contractors south of the Delta. The continued reliance on, and distribution of, "paper water" is the core issue of the State's mismanagement of this precious resource.

Once the supply/demand inequities are known, **a Public Trust assessment must be completed** in order to allocate water for the benefit of all stakeholders and the environment. This assessment will examine all needs for water and give an economic value to each. Having this Public Trust assessment is key to balancing the availability of water to the public benefit of the State and its people.

Finally, we know that relying on current water practices of over-allocating water that doesn't exist (paper water) highlights the need for new sources of this life-sustaining element. We cannot create new water in the watersheds of California's rivers and streams, but we can increase its efficient use. **This is the mandate of the Delta Reform Act; its work should be completed with a Plan to reduce exports.** Many groups have researched the potential for lowering demand and improving efficiency through urban conservation, recycling, storm water capture, and better agricultural practices. The path is there.

california water impact network

17 January 2019

Dear Governor Newsom,

Your election as Governor represents an unprecedented opportunity for you to permanently correct a problem that has plagued Californians for over 150 years. The path forward has been developed over time among a consortium of environmental organizations, of which the California Water Impact Network (C-WIN), is a key player. C-WIN is the public interest group I established with Yvon Chouinard, founder of Patagonia.

The challenge ahead is to bring the State's water demand and supply into an equitable and realistic balance. This can be done with a series of measures you can initiate.

1. Quantify how much water is available for export from the Delta. The Department of Water Resources has never quantified the amount of water available for export from the Delta watershed. After a three-year investigation, C-WIN determined that **the water of the 20 rivers of the Delta watershed have been oversubscribed by 5 1/2 times what is available.** Our thorough analysis has been corroborated by an independent U.C. Davis study. This "paper water" is at the heart of California's water mismanagement. The Twin Tunnels should be suspended until this work is completed.

2. Initiate a Public Trust Analysis. As the steward of California's Public Trust resources, the State is obligated to perform this analysis, which will determine the needs of all players. C-WIN is already working with the experts who can perform a Public Trust analysis. EcoNorthwest are the highest court-designated experts in the Exxon Valdez, Hudson River PCB and BP Gulf oil spill cases — world-class economists with years of experience **quantifying the financial value of natural resources and the impacts of policy and infrastructure on communities and the environment.**

3. Implement the standards of the 2009 Delta Reform Act. Determine how much new water is available from south of the Delta regional supplies, including reclamation, storm water capture and environmentally responsible desalination. Money spent here is more productive than tunnels and dams that supply no new water.

4. Adjudicate the 20 rivers of surface water and the groundwater in the Delta watershed. The California Delta watershed supplies half of all consumptive fresh water in the state. Until the source quantity is measured and beneficial water rights established through adjudication, no realistic solutions can be developed.

Until California understands how much real water there is to manage, it's impossible to fix the problem of paper water and create sustainable and equitable policy benefiting all Californians. You have the opportunity and the tools to change the course of California water history for good. C-WIN has formed a coalition of the many constituencies affected by the water crisis. We trust you will make the right decisions for the people of California.

We would very much like to meet with you as soon as possible to discuss further.

Sincerely,

Carolee Krieger

Carolee Krieger, Executive Director, C-WIN

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California Water Impact Network Produces First Study Quantifying "Paper Water" in the 20 Rivers of the Delta Watershed

The California Water Impact Network (CW WIN) has completed the first analysis comparing Central Valley water availability with water rights claims. **Consumptive water rights claims are 5.5 times more than the available water supply.**

This Study (link) was submitted as testimony to a State Water Resources Control Board (SWRCB) workshop on the possible revision of the Bay Delta Water Quality Control Plan (BDCP). C-WIN's testimony documents the disparity between the availability of water and existing water rights claims in the Sacramento, San Joaquin and Trinity Rivers and their tributaries. Further, the report demonstrates that the federal Central Valley Project (CVP) and the State Water Project (SWP) lack adequate water to service promised contract deliveries.

C-WIN's testimony shows that water rights account for up to five times the water that is available in the Sacramento and San Joaquin Rivers. For the Trinity River, water rights claims exceed available supply by a factor of seven. The difference between claimed water rights and average river flows is summarized below from the report.

River Basin	Annual Flows	Water Rights***	Ratio
Sacramento R. Basin*	21.6 MAF	120.5 MAF	5.58
San Joaquin R. Basin**	6.2 MAF	32.7 MAF	5.28
Trinity R. Basin*****	1.283 MAF	8.725 MAF	6.70

The problem facing our rivers and the Delta is thus clarified when annual flows are compared to the water rights that are claimed. This disparity between real and contractual water is known as "paper water." It is water, in other words, that exists only in state or federal documents, not in California's rivers.

The CVP and SWP are predicated on junior water right claims; they can only divert water after stakeholders with senior water rights have taken their shares. The projects therefore cannot provide full contract deliveries, especially during drought. Water rights are a form of property. They entitle an owner to use water from a specific point at a specific stream at a specific time. But disaster looms when the state authorizes far more water rights than nature and human engineering can provide. California's water code has evolved – or metastasized – over the course of 150 years. It is a jumble of prior practices, dueling lawsuits, conflicting legislation, and water projects that consistently have performed under expectations. The current over-allocation of water is the end result of this ad hoc, and ultimately unworkable, process.

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This over-allocation is similar to the "clouded titles" problem in real estate: a lack of clarity in legal rights that leads to continuous dispute. In the case of water, this ratchets up the pressure on water agencies to "produce" water that doesn't exist. The CVP and the SWP water rights are essentially "clouded titles" for water in the Sacramento and San Joaquin Rivers and their tributaries. The SWP was predicated on damming the state's North Coast Rivers, with their waters delivered to the Delta for export. These streams ultimately were declared off-limits due to Wild and Scenic designations in the 1980s. Five million acre feet of water from the North Coast never made it to the CVP and SWP, but the operators of these projects distributed contracts and exported from the Delta as though the water was in the pipeline. They were, in short, creating "paper water." The Delta's ecological collapse has been the result.

If Wild and Scenic River protections remain in place, senior water rights are honored and water quality standards are met, there will be little if any "surplus" water available for export south of the Delta. In plain language, this means that there is scant water available to the CVP and the SWP at any time – especially during drought. While the C-WIN Paper Water Availability Analysis did not discuss the implications of the Twin Tunnels, it is clear that the inadequate water rights of the CVP and the SWP would make it legally difficult to operate such a conveyance system. Any rights the state could acquire to operate the tunnels on the lower Sacramento River would be at least as junior as current rights. Also, there is insufficient water to fill the tunnels. Reduced snowpack due to climate change will exacerbate an already untenable situation. Water ratepayers and taxpayers should not be expected to expend billions of dollars for a system that will provide no extra water, and could actually result in reduced deliveries.

Further, the Bay Delta Conservation Plan (BDCP) and the Twin Tunnels would reduce Bay-Delta outflows, conflicting with the SWRCB's 2010 Bay-Delta outflow recommendations, which were developed to determine the flows necessary for the recovery of listed fish populations. Decreased flows will also concentrate and increase the persistence of contaminants such as selenium and pesticides in the Bay-Delta. The C-WIN analysis thus recommends that the SWRCB enforce water rights and water quality standards as a priority, and provides suggestions to that end; indeed, the Board's public trust and beneficial uses mandate requires such action.

The CW WIN report clearly documents the great and growing gap that separates water rights claims from available water. It is a fact that the state and federal water projects are at the back of the line in water rights seniority. They face the most immediate cutW backs in the event of decreasing snowpack, increasing drought, and dedication of water to meet public trust and beneficial use obligations. The State Water Resources Control Board clearly has been unable or unwilling to reign in paper water claims. It would be catastrophic to compound the error with a massive, ruinously expensive and environmentally destructive project like the Twin Tunnels.

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100 years of California's water rights system: patterns, trends and uncertainty

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Abstract

For 100 years, California's State Water Resources Control Board and its predecessors have been responsible for allocating available water supplies to beneficial uses, but inaccurate and incomplete accounting of water rights has made the state ill-equipped to satisfy growing societal demands for water supply reliability and healthy ecosystems. Here, we present the first comprehensive evaluation of appropriative water rights to identify where, and to what extent, water has been dedicated to human uses relative to natural supplies. The results show that water right allocations total 400 billion cubic meters, approximately five times the state's mean annual runoff. In the state's major river basins, water rights account for up to 1000% of natural surface water supplies, with the greatest degree of appropriation observed in tributaries to the Sacramento and San Joaquin Rivers and in coastal streams in southern California. Comparisons with water supplies and estimates of actual use indicate substantial uncertainty in how water rights are exercised. In arid regions such as California, over-allocation of surface water coupled with trends of decreasing supply suggest that new water demands will be met by re-allocation from existing uses. Without improvements to the water rights system, growing human and environmental demands portend an intensification of regional water scarcity and social conflict. California's legal framework for managing its water resources is largely compatible with needed reforms, but additional public investment is required to enhance the capacity of the state's water management institutions to effectively track and regulate water rights.

S Online supplementary data available from stacks.iop.org/ERL/9/084012/mmedia

Keywords: water rights, water resources management, surface water, rivers

1. Introduction

Recent droughts and increasing hydroclimatic volatility in western USA are testing the ability of water managers to meet diverse and growing demands for supply reliability, improved water quality, and healthy ecosystems (Gleick and Chalecki 1999, Christensen *et al* 2004, Wilhite *et al* 2007). Despite evidence that human water demands have begun to stabilize, decreasing surface water availability has caused high levels of water stress throughout much of the western USA (Averyt *et al* 2013). Climate models predict that much of arid and semi-arid western North America is likely to become warmer and perhaps drier in the future (Stewart *et al* 2005, Westerling *et al* 2006, Barnett *et al* 2008), suggesting that major changes in water use and allocation patterns will be required. In California, for example, projections of decreasing snowpack and population growth will make it difficult to meet growing urban demands while maintaining agricultural deliveries and needed water for the environment (Hayhoe *et al* 2004, Tanaka *et al* 2006, Medellín-Azuara *et al* 2008). These trends are commensurate with global projections for other regions with semi-arid or Mediterranean-type climates (Klausmeyer and Shaw 2009), which are characterized by extremes in seasonal and interannual variability in precipitation, large scale development of irrigated

agriculture, and higher human population density (Grantham *et al* 2013).

Emerging water management challenges in semi-arid regions of the world are typified by California—the world's tenth largest economy—which must satisfy water demands for 38 million people, a US$40 billion agricultural economy, and freshwater ecosystems (DWR 2009). Recent studies indicate that the state is ill-prepared to adopt measures required for the sustainable management of water resources (Hanak *et al* 2011, California Natural Resources Agency 2014). For example, California's water rights system is the primary regulatory framework under which surface water is allocated yet the amount of water actually used by water rights holders is poorly tracked and highly uncertain (Little Hoover Commission 2010). The lack of accurate accounting thus represents a critical challenge to the allocation of water among competing users in a cost-efficient and sustainable manner.

California's water rights administration system was legislatively established in 1914 with the creation of a Water Commission, which later would become the State Water Resources Control Board (Water Board) (Littleworth and Garner 2007). The Water Board administers the water rights system and is responsible for allocating available water supplies for beneficial uses in an orderly manner (Water Board 2014b). However, since its establishment a century ago, the Water Board has issued water rights that amount to over five times the state's average annual supply (Little Hoover Commission 2010). Today, over-allocation of available supplies, coupled with uncertain water use by individual water right holders, has become a significant handicap for water policy and management reform (Hanak *et al* 2011). As regional drought and growth reduce available supplies, inaccurate water use accounting has also intensified conflicts over water (Wines 2014, Dearen and Burke 2014) and made it difficult to secure adequate water allocations for freshwater ecosystems (Gillilan and Brown 1997, Water Board 2014c). Consequently, the water rights system has been identified by water managers as one of the state's most important long-term water problems (Null *et al* 2012).

Accurate quantification of water supply and use is an essential first step towards sustainable water management. Yet, a comprehensive assessment of surface water allocations of the state's rivers and streams has not been conducted. Furthermore, the extent to which water right allocations approach, or exceed, natural surface-water supplies has not been systematically evaluated in rivers throughout the state. Here, we analyze the state's water rights database to estimate the degree of water appropriation in approximately 4000 catchments in California by comparing water rights allocation volumes with modeled predictions of unimpaired, surface water availability. The water right holder, intended uses, and dates of water rights records are also examined to compare allocations among ownership and use-classes and to examine trends in water allocation volumes from 1914 to 2013. Finally, we analyze county-level water use data to quantify the disparity between water rights allocations and estimated surface water withdrawals. These analyses highlight deficiencies in the water rights system that should be addressed as part of state water management reforms (e.g., California Natural Resources Agency 2014) and can be used to identify river basins where inaccuracies in water rights records may impede local efforts to efficiently and sustainably manage water resources.

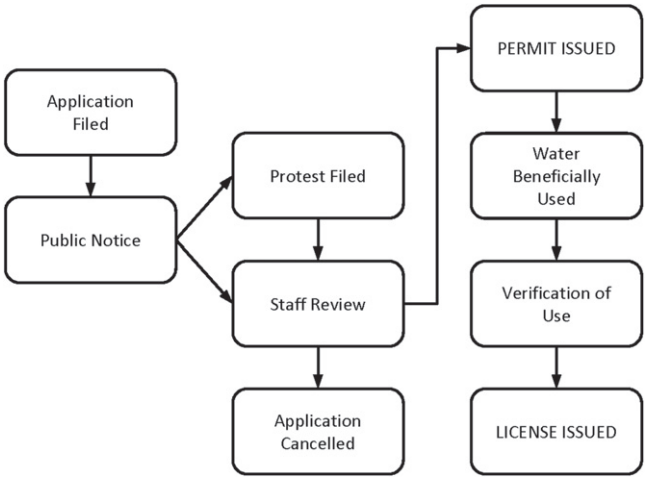

Figure 1. Simplified diagram of appropriative water rights review process by the State Water Board, modified from permitting and licensing flow charts (Water Board 2014b).

2. Background and methods

2.1. California's water rights system

California water management is a highly complex amalgamation of laws, policies and institutions derived from Roman, Spanish, English and indigenous governance systems, which has been described in detail by others (e.g., Hundley 2001, Hanak *et al* 2011). Here, we provide a brief overview of the state water rights system, summarized from Littleworth and Garner (2007) and Water Board documents (2014b). California's modern water rights system began to take form in the mid 19th century and early 20th century with the influx of settlers from the eastern USA. Initially, competing claims for water in the water scarce state were settled through litigation and court decisions. But as the number of claims and scale of water projects grew, a more comprehensive system for regulating water rights was required. In 1914, the state legislature established a Water Commission, which would later become the Water Board. Because of political pressures, several types of water rights including groundwater, riparian and pre-1914 appropriations were excluded from the Water Board's authority. However, the Water Board was given primary responsibility for administering post 1914 appropriative water rights, which were required for the state's major agricultural and water supply systems developed in the 20th century. In addition, the Water Board retains broad authority in enforcing the state's reasonable use and public trust doctrines (Littleworth and Garner 2007).

Any person or entity wishing to appropriate surface water must file an application with the Water Board, which initiates a permit review process (Water Board 2014b) (figure 1). Decisions to issue a water right permit are based on availability of water, satisfaction of reasonable use requirements, and preservation of environmental uses (e.g., fish and wildlife resources). Once an application is approved, the right must be exercised according to permit terms and conditions, which may include a maximum seasonal or annual allocation volume, limits on timing and rates of diversion, specifications on where the water can be used, and other measures to minimize environmental impacts. The 'face value' amount of water granted by a permit is an estimate of the maximum possible volume required by the applicant; actual amounts used vary by year but may be significantly less than the face value (Littleworth and Garner 2007).

Following a monitoring period, typically ten or more years, the Water Board confirms terms and conditions of the permitted water use, and may issue a license to the appropriator (figure 1). The Water Board has limited authority over non-appropriative water rights (Littleworth and Garner 2007). However, in 2009, the Board implemented new reporting requirements for groundwater, riparian and pre-1914 surface water rights, with penalties for failing to file statements of use (California Water Code section 5101). This has led to an increase in water use reporting, although reports are not systematically audited for accuracy and have been filed only for a small fraction of non-appropriative water users (personal correspondence with Phil Crader, Division of Water Rights, 28 June 2013).

2.2. Analysis of water rights database

The Water Board maintains a public water rights database, the electronic Water Rights Management System (eWRIMS), to track and share water rights information (Water Board 2014a). The database contains information on water rights and statements of use and is the basis for our assessment, focusing on all active, appropriative water rights records. These are the most common types of surface water right in the database and account for the greatest allocation volumes. The records used in our analysis consisted of pending, permitted and licensed water rights filed since 1914, and included information on face-value allocations, year of filing, right holder, use types, and geographic location. We did not consider statements of use, which have been filed for some riparian and pre-1914 water rights claims because the data are incomplete and of uncertain quality.

Based on the water rights records, appropriative water rights holders were classified into private and public entities. For privately held rights, individuals were distinguished from corporate entities (e.g., corporations, associations, private power utilities, and partnerships). Public water rights holders included federal, state, and municipal agencies and irrigation and reclamation districts. Purpose of use was also evaluated, based on use-designations for individual water rights (e.g., hydropower, agriculture, domestic, industrial, recreation, and environmental).

2.3. Assessment of spatial allocation patterns

Locations of surface water diversions have been mapped in a Geographic Information System (GIS) by the Water Board. Water rights may have multiple points of diversion (PODs), which collectively divert an annual volume up to the face value of the permit or license. Because diversion volumes are not reported for individual PODs, we selected a single POD for each water right and attributed the entire face value to that location. Next, total face-value allocations were calculated at the 12-digit Hydrologic Unit (HUC12) scale (USGS 2012) for 4108 catchments in California. Finally, water allocations were accumulated downstream to determine the cumulative annual water allocation for each catchment. To visualize the HUC12 drainage network, line segments were created between HUC12 centroids to represent directional flow paths to receiving catchments. Because most of the Colorado River basin occurs outside of California, we did not evaluate allocation volumes for the Colorado River.

To evaluate water right allocation volumes in relation to water availability, we used an empirical modeling approach to predict mean annual flows for California's HUC12 catchments. Models were developed using Random Forests (RF) (Breiman 2001), a statistical approach used for prediction and classification. Following methods described in Carlisle *et al* (2010), a RF model to predict expected (E), annual natural flow was trained with data from 180 USGS reference gages (e.g., those minimally affected by land- and water-management activities) and catchment predictor variables (e.g., climate, topography, soils and geology) in the Gages-II database (Falcone 2011). The RF model was implemented in *R* with the randomForest package (Liaw and Wiener 2002).

Model performance was assessed by comparing predictions with randomized subsets of observed data (O) withheld during RF model development. Several performance metrics were calculated (Moriasi *et al* 2007), including coefficient of determination (r^2), Nash–Sutcliffe coefficient, and percent bias. In addition, predictive performance was assessed in a jack-knife technique by sequentially excluding individual reference gages and re-running the model to evaluate observed against predicted (O/E) values at the omitted site. To predict monthly flows at ungaged HUC12 catchments, the same set of catchment predictor variables used in model training was calculated for each HUC12 catchment including the upstream drainage area. The trained RF model was then used to predict expected mean annual flows in each catchment from 1950 to 2010, from which a long-term average was calculated and compared with water rights allocation volumes.

2.4. Comparison of water rights allocations with surface water withdrawals

To compare water rights allocations with actual water use, total face value water right volumes were calculated at the county level and compared with estimates of actual surface water withdrawals. Water rights used exclusively for hydropower generation were excluded from the face-value

Table 1. Summary of active surface water right records in State Water Rights Database (Water Board 2014a).

Water Rights type	Count	Face-value total (10^6 m^3)
Appropriative		
Licensed	10 810	123 517
Permitted	1 466	263 647
Pending	345	11 038
Subtotal	12 621	398 202
Statements of Diversion and Use	10 885	40 571
State & Federal Filings	2152	15 986
Stockpond	5613	7
Small Domestic	611	3
Adjudicated (pre-1914 and Riparian)	8	0.3
Total	31 890	454 770

calculations. Gross water use estimates were obtained from US Geological Survey Water Use Data for California, 1985–2005 (USGS 2014). Average, county-level use was calculated by the sum of reported self-supplied, surface water withdrawals for public supply, domestic, industrial, livestock, and irrigation purposes.

3. Results

3.1. Appropriative water right allocations

We obtained 31 890 active, surface water rights records from the eWRIMS database (Water Board 2014a), representing approximately 450 000 million cubic meters (Mm^3) (table 1). Records included 12 621 active appropriative water rights, accounting for 398 202 Mm^3 of water. Most (85%) appropriative water rights are licensed, although permitted water rights account for two-thirds of the volume allocated. In addition, most water is granted to a relatively small number of appropriative water rights (figure 2(a)). For example, of the top 1% water rights by count account for over 80% of the total water volume allocated.

Based on the water rights records analyzed in this study, the volume of water allocated per right has declined since the early 20th century (figure 2(b)). Ten-year average volumetric water allocations peaked in the early 1930s (>120 Mm^3 per right), but has fluctuated between 5 and 40 Mm^3 per right since the 1950s. However, the number of water rights filed has steadily increased over time (figure 3(a)). Following a period of relatively slow growth in the early 1900s, the number of rights filed accelerated in the late 1940s. The rate of water rights filings slowed in the 1990s, but has remained stable at approximately 60 water rights filed per year. Since the 1970s, most new water rights have been issued to individuals and private entities, while holdings by federal, state and other public agencies has not appreciably changed (figure 3(a)).

Although private entities hold the vast majority (78%) of water rights filed, most water by volume is allocated to public entities (figure 3(b)). Notable increases in water allocation volumes occurred in 1927, when the appropriative water rights were filed for major federal dam projects on the Sacramento River (Shasta Dam) and Trinity River (Trinity Dam), and in 1933, when water rights were filed by the Imperial Irrigation District to divert water from the Colorado River. Currently, over 80% of the water rights issued by volume are held by federal (32%), state (10%), municipal (15%) and other public entities (24%). Private corporations hold approximately 18% of all water allocated, while individuals hold rights to less than 1% of water by volume.

Of 12 621 appropriative water rights in the eWRIMS database, nearly 70% have PODs with agricultural use designations (figure 4). Other common designations were domestic (35%) and recreation (27%) uses. Approximately 3% of applications are designated for hydropower, although they account for 68% of total water right allocations by volume. Other uses associated with high water allocation volumes are domestic (42%), agricultural (34%), and recreation (26%).

3.2. Spatial distribution of water rights

To quantify the spatial distribution of water right allocations, local and cumulative face value totals were calculated at the HUC12 watershed scale. Trends in the extent and intensity of water allocations were also evaluated by mapping water allocations to catchments since 1914 (figure S1). Currently, face value allocation volumes are greatest for the Sacramento and San Joaquin Rivers and their major tributaries (figure 5(a)). When water rights used exclusively for hydropower generation are excluded (because hydropower is a non-consumptive use), allocation volumes significantly decrease (figure 5(b)). Excluding hydropower water allocations, the total volume allocated to appropriative water rights in the Sacramento-San Joaquin Delta is 109 000 Mm^3, approximately three times the average unimpaired outflow of the system (35 000 Mm^3) (DWR 2007).

Cumulative water allocation volumes were evaluated relative to predicted, unimpaired surface water availability for all HUC12 catchments (figure S2). The model performed well in predicting mean annual flow based on several performance metrics ($r^2 = 0.95$, NSE = 0.94, PBIAS = 1.2). Assessment of predictive performance using jack-knife removal of individual reference gages yielded a mean O/E ratio of 0.94, suggesting high accuracy in predicting unimpaired annual flow (a value of 1.0 indicates perfect model performance).

Water right allocations exceed average local surface water supplies in much of the drainage network (figure S3 and figure 6) and allocation percentages increase with river size. Among catchments with annual runoff of less than 100 Mm^3 ($n = 685$), mean allocation is 1% and nearly three-quarters of the small catchments have allocations levels below 10%. In contrast, catchments with runoff greater than 1000 Mm^3 and 5000 Mm^3 are predominately allocated at levels above 100%. Excluding water allocations for hydropower (figure 6), catchments with annual runoff of 500–1000 Mm^3, 1000–5000 Mm^3 and greater than 5000 Mm^3 have mean allocation values of 41%, 107%, and 158%, respectively.

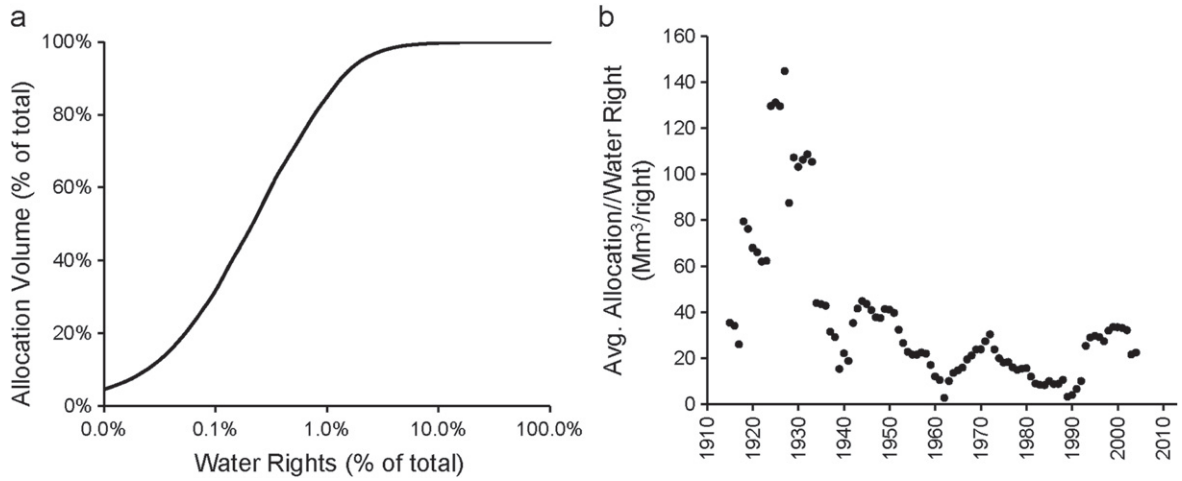

Figure 2. Water allocation volumes (a) by water right count and (b) over time (10-year rolling average), based on appropriative water rights records (Water Board 2014a).

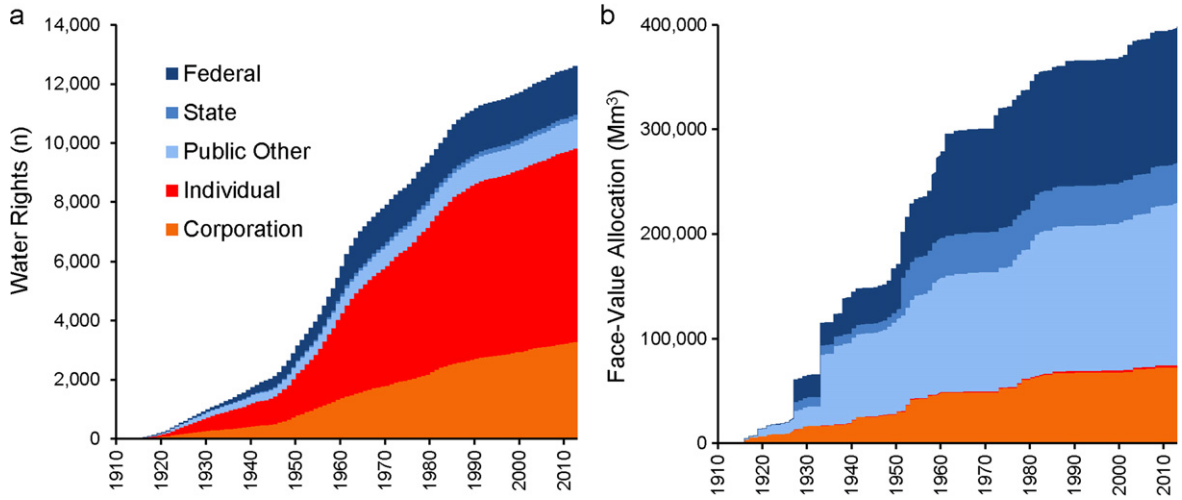

Figure 3. (a) Water rights and (b) face value allocation volumes issued to public and private entities since 1915, based on appropriative water rights records (Water Board 2014a). Note, volumetric allocations to water rights held by individuals (in (b)) is negligible.

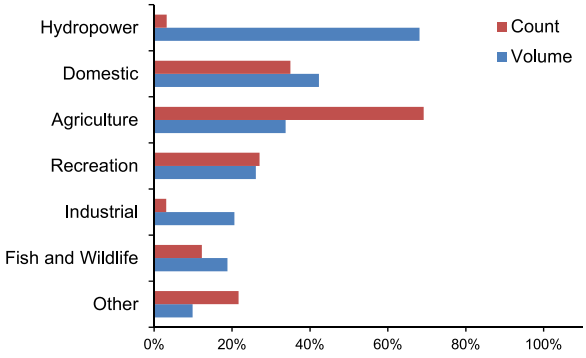

Figure 4. Water rights use designations, expressed as percentage of total water right count and volumetric water allocation.

Most of California's major river basins have water rights allocations that exceed their natural, unimpaired annual supply (table 2; figure S4). Among 27 major rivers, 16 had allocation levels greater than 100% of natural supplies. Excluding hydropower water rights, catchments with the highest water allocation levels are the San Joaquin River (861%), Salton Sea basin (705%), Putah Creek (673%), Kern River (631%) and Stanislaus River (391%). Large river basins with relatively low allocation levels are the Smith River (<1%) and Cottonwood Creek (2%). The Owens River basin, which is a primary water supply source for the City of Los Angeles, has a low water allocation percentage (4%). However, when water rights associated with hydropower use are included, allocation percentage increases to 224%, indicating that water rights designated for hydropower are used for water supply. Public entities hold nearly all of the water allocated by appropriative water rights in California's major river basins (table 2).

3.3. Comparison of water rights allocations with surface water use

Face value allocations (excluding hydropower use) were compared with estimates of annual surface water withdrawals

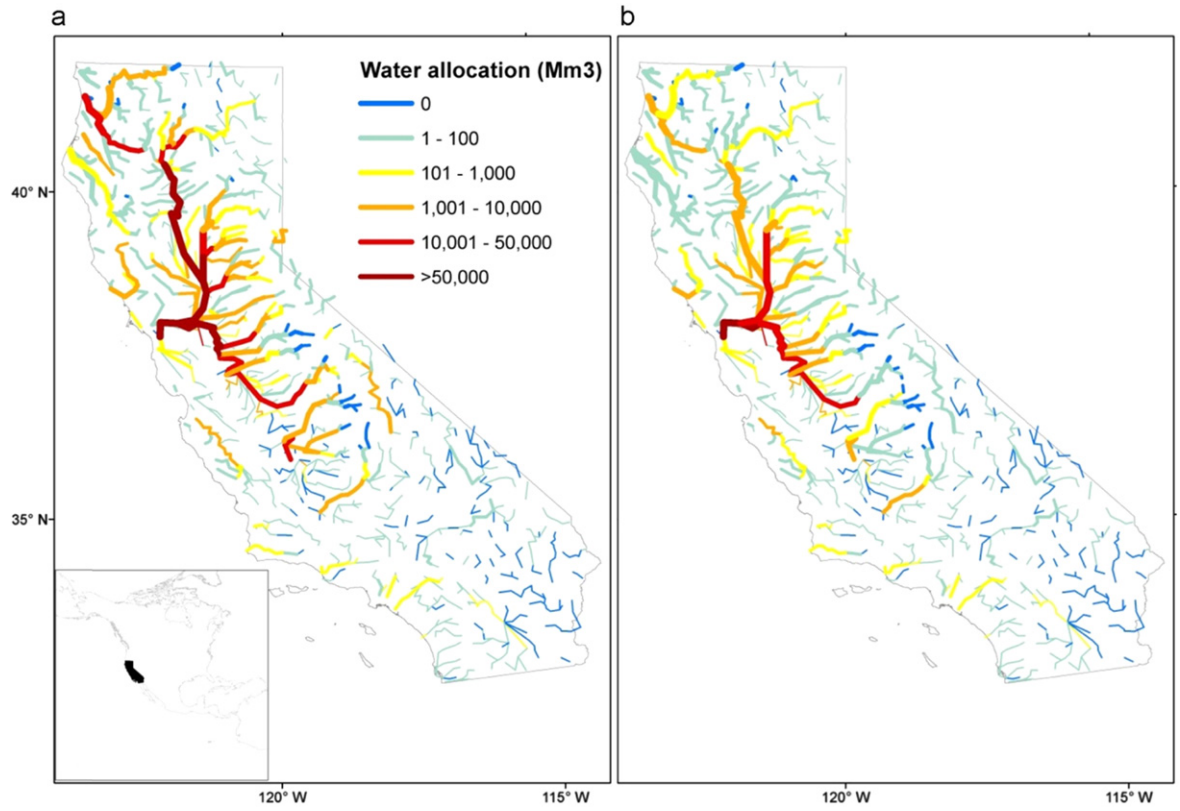

Figure 5. Cumulative water allocation volumes (a) for all water rights and (b) excluding water rights used exclusively for hydropower generation.

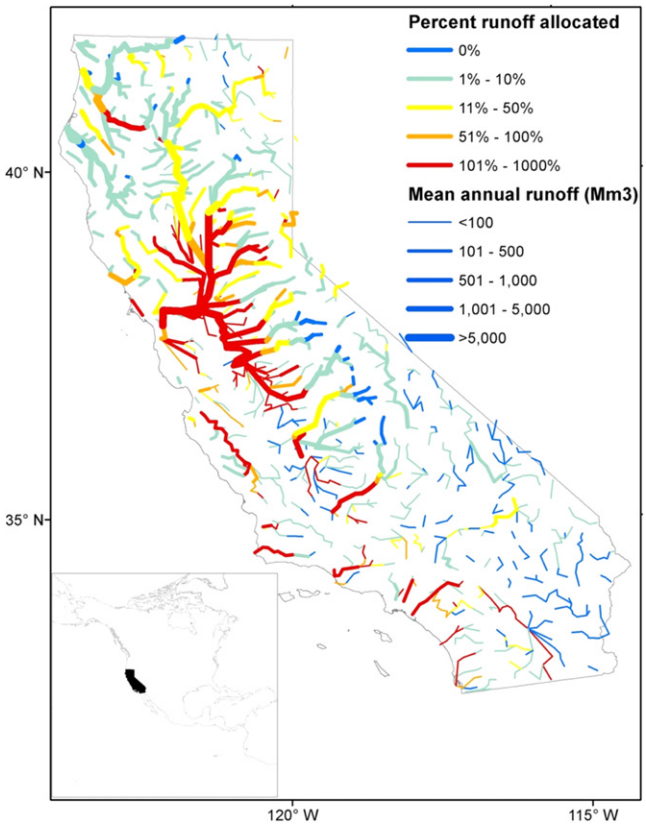

Figure 6. Cumulative water right allocations relative to mean annual runoff, excluding water rights for hydropower generation.

at the state and county scale (USGS 2014). Statewide, appropriative water rights filed for consumptive uses (totaling 149 400 Mm^3) are approximately five times greater than estimated annual surface water withdrawals (30 350 Mm^3). At the county scale, volumetric allocations of water rights are poorly correlated with ($r = 0.16$) and generally over-predict surface water withdrawals (figure 7). This, in part, is explained by differences in water diversion locations and place of use. For example, major intake facilities for the State Water Project and Central Valley Project are located Contra Costa County and are associated with water rights exceeding 40 000 Mm^3. Nearly all of the water diverted at this location is delivered south of Contra Costa County. The discrepancy between local water rights allocations and use is compounded by the fact that the water projects are known to deliver a small fraction of their entitlements (Littleworth and Garner 2007). Although water rights allocations generally exceed estimated annual surface water use, there are several counties that use more water than their local water right entitlement. These include counties in southern California that import significant volumes of water for agricultural production (e.g., Tulare and Fresno) and urban water supply (e.g., San Diego and Los Angeles) (figure 7; figure S5).

4. Discussion

This assessment indicates that water allocated through the state appropriate water rights system exceeds overall mean

Table 2. Water allocation volumes for California's major rivers. See figure S4 for river locations.

River	Drainage area (km^2)	Annual natural run-off (Mm^3)[a]	Water rights allocation[b] (Mm^3)	Percent runoff allocated	Percent allocated to public[c]
Smith River	1864	3659	8	0.2% (0.2%)	82%
Klamath River	31 402	18 213	5833[d]	32% (100%)[d]	99%
Trinity River	7692	6006	5635	94% (250%)	100%
Eel River	9536	8330	42	1% (2.6%)	31%
Russian River	3846	2194	1141	52% (113%)	89%
Salinas River	11 082	431	1032	239% (343%)	99%
Sacramento River	67 830	23 282	35 336	152% (655%)	92%
Pit River	14 220	3454	217	6% (500%)	62%
Cottonwood Creek	2444	702	11	2% (2%)	57%
Stony Creek	2012	494	268	54% (484%)	98%
Feather River	15 350	9027	16 934	188% (633%)	98%
Yuba River	3483	2966	3613	122% (431%)	97%
Cache Creek	2971	714	1149	161% (213%)	98%
Putah Creek	1694	471	3171	673% (886%)	98%
San Joaquin River	45 877	7949	68 473	861% (1585%)	97%
Mokelumne River	5157	1646	2335	142% (436%)	96%
Consumnes River	2460	576	304	53% (53%)	88%
Stanislaus River	3100	1342	5246	391% (1787%)	99%
Tuolumne River	4851	2022	3273	162% (438%)	99%
Merced River	3288	1170	1285	110% (583%)	99%
Kings River	5046	1799	1412	78% (520%)	0%
Kern River	6322	801	5057	631% (1185%)	100%
Owens River	9004	539	19	4% (224%)	34%
Salton Sea	15 219	227	1601	705% (710%)	96%
Santa Ynez	2322	249	831	334% (334%)	99%
Santa Clara River	4165	264	417	158% (196%)	99%
Santa Ana River	6370	306	559	183% (183%)	85%

[a] Mean annual runoff at outlet, predicted from statistical model (1951–2010 average).
[b] Water right allocations percentages, excluding water rights for hydropower. Allocations levels including hydropower shown in parentheses.
[c] Proportion of cumulative water right allocation (excluding hydropower), that are held by public entities including federal, state, and municipal agencies.
[d] Klamath River water rights calculations do not account for water allocations in upper river basin located in the State of Oregon.

water supplies by approximately five times. Our findings also highlight river basins where significant over-allocation of surface water supplies is likely to lead to conflicts among water users, particularly during periods of water scarcity when insufficient water is available to satisfy all face-value water right demands. For example, the results underscore the challenge of balancing human and ecosystem water needs in the Sacramento-San Joaquin Delta, the hub of California's water management system and source of its greatest vulnerability (Hanak *et al* 2011), where cumulative rights allocations are approximately three times greater than average natural supplies. Allocation levels tend to increase with river size, although many small rivers, particularly on the south coast, are also subject to high water demands. In recent years, new water rights applications have been concentrated in small river basins (figure S1), suggesting that appropriation levels will continue to intensify throughout the river network.

The face values of appropriative water rights reflect the degree to which surface water supplies have been allocated, but must be interpreted with caution. For example, the appropriative water rights system incentivizes permit holders to over-report water use to protect the face-value amount of their water right and therefore represents a generous estimate of actual water use. In addition, return flow (e.g., from irrigation runoff or canal leakage) can be re-used by downstream appropriators, allowing for 'double-counting' of the same volume of water. Nevertheless, the large magnitude of water right allocation volumes relative to natural supplies and poor correlation between county-level allocations and estimates of actual use provide strong evidence that the state has over-allocated water in many, if not most, river basins. Furthermore, allocation volumes only account for post-1914 appropriative water rights; other types of water rights (e.g., riparian claims) make the total amount of surface water allocated significantly higher than estimates provided here.

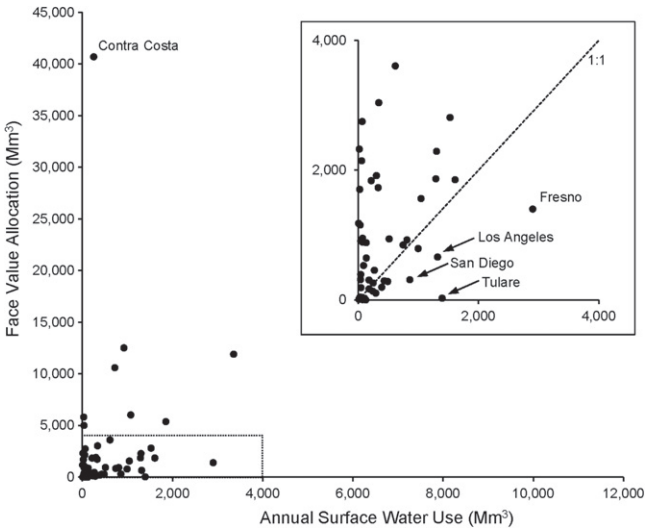

Figure 7. Total face-value allocations for California counties ($n = 58$) compared with mean annual surface-water withdrawals (USGS 2014).

In a well-functioning appropriative water rights system in which allocation volumes are accurately tracked and verified, over-allocation of water supplies is not necessarily a problem. During periods of water scarcity, junior appropriators have to forego their entitlement, but when water is abundant, most water rights holders should be able to exercise their claims. However, inaccurate accounting threatens the value and security of water right entitlements, particularly when curtailments are required during times of scarcity. For example, the current drought in California has led the Water Board to issue emergency curtailments of all water users in specific watersheds to protect fishery resources (Water Board 2014c). Such blanket curtailments would not be necessary if the Water Board had accurate water-use information, which could potentially be used to target specific water users and develop cooperative strategies to reduce water diversion impacts on environmental flows.

In over-allocated systems, water to satisfy new demands will likely require re-allocation of existing water rights. While modification of water rights represents a potential threat to right holders, the disproportionate control of the state's water supply by state and federal agencies indicates that impacts to private water rights will be limited. This is because improvements in water rights accounting will have a much greater effect on large, publically held entitlements (that are probably over-prescribed) than on relatively small entitlements held by individuals. Furthermore, most dedicated water by volume is held as water rights permits (not licenses) by state and federal agencies, and thus could be curtailed to better reflect actual use through the licensing process. Therefore, there is significant flexibility in the current water rights system to support re-allocation of water to uses that support the public interest.

California water law also authorizes the re-allocation of water rights to address evolving societal needs and changing environmental conditions (Shupe *et al* 1989, Littleworth and Garner 2007). For example, the public trust doctrine establishes that the government has an ongoing duty to safeguard the long-term preservation of natural resources (Frank 2012). In California, Fish and Game Code 5937 is an expression of the public trust doctrine, which requires that flows be provided below dams to maintain fish in good condition, and has been used to limit water rights in order to preserve environmental resources (Börk *et al* 2012). In addition, the state's reasonable use doctrine requires that all water rights be exercised in a reasonable manner, which is determined in the context of broader public interest in water supply reliability, ecosystem health, and other public trust values (Littleworth and Garner 2007).

Improving the scope and implementation of the state's water rights system is one of many challenges that California must overcome to adapt its water management system to 21st century conditions (Hanak *et al* 2011). Foremost, efforts to reform surface water rights administration must be coupled with improved monitoring and quantification of riparian and pre-1914 appropriative rights. In addition, the archaic separation of surface and groundwater rights and absence of state-level groundwater regulation prevents the development of conjunctive-use schemes (e.g., groundwater banking and water marketing), while contributing to overdraft of the state's major groundwater basins (Faunt 2009). Dysfunctional groundwater management also threatens surface water supplies and freshwater ecosystems in many of the state's rivers (Zektser *et al* 2005, Howard and Merrifield 2010).

Chronic under-funding of state regulatory agencies is a critical constraint to modernizing the state water rights system. Water rights administration has long suffered from low levels of staffing, contributing to decades-long backlogs in processing water rights applications (Little Hoover Commission 2010). Underfunding, in part, reflects political opposition to action by those who benefit from lax enforcement. However, population growth, hydroclimatic volatility, and changing societal values are expected to disrupt state water management and to be potential catalysts for policy innovation, as has occurred in other Mediterranean-climate regions of the world. In Australia, for example, an unprecedented 13-year dry period led government to undertake major water reforms in the 1990s, which included restructuring the national water rights system. Under the new policy, water rights were separated from land title, quantified, and restricted to 'environmentally sustainable levels of extraction' (2004 National Water Initiative). A similar overhaul of the water rights system occurred in South Africa in the 1990s (Backeberg 2005). In California, the legal framework for managing water resources is largely compatible with needed reforms, as described above, and significant legislative actions is probably not necessary. Rather, political will and sufficient funding are the essential elements for improving the state's capacity to perform its water rights administrative, monitoring and enforcement functions.

After 100 years since its establishment, California's water rights system is struggling to adapt to 21st century realities of increasing water stress, changing climate, and societal demands for water supply security and a healthy

environment. Innovative solutions have been proposed to address these challenges, including market schemes, institutional reforms, and new approaches to ecosystem management (Renwick and Green 2000, Gleick 2003, Hanak *et al* 2011). However, the effectiveness of these strategies fundamentally relies on our ability to accurately measure and track water availability, movement, and uses. Recognizing that addressing deficiencies in the water right system will not alone be sufficient for ensuring reform, without improved quantification and regulation of water rights, such reform will be impossible. To date, the state simply does not have accurate knowledge of how much water is being used by most water rights holders. As such, it is nearly impossible to curtail or re-allocate water in an equitable manner among water users and to effectively manage for environmental water needs. Quantifying spatial patterns and uncertainty in the water rights allocations is an important first step for developing strategies to reconcile and sustainably manage competing water demands in a water-stressed region. California's legal framework for managing water resources is largely compatible with needed reforms, but without additional public investment, the capacity of the state's water management institutions to effectively regulate water rights will remain weak. This is a situation that urgently needs correcting to meet water management challenges arising from drought, population growth and climate change.

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The Economics of Public Trust

What is the Public Trust Doctrine?

The Public Trust Doctrine (PTD) provides that government entities hold certain natural resources "in trust" to safeguard them for the longterm benefit of the general public.[i] In California, PTD responsibilities for water resources include protecting instream flows—and the ecological, habitat and recreational benefts these flows provide—along with municipal, industrial and agricultural water uses.[ii]

Why is the Public Trust Doctrine relevant to managing Bay Delta flows?

Water is a scarce resource. There's not enough of it to go around. That means allocating water to one use, e.g., irrigated agriculture, will likely have negative implications for other users, e.g., instream flows. And vice versa. The PTD requires that the relevant government entities, e.g., the State Water Resources Control Board (SWRCB), take the public trust into account when balancing competing demands for water. What's know as the Mono Lake decision is one of the most cited application of the PTD to protecting instream flows. In that case the court stated that government entities have an, "affirmative duty to take the public trust into account in the planning and allocation of water resources, and to protect public trust uses whenever feasible."[iii] According to this ruling, the SWRCB and other state agencies must take the public trust of instream flows and other water uses into account when allocating Bay Delta flows to competing uses.

What role does economics play in Public Trust deliberations?

Using the Mono Lake case as a model for how balancing decisions for Bay Delta flows may play out, the SWRCB and others will make these decision after considering the impacts of a range of allocation alternatives. This information will likely include descriptions of the consequences of alternatives on biophysical factors affected by changes in instream flows including flow volumes, water quality and temperature, status of threatened or endangerd species, and riparian habitats. Other relevant factors include impacts on recreation demand, and water use by agriculture, industry and municipalities. Benefit cost analysis (BCA) is a commonly used method of evaluating the impacts of these types of allocation alternatives. BCA is simple in concept: identify the user groups affected by the water allocation alternatives; calculate the costs to each group for each alternative; calculate the benefits to each group for each alterantive; compare costs and benefits; select an anternative. Applying BCA, however, can be complex. This is especially true when some of the trust resources at issue, e.g., instream flow and

riparian habitats, are not traded in markets and so have no market prices with which to compare with other trust resources that are traded in markets, e.g., agricultural production. That is, some trust resources have values but no prices. Economists and others refer to these as non-market values. As the name implies, resources traded in markets have market values. The economic analysis in the Mono Lake case concluded that the economic benefits of preserving the public trust of instream flows for Mono Lake—the non-market values—outweighted the cost to Los Angeles of finding an alternative water source to Mono Lake—a market value—by a factor of 50.[iv]

How do economists conduct economic analyses for Public Trust deliberations?

The economic analysis portion of a Public Trust deliberation should answer the general question: What are the costs and benefits of increasing/decreasing water allocations to instream flow, recreation, industry, municipal and agricultural water uses? The major steps in answering this question include the following.[v]

Identify the full range of trust resources at issue. Instream flow resources provide a range of services that benefit society. These services, known as ecosystem services, may include: habitat for aquatic and riparian species; water-related amenities including scenic vistas and recreation; and water quality benefits. Many of these services have non-market values. Other trust resources and services at issue include water use by municipalities, businesses and, irrigators. These services are traded in markets and so have market values. Its important to include all trust resources and the services they provide in the economic analysis. Failing to do so can lead to underestimating or overestimating the affected benefits and costs. Incomplete analyses typically ignore or underestimate the affected non-market values.

Develop economic measures of the relevant benefits and costs of alternative water allocations. As noted above, such a description will likely include a mix of market and non-market values. A complete analysis would include all relevant costs, prices or payments in the analysis. For example, an alternative that reduces water allocation to agricultural production may reduce agricultural jobs and incomes. It may also, however, reduce subsidy payments that would normally support the affected agricultural production. The economic analysis should count both the negative impacts on agricultural producers and the beneficial impacts of reduced subsidy payments. That is, the analysis should describe the net effect on this economic sector.

Take account of relevant trends including scarcity of resources and changing patterns of economic demand. For example, species or habitats close to the extinction tipping point will likely have greater biophysical and economic value than species or habitats in abundance. In another example, to the extent that recreation demand is projected to increase faster than other resource uses, the economic analysis should take this into account by considering the likely future consequences of decisions made today.

Identify measures that could mitigate economic costs. Economies are dynamic. Business and industries constantly adjust and react to shifting economic conditions including things like changing interest rates, competitive forces, supply and demand conditions. The BCA analysis of alternative Bay Delta allocations should acknowledge this dynamic nature. For example, the analysis could describe the extent to which water users have alternatives to Bay-Delta water, what those alternatives cost, and how these costs compare to the non-market and market values of the benefits of instream flows.

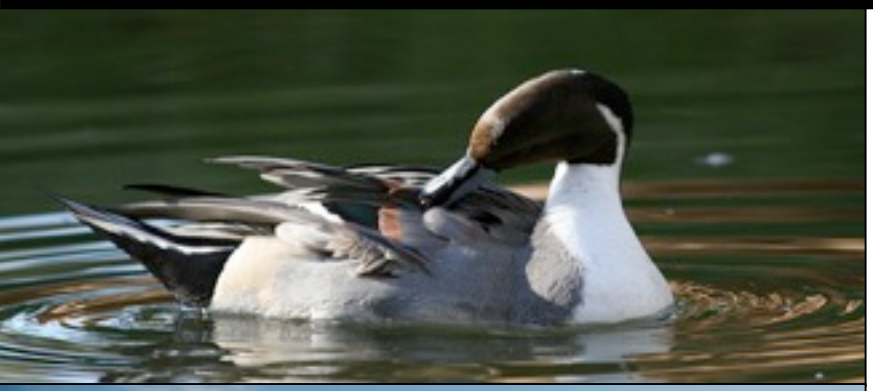
Through BCA, economists offer a rigorous, legally and academically validated set of tools to help the SWRCB adopt a plan for managing Bay-Delta flows that balances protecting instream flows with other trust resources.

Endnotes

[i] Frank, R. 2012. "The Public Trust Doctrine: Assessing Its Recent Past &Charting Its Future," *UC Davis Law Review*, Vol.45: 665-691.
[ii] Stevens, J. 2005. "Protecting California's Rivers: Confluence of Science, Policy and Law. University of California at Davis, June 9, 2004. Applying the Public Trust Doctrine to River Protection." *California Water Plan Update 2005* Volume 4: 393-400; Frank, 2012; Broussard, J. 1983. *National Audubon Society et al., Petitioners, v. The Superior Court of Alpine County, Respondent; Department of Water and Power of the City of Los Angeles et al., Real Parties in Interest*. 33 Cal.3d 419. S.F. No. 24368. Supreme Court of California. February 17.
[iii] Stevens, 2005, page 397; California State Water Resources Control Board. 2015. *Water Rights: Public Trust Resources.* Last Updated October 28. Retrieved November 30, 2015, from http://www.swrcb.ca.gov/waterrights/water_issues/programs/public_trust_resources/#beneficial.
[iv] Loomis, J. 1998. "Estimating The Public's Values for Instream Flow: Economic Techniques and Dollar Values," Journal of the American Water Resources Association. Vol. 34, No. 6: 1007 – 1014.

Bay-Delta Water

Economics of Choice



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ECONorthwest specializes in economics, planning, and finance. Founded in 1974, we're one of the oldest independent economic consulting firms in the Pacific Northwest. ECONorthwest has extensive experience applying rigorous analytical methods to examine the benefits, costs, and other economic effects of environmental and natural resource topics for a diverse array of public and private clients throughout the United States and across the globe.

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SECTION 1: CONTEXT AND ASSIGNMENT

Water flows from the Sierra Nevada into the Sacramento and San Joaquin Rivers, which in turn flow into the San Francisco Bay-Delta, and from the Delta Bay into the Pacific Ocean. In 2009, the California state legislature enacted the Delta Reform Act. As part of that legislation the California State Water Resources Control Board (State Water Board) was instructed to report to the Delta Stewardship Council (Council) the Board's view of what flows would be necessary to protect the Delta ecosystem. In its August 2010 report, *Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem* (*Flow Report*)[1], the State Water Board expressed its concerns about the Bay-Delta flows.[2] It concluded that the Bay-Delta flows are inadequate. They threaten native fish[3], and thereby violate California's obligations under the public-trust doctrine.[4] According to the *Flow Report*, changing flow conditions in ways that would support native fish species requires improving the Bay-Delta flows throughout the year.

If we understand the Council's role correctly, then to allocate the Bay-Delta flows well, the Council would seek to balance its obligations to protect public-trust use of the Bay-Delta flows with its obligations to support the dual coequal goals of i) habitat conservation and management, and ii) improving reliability of water supplies. This balancing task includes:

a. Developing alternatives to increase the efficiency and equity of allocating the Bay-Delta flows among the competing instream and consumptive demands[5]

b. Describing the economic, biophysical[6] and other effects of the alternatives

c. Selecting what it regards as the best of the alternatives and enforcing the efficient allocation of the imputed flow conditions.

Economics, at its core, is the science of choice[7] or, as it is defined frequently in introductory textbooks, the study of the allocation of scarce[8] resources among competing

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[3] These species include Chinook Salmon, Delta Smelt, and Bay Shrimp. *Flow Report*, p. 5 and 8.

[4] *Flow Report*, p.1-7; *Flow Report*, p.12: "The purpose of the public trust is to protect commerce, navigation, fisheries, recreation, ecological values, and fish and wildlife habitat. Under the public trust doctrine, the State of California has sovereign authority to exercise continuous supervision and control over the navigable waters of the state and the lands underlying those waters. [citation omitted] A variant of the public trust doctrine also applies to activities that harm a fishery in non-navigable waters. [citation omitted]"

[5] Instream demands are water uses that can be carried out without removing the water from its source, such as in navigation and recreation. Consumptive demands are water uses which lessen the amount of water available for other uses, such as in manufacturing, agriculture, and food preparation. [U.S. Bureau of Reclammation. *Glossary*. January 5, 2011. Retrieved June 24, 2011, from http://www.usbr.gov/library/glossary/.]

[6] By 'biophysical,' we mean the biological effects (e.g., on plants and animals), ecological effects (e.g., on ecological systems), and physical effects, e.g., on water, land and air). We do not mean the interdisciplinary science of biophysics that, as Wikipedia tells us, 'uses the methods of physics and physical chemistry to study biological systems.' We apologize for any confusion, and plead only expedience for our lack of precision. [2011. *Biophysics*. May 16. Retrieved June 27, 2011, from en.wikipedia.org/wiki/Biophysical].

demands.[9] The State's balancing decision, whether good or bad, would include such an allocation among competing demands. Michael Jackson, an attorney working with Bay-Delta stakeholders, asked ECONorthwest to describe economic issues relevant to the State's balancing of competing demands for Bay-Delta flows. We at ECONorthwest recognize the diverse group of people interested in the Bay-Delta Flows, and have sought to write an accessible yet technically sound report rooted in established economic practices and theory. To that end, we have prepared this report.

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[7] See, for example, <http://www.google.com/search?sclient=psy&hl=en&site=&source=hp&q=economics+science+choice&btnG=Search>

[8] By "scarcity," we mean situations in which the resources available for producing output are insufficient to satisfy wants. This is different to saying that they are insufficient to satisfy demand since demand relates to an expression of want backed by money. This concept of relative scarcity in relation to wants is widely held to define the central conflict of economics since, otherwise, there would be no need to think about the 'best' allocation of resources. [Pearce, D.W. 1992. *The MIT Dictionary of Economics*, 4th edition. Cambridge, MA: The MIT Press.]

[9] See, for example, <http://www.google.com/search?sclient=psy&hl=en&site=&source=hp&q=economics+allocation+scarce+resources+competing+demands&btnG=Search>; Field, B.C. 1997. *Environmental Economics*, Second Edition. San Francisco: McGraw-Hill Company, Inc.; Gramlich, E.M. 1990. *A Guide to Benefit-Cost Analysis*. Englewood Cliffs, New Jersey: Prentice Hall.; Harberger, A. and G. Jenkins, eds. 2002. *Cost-Benefit Analysis*. The International Library of Critical Writings in Economics: 152. Northampton, Massachusetts: Edward Elgar Publishers.; and U.S. Environmental Protection Agency. 2010. *Guidelines for Preparing Economic Analyses*. December.

SECTION 2: ECONOMICS AND THE CHOICES CALIFORNIA FACES

If the waters flowing from the Sierra Nevada to the San Francisco Bay-Delta had conditions of abundance, the State might not have felt compelled to prepare the *Flow Report*. But scarcity rules the waters and causes fierce competition. The consequences of the competition for these scarce waters lies at the heart of the State Water Board's *Flow Report*.[10]

Instream uses of the Bay-Delta flows compete with what the State Water Board describes as "other beneficial uses" of water.[11] These *other beneficial uses* include municipal, industrial, and agricultural uses.[12] If, once again, we understand the State role correctly, then in allocating the Bay-Delta flows the State would seek to balance its obligations to protect public-trust use of the Bay-Delta flows, with its obligations to support the "other uses" of the Bay-Delta flows.

To balance its obligations effectively, the State would, as we state in Section 1, seek to develop alternatives to improve the Bay-Delta flows, describe the economic, biophysical and other effects of these alternatives, and then select the best of the alternatives. To serve these ends, a necessary step for the State would be to describe how each alternative would affect economic well-being, power production, human health and welfare, the sustainability of natural resources, habitats and species, and possibly other factors.[13] Economists have developed tools for describing such effects.

Among the tools economics offers for comparing competing alternatives, the most widely known and frequently used in environmental and natural resource matters is benefit-cost analysis (BCA).[14] As applied in this case by the State, a properly conducted BCA would describe differences in net economic values—economic benefits minus economic costs—across the alternatives. In our experience, stakeholders and decision makers frequently care about other types of economic consequences besides changes in economic values. They want to know how policy alternatives will affect things like jobs and income, which economists describe as economic impacts, and the distribution of changes in economic values and impacts among stakeholders and households, which

[10] For a description and explanation of the economic consequences of a shift from abundance to scarcity in an ecological system, e.g., a watershed, see Courant, P., E. Niemi, and E. Whitelaw. 1997. *The Ecosystem-Economy Relationship: Insights from Six Forested LTER Sites*. Grant No. DEB-9416809. National Science Foundation. November.; Hulse, D., G. Gordon, and E. Niemi. 2001. *Establishing Correlations Between Upland Forest Management Practices and the Economic Consequences of Stream Turbidity in Municipal Supply Watersheds*. EPA Grant No. R825822. Environmental Protection Agency. September.

[11] In the rest of the report, we will italicize the phrase "other beneficial uses" to signal that these are not all other uses but only those specified by the State Water Board.

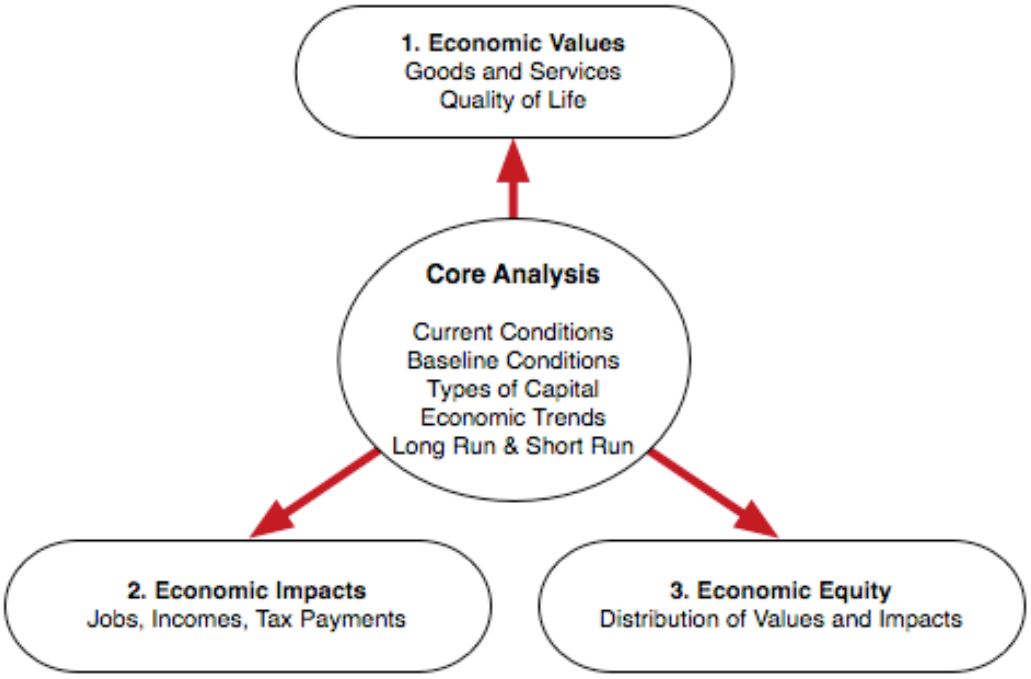
[12] *Flow Report*, p.1-7.

[13] *Flow Report*, p.2-3.

[14] Mishan, E.J. *Elements of Cost-Benefit Analysis*, 3rd Edition. 1972. p.11-13; Turner, R., D. Pearce, and I. Bateman. 1993. *Environmental Economics*, p.93-4; Teitenberg, T. and L. Lewis. *Environmental and Resource Economics*, 8th Edition. 2008. p.28.

economists generally address as economic equity. Thus, a comprehensive economic assessment from alternative Bay-Delta flows would describe economic consequences that include changes in economic values, changes in economic impacts, and the distributional outcomes for each alternative. Figure 1 shows the three categories of economic effects each alternative would cause.

Figure 1. Categories of Economic Effects



Source: ECONorthwest

The first category, Economic Values, represents *changes in the values of goods and services* available to Californians that result from the market and non-market activities associated with each alternative. Such effects include changes in economic benefits, costs or both, as well as changes in the quality of life. The second category, Economic Impacts, represents changes in jobs and incomes for workers, costs or revenues for private firms, and expenditures or tax revenues for governments. These impacts occur directly, as workers are employed on construction, deconstruction, and restoration, for example, and indirectly, as dollars are spent locally on goods and services, dollars which multiply through the local economy, supporting additional jobs and incomes. The third category, Economic Equity, represents the distribution of the other two categories of effects, Economic Values and Economic Impacts, across income brackets of households, across ethnicities, and across geographic areas. These changes are particularly challenging to describe and evaluate when, say, groups of households who enjoy the benefits, jobs, and incomes, differ from those who bear the costs.

The center of Figure 1—the Core Analysis—shows the analyses common to characterizing or calculating all three categories of economic effects.

1. By describing the Current Conditions and Baseline Conditions for each alternative, the analyst can describe the gap between the two. The larger the gap, the larger the problem.
2. By describing the four basic forms of capital (physical capital, human capital, social capital and natural capital)[15] under both Current and Baseline Conditions for each alternative, the analyst can, for example, measure the effects of the alternative on the stocks of economic assets and thereby on the flows of services from those assets.[16]
3. By taking economic trends into account, the analyst can apply a with-versus-without approach, which isolates the economic effects (values, impacts, equity) caused by the alternatives from changes that will likely occur unrelated to the alternatives.
4. By addressing both the short- and long-term effects, the analyst can avoid errors of omission and commission through confusing today and tomorrow. The literal differences in effects between today and tomorrow would be trivial. But since the relevant period of time may stretch to a century, the figurative differences would likely be huge.

In 1983, the California Supreme Court issued its opinion in the case of *National Audubon Society et al. v. The Superior Court of Alpine County, et al*.[17] That ruling, commonly called the "Mono Lake decision," (*Mono Lake*) clarified the extent of the State's public-trust obligation to protect water resources. In general, the Court ruled that protecting water resources takes precedence over consumptive water use. The Court's ruling relied in part on economic analyses of the competing demands for Mono Lake water.

The State's analysis of the economic effects of its balancing decision can benefit from applying the widely accepted professional standards applicable to economic analyses in this type of matter, and the precedents set by the *Mono Lake* decision. In this report we examine the relevant professional standards and the *Mono Lake* decision and describe their implications for the State as it seeks a balance.

In the next section, Section 3, we present an economic perspective of the Supreme Court's decision.

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[15] These four types of capital affect local economic productivity, which in turn is the source of economic growth in, say, California. Examples of physical capital are private and public machines, buildings, roads, and water and sewage systems. Examples of natural capital are rivers and streams, mountains and valleys, and grasslands and forests. Examples of human capital are workers of all types and their knowledge and skills. Examples of social capital are social networks and the norms, laws, and judicial and political systems.

[16] O'Sullivan, A. 2008. *Urban Economics*, 7th Edition. p.90-91.

[17] Broussard, J. 1983. *National Audubon Society et al., Petitioners, v. The Superior Court of Alpine County, Respondent; Department of Water and Power of the City of Los Angeles et al., Real Parties in Interest*. 33 Cal.3d 419. S.F. No. 24368. Supreme Court of California. February 17.

SECTION 3: ECONOMICS AND THE STATE WATER BOARD'S BALANCING DECISION IN *MONO LAKE*

In *Mono Lake*, the State Water Board faced a classic public-policy choice, a choice resembling the choice it faces with Bay-Delta flows: allocating a scarce and valuable natural resource—Mono Lake—among competing demands. The State can therefore look to its own history for guidance on balancing its public-trust obligation to protect Bay-Delta flows with the demands from other beneficial uses, and the role that economic information can play in the deliberations. As it balanced competing interests and reached its decision in *Mono Lake*, the State Water Board described the biological significance of the water at issue, developed economic measures of the relevant costs and benefits of alternative water allocations, and considered measures that could mitigate negative economic outcomes.[18] It should take similar steps as it sets criteria for the Bay-Delta flows.

In *Mono Lake*, the State Water Board considered the consequences of the City of Los Angeles (City)— acting through the Los Angeles Department of Water and Power (LADWP)—exercising its right to draw water from Mono Lake for urban-consumption uses, and the resulting impacts on the lake's ecological habitats and affected species. The State Water Board began by considering the biophysical aspects of its decision. It first identified the ecological uses of trust resources at issue and their biological requirements, e.g., the species that depend on Mono Lake and their water requirements. Next, it studied the relationship between water flows out of Mono Lake and the impacts on ecological uses. It then compared the costs of the City acquiring water from sources other than Mono Lake with the economic benefits of protecting the ecological uses of the lake's affected public-trust resources.[19]

Dr. John Loomis, a natural-resource economist,[20] helped quantify the economic benefits in the State Water Board's analysis. Dr. Loomis surveyed California residents and calculated their willingness to pay to protect Mono Lake's habitats and affected species. Based on this information, Dr. Loomis calculated the economic benefits of protecting the ecological uses of the lake's water at $1.5 billion to $3.5 billion annually. This amount significantly exceeded the estimated cost, $26.5 million per year, of finding alternative sources of water for the City.[21]

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[18] Koehler, C.J. 1995. "Water Rights and the Public Trust Doctrine: Resolution of the Mono Lake Controversey." *Ecology Law Quarterly* 22: 451.; Casey, E. 1984. "Water Law—Public Trust Doctrine," *Natural Resources Journal* 24: 809-825.

[19] Koehler, 1995; Casey, 1984.

[20] Dr. Loomis conducted this research while at the Department of Agricultural Economics at the Davis campus of the University of California.

[21] Loomis, J. 1987. "Balancing Public Trust Resources of Mono Lake and Los Angeles' Water Right: An Economic Approach." *Water Resources Research* 23: 1449-1456. August; Loomis, J. 1997. Use of Non-Market Valuation Studies in Water Resource Management Assessments. Colorado State University; Duffield, J. 2010. *Valuing Ecosystem Services in River and Lake Systems: Methods and Western U.S. Case Studies*. Presentation, Salt Lake City, April 28.

Dr. Loomis conducted his analysis as independent research that was not part of the State Water Board's balancing decision. The State Water Board, however, took notice of Dr. Loomis' work and directed the consultant performing the economic portion of the Environmental Impact Statement for the balancing analysis to adopt and implement Dr. Loomis' approach. The consultant's assessment reached the same conclusion: the economic benefits of protecting the ecological uses of trust resources in Mono Lake significantly exceeded the cost of supplying the City with water from alternative sources. The State Water Board considered other factors along with these economic results and ultimately reduced by half the amount of water that the LADWP could divert from Mono Lake.[22]

The State Water Board's *Mono Lake* experience can help inform current deliberations on the relevant economic aspects of balancing competing uses of Bay-Delta flows. Analytical factors from the *Mono Lake* analysis that have relevance to the Delta Stewardship Council's planning decision include:

- *Conduct economic analyses in the context of the biophysical requirements of the ecological uses of public-trust resources*. The State Water Board identified the ecological uses of public-trust resources at issue in *Mono Lake* and the water requirements that support these uses *before* considering the costs and benefits of allocation scenarios. That is, the State Water Board acknowledged its obligation to protect the ecological uses of public-trust resources, and then considered reasonable methods of satisfying this obligation.[23]

- *Account for all relevant economic, legal, and other forces and trends*. The LADWP proposed that the State Water Board make its decision based on a worst-case scenario of future water supplies for the City. Such an approach ignored current trends in water policy at the local, state and federal level. For example, the worst-case approach ignored the fact that trends in state and federal water law at the time encouraged water transfers between and among entities. Such transfers meant that LADWP could tap sources other than Mono Lake for future demands. On this point the State Water Board noted, "[T]he LADWP analysis assumes that insufficient replacement water will be available thereby causing high water shortage costs to be imposed on water users in Los Angeles. This assumption does not appear to be realistic in light of the evidence…." The State Water Board took the current trends in water transfers into account when making its decision.[24]

- *Consider likely mitigating circumstances*. LADWP also asked that the State Water Board assume that the City would take no actions to mitigate the impacts of reduced flows from Mono Lake. That is, the LADWP asked that the State Water Board base its decision on a *static analysis* that assumed conditions would remain fixed over the foreseeable future. The State Water Board, instead, based its decision on a *dynamic analysis*, which assumed the City and others would take appropriate actions, such as

[22] Loomis, 1997; Duffield, 2010.

[23] Koehler, 1995; Casey, 1984.

[24] Koehler, 1995; Casey, 1984.

doing more to conserve water, to mitigate the initial effects of a reduction in water supplied from Mono Lake. More broadly, this dynamic analysis took into account relevant economic and other forces and trends, as noted above.

- *Account fully for both values reflected in market prices and values that are not.* In reaching its *Mono Lake* decision, the State Water Board considered estimates of the City's potential costs to acquire water from another source. These estimates derived from data on the prices at which water was bought and sold in the region. No such prices and data existed for the economic value of protecting the ecological uses of public-trust resources. The State Water Board recognized, however, that the absence of prices did not mean that protecting these uses had little or no value, but, instead, that market prices are not an appropriate tool for measuring the value. Hence, the State Water Board looked to the results of research that employed non-market techniques for estimating the value.[25] We address this point in more detail in the next section.

[25] Loomis, 1987; Loomis, 1997; Duffield, 2010.

SECTION 4: THE EVOLUTION OF THE ECOLOGICAL USES OF PUBLIC-TRUST RESOURCES AND ECONOMIC METHODS

Stakeholders in the *Mono Lake* case litigated to clarify the relationship between the City's water rights and the State's public-trust obligation to protect water resources. The Supreme Court of California ultimately ruled that, in general, the State's public-trust obligations have precedence over the City's water rights. This ruling helped inform the State Water Board's balancing decision in that case. The Supreme Court's decision emphasized that stakeholders and decision makers should consider public-trust obligations as dynamic and evolving over time, rather than fixed and based exclusively on historical conditions. What constitutes a protected use of public-trust resources can evolve along with changes in understanding of the natural environment and its relationship to the well being of human society.

Methods of describing the economic effects of public policies on ecological uses of water resources have also evolved. Markets do not exist for many of these uses and so economists calculate their economic significance using non-market valuation methods. Years ago, economists and public-policy analysts could reasonably debate the analytical veracity of these methods. Not so today. Analytical methods continue evolving, and areas of legitimate disagreement still exist, however, detailed descriptions of these analytical methods appear in economic textbooks, articles in academic journals, undergraduate and graduate economics courses, and reports by federal and state natural-resource agencies in the U.S. Economists in Europe, Asia and elsewhere also regularly use these methods.

In this section we describe the evolution of thinking on ecological uses of California's public-trust resources. We then summarize methods of describing the economic significance of ecological uses of trust resources, especially those that provide society with ecosystem-services for which markets do not exist. The information in this section provides a context for the sections that follow, in which we describe in more detail the analytical principles relevant to describing the economic effects of the State's balancing decision regarding the Bay-Delta flows.

A. Ecological Uses of Public-Trust Resources

Implementing the public-trust doctrine in California has evolved over time. Early in the state's history, the doctrine protected the public's access to, and use of, tidelands for navigation, commerce and fisheries. More recent court decisions recognized the changing nature of the use of trust resources and expanded the list of protected uses to include recreational uses and ecological uses that support habitats and species. Litigation related to the State Water Board's *Mono Lake* decision help clarify the responsibilities of the State as administrator of the public-trust resources. The Supreme Court of California ruled that the State Water Board must take impacts of allocation decisions on uses of trust resources into account when administering water rights.[26]

[26] Koehler, 1995; Casey, 1984.

The Court's ruling also emphasized a flexible definition of use, one that responds to changing public needs. The Court also identified ecological resources as one of "the most important" uses of trust resources.[27]

"[W]e stated that '[t]he public uses to which tidelands are subject are sufficiently flexible to encompass changing public needs. In administering the trust the state is not burdened with an outmoded classification favoring one mode of utilization over another. [citation omitted] There is a growing public recognition that one of the most important public uses of the tidelands—a use encompassed within the tidelands trust—is the preservation of those lands in their natural state, so that they may serve as ecological units for scientific study, as open space, and as environments which provide food and habitat for birds and marine life, and which favorable affect the scenery and climate of the area.'"[28]

Preservation of water-based natural resources "in their natural state" can affect a wide range of ecosystem services that trust resources provide. An illustrative, though incomplete, list of these ecosystem services includes flood mitigation and groundwater recharge, water filtration, sediment capture, nutrient cycling, gas regulation, provision of habitat for economically important fish and wildlife, and scenic and amenity values. While the natural resources at issue exist independent of human society, ecosystem services only exist insofar as there is human demand for their supply, at a particular place and time, and their value reflects the specific context within which the demand exists. Ecological uses of trust resources are not traded in markets, however, and so we must look to non-market valuation methods for measures of their values. We describe these methods in the next subsection.

B. Evolution of Economic Methods

Methods of measuring the economic effects of water allocation decisions on what the California Supreme Court described as one of the most important uses of public-trust resources—uses by aquatic resources that provide ecosystem services—have evolved over time. In the remainder of this section, we illustrate the evolution of these economic methods using reports by federal and California state agencies. We picked these sources because they help guide federal and state public policies, and because they often incorporate analytical principles or methods only after they have been subject to peer review and debate in academic and professional forums. We begin with federal guidelines.

1. Federal Guidelines

a. Principles and Guidelines

In 1983, the U.S. Water Resources Council published, *The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (*P&G*).

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[27] Broussard, J. 1983. *National Audubon Society et al., Petitioners, v. The Superior Court of Alpine County, Respondent; Department of Water and Power of the City of Los Angeles et al., Real Parties in Interest*. 33 Cal.3d 419. S.F. No. 24368. Supreme Court of California. February 17.

[28] Broussard, 1983.

This report helps federal agencies, including the Corps of Engineers and Bureau of Reclamation, plan water-related projects. The *P&G* have not been updated since they were introduced. Recently, the National Research Council (NRC) of the National Academies, reviewed proposed changes to the *P&G*. The NRC's review begins by describing some of the significant changes in water-resources planning since the publication of the *P&G* in 1983.

"Since the early 1980s there have been may changes in the national water resources planning landscape. For example, … [s]cientific understanding and appreciation of the natural functions of aquatic ecosystems have increased, and environmental protection and ecosystem restoration have become primary planning objectives for some projects ... Many national water planning challenges involve balancing decisions and resources among a greater number of water resource users and interests."[29]

"For the Corps of Engineers, new missions have been added … especially aquatic ecosystem restoration."[30]

"[Other water-planning issues] such as design of ecosystem restoration projects, reallocating water from traditional users to rapidly growing cities or ecosystem restoration purposes, and controlling nonpoint source pollution reflect more recent changes and needs. Many of today's key national water management issues lie largely outside the missions of the agencies for which the *P&G* was written."[31]

"In light of these developments, many groups—including committees of the National Research Council—have recommended that the P&G be reviewed and modernized.[32]

The NRC concluded, however, that the proposed changes did not adequately address the many deficiencies in the outdated *P&G*. The proposed revisions "lacked clarity and consistency,"[33] which precluded the NRC from offering specific suggested changes. The NRC did comment on a few areas for improvement.

"…[T]he 2007 Water Resources Development Act requires that the P&G revision ensure the use of best available economic principles and analytical techniques. However, the proposed revisions contain concepts, advice, and language that are carryovers from historical practices and documents and are not fully consistent with contemporary best practices in decision science and economics. This relates

[29] National Research Council of the National Academies. 2010. *A Review of the Proposed Revisions to the Federal Principles and Guidelines Water Resources Planning Document*. Committee on Improving Principles and Guidelines for Federal Water Resources Project Planning, Water Science and Technology Board, Division on Earth and Life Studies. p.1.

[30] National Research Council, 2010, p.5.

[31] National Research Council, 2010, p.6.

[32] National Research Council, 2010, p.1.

[33] National Research Council, 2010, p.2.

to both how analysis is conducted and the role that it plays informing decisions."[34]

For example, the NRC noted that limiting an economic analysis of an environmental policy to costs and benefits would not satisfy current professional standards. An adequate analysis will look beyond costs and benefits to describe all relevant impacts and tradeoffs that affect jobs, income, competitiveness, etc. The *P&G* also separated the analysis of economic effects of environmental changes, which are described qualitatively, from the analysis of economic-development changes, which are described quantitatively. The NRC characterized this approach as a "residue" from the 1983 *P&G* that is inconsistent with current best practices.[35]

The NRC described the *P&G* as outdated and not representative of current best economic practices. This is especially true for analyses of the economic effects of public policies on environmental resources and ecosystem services. Given the significance of public-trust resources that support ecological habitats and ecosystem services that the Bay-Delta flows support, and given the deficiencies in the *P&G*, this report can offer the State Water Board little useful guidance on economic aspects balancing Bay-Delta flows.

b. EPA Guidelines on Economic Analyses

In December of 2010, the Environmental Protection Agency (EPA) released *Guidelines for Preparing Economic Analyses (Guidelines)*. The 2010 edition of the *Guidelines* represents the third update since the first edition was released in 1983. Unlike the *P&G*, which remain unchanged since first introduced in 1983, EPA anticipated periodically revising the *Guidelines* to account for "new literature published since the last revision" and the "growth and development of economic tools and practices."[36] These revisions and updates help keep the *Guidelines* more consistent with current best economic practices than do the *P&G*.

The 2010 edition includes a number of updates that help make the document a useful planning tool in general, and specifically for the State's balancing decision in the Delta. These updates include:[37]

- More detailed recommendations on identifying and describing baseline conditions that would exist without a proposed policy revision or regulation.

- An expanded description of methods of defining and valuing ecological benefits of projects and policies that protect natural resources.

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[34] National Research Council, 2010, p.12.

[35] National Research Council, 2010, p.11-12.

[36] National Center for Environmental Economics. 2010. *Guidelines for Preparing Economic Analyses. U.S. Environmental Protection Agency*. EPA 240-R-10-001. December. p.1-1.

[37] National Center for Environmental Economics, 2010, p.1-1.

- A revised and updated description of methods of discounting costs and benefits that occur at different times in the future.

- Directions on presenting the results of benefit-cost studies, including effects that cannot be quantified or expressed in dollar amounts.

c. EPA Guidelines on Valuing Ecological Services

EPA's Science Advisory Board (SAB) released a report titled, *Valuing the Protection of Ecological Systems and Services* in May of 2009. As the name implies, the report describes methods of identifying and describing the economic significance of natural resources and associated ecosystem services affected by policies or projects. The SAB noted the importance of valuing ecosystem services using up-to-date economic methods, and promoting collaboration among social scientists and biophysical scientists.[38]

"This report describes and illustrates how EPA can use an 'expanded and integrated approach' to ecological valuation. The proposed approach is 'expanded' in seeking to assess and quantify a broader range of values than EPA has historically addressed and through consideration of a larger suite of valuation methods. The proposed approach is 'integrated' in encouraging greater collaboration among a wide range of disciplines, including ecologists, economists, and other social and behavioral scientists, at each step of the valuation process."[39]

The report describes a number of recommendations that facilitate the "expanded and integrated approach." Many of the recommendations have relevance to assessing the economic effects of water allocations in the Delta. These include:[40]

- Identifying and describing the critical relationships between biophysical aspects of affected natural resources and ecosystem services, and analyses of the economic effects of policies that impact resources and services.

- Choosing appropriate valuation methods.

- Identifying and describing sources of uncertainty in analyses of the economic significance of ecosystem services.

2. Guidelines by the California Department of Water Resources

The California Department of Water Resources (Department) recently produced guidelines for economic analyses of public policies that affect water resources. We describe two of these works in this subsection. The first, a four-part study published in 2005, describes the importance of considering the full range of economic costs and

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[38] Environmental Protectation Agency (EPA) Science Advisory Board. 2009. Valuing the Protection of Ecological Systems and Services. EPA-SAB-09-012. May. p.2.

[39] EPA, 2009, p.2.

[40] EPA, 2009, p.1-7.

benefits of public policies that affect aquatic resources. The Department refers to this as a "multi-objective approach" to floodplain management because it takes into account objectives besides flood mitigation (a single objective) to consider consequences on habitats, water quality, society, etc. The second is a guidebook on conducting economic analysis published by the Department in 2008.

a. Multi-Objective Approach to Floodplain Management

1. Ecosystem Valuation Methods

The first of the four reports in the multi-objective approach, *Ecosystem Valuation Methods* (*Methods*), describes a number of up-do-date methods of valuing aquatic-based ecosystem services. [41] The report summarizes ten analytical methods and their advantages and disadvantages. The floodplain focus and the up-to-date descriptions of analytical methods in this and the other three reports, have relevance to, and can help inform, the State's assessment of the economic significance of ecological uses of the Bay-Delta flows.

2. Natural Floodplain Functions and Societal Values

The second report, *Natural Floodplain Functions and Societal Values* (*Functions*), describes biophysical aspects of floodplain habitats and examples of economic values of the ecosystem services that floodplains provide.[42] The report provides background information on floodplain habitats and the biological and human services they provide, and the importance of considering this information when making decisions that affect floodplains. The report describes economic values of ecosystem services including managing flows, maintaining natural channel processes, water supply, water quality, soil quality, and plant and wildlife habitat. The staff conducting the study applied some of the analytical methods described in the *Methods* report.

3. Middle Creek Restoration Project Case Study: Benefit and Cost Analysis

The third report, *Middle Creek Flood Ecosystem Restoration Project Case Study: Benefit and Cost Analysis* (*Case Study*), describes the results of a case study of applying analytical methods and data described in the *Methods* and *Functions* reports to a floodplain restoration project.[43] The Middle Creek Ecosystem Restoration Project restored damaged floodplain structure, habitats and functions in the Clear Lake watershed.

The analysis compared the benefits and costs of a no-action alternative and four restoration alternatives. The five alternatives described land use scenarios including maintaining current agricultural and rural-residential uses and flood protection,

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[41] California Department of Water. 2005A. *Ecosystem Valuation Methods. Revised Draft*. Multi-Objective Approaches to Floodplain Management on a Watershed Basis. May.

[42] California Department of Water Resources. 2005B. *Natural Floodplain Functions and Societal Values Revised Draft*. Multi-Objective Approaches to Floodplain Management on a Watershed Basis. May.

[43] California Department of Water Resources. 2005C. *Middle Creek Flood Ecosystem Restoration Project Case Study: Benefit and Cost Analysis*. Multi-Objective Approaches to Floodplain Management on a Watershed Basis. May.

restoring portions of the floodplain, and providing increased flood protection for existing uses and enhanced agricultural production.

4. Floodplain Management Benefit and Cost Framework

The fourth report, *Floodplain Management Benefit and Cost Analysis Framework* (*Framework*), describes a framework for analyses of ecological, social and economic consequences of policy decisions that affect aquatic resources. [44] It emphasizes the importance of including information on ecological consequences in decision-making. The report cites sources that are somewhat dated, though more current than those referenced in the 1983 *P&G*. In spite of this drawback, the document describes analytical concepts relevant to the State's balancing decision on the Bay-Delta flows. These concepts include the following.

- Incorporate environmental and social consequences into management decisions.[45]
- Measure the economic effects of policies on ecosystem services that have value to humans using non-market valuation techniques. The report references the *Methods* report for information on valuation techniques.[46]
- Not all economic effects of management decisions will occur over the same geography and time. Take these differences into account.[47]
- Select the appropriate discount rate for economic effects that will occur in the future.[48]
- Account for analytical uncertainty and risk. The report describes four methods of doing so.[49]
- Consider ecological, social and economic effects of policy decisions on a broad watershed scale. Do not limit economic analyses to the geographic boundaries of an individual project.[50]

State water projects that have a federal nexus must conduct economic analyses using the 1983 *P&G*. The *Framework* notes some of the limitations of the *P&G* and describes analytical principles that will produce more comprehensive assessments of ecological, social and economic effects of management decisions.

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[44] California Department of Water Resources. 2005D. *Floodplain Management Benefits and Cost Analysis Framework. Revised Draft*. Multi-Objective Approaches to Floodplain Management on a Watershed Basis. June.

[45] California Department of Water, 2005D, p.2.

[46] California Department of Water, 2005D, p.11-12.

[47] California Department of Water, 2005D, p.12.

[48] California Department of Water, 2005D, p.14.

[49] California Department of Water, 2005D, p.15-17.

[50] California Department of Water, 2005D, p.22-24.

"Local agencies seeking federal cost-sharing assistance for multi-objective projects with the [Army] Corps [of Engineers] will still be subject to the [P&G] However, if the local agencies are able to perform an economic analysis following the framework presented [in this report], they will not only have generated the information necessary to do the Corp's analysis, but more importantly, they will also have developed the information necessary to make a more informed decision about proposed floodplain management projects."[51]

b. Economic Analysis Guidebook

Economic analyses conducted by the Department must conform to the Federal *P&G* because of the significant amount of interactions and partnerships between the Department and Federal agencies. The Department recognized, however, that the outdated *P&G* could not adequately address the complex nature of water-management challenges that the Department faces. Department staff, therefore, developed the *Economic Analysis Guidebook* (*Guidebook)* in 2008, to address deficiencies in the *P&G*, help Department economists conduct economic analyses using up-to-date methods, and describe economic concepts and analyses to non-economists Department staff. [52]

"It is … DWR [Department] policy to adopt, maintain, and periodically update its own *Economics Analysis Guidebook*, which is consistent with the *P&G* but can also incorporate innovative methods and tools when appropriate. This policy is necessary because (a) the *P&G* has not been updated for more than 20 years, (b) federal and State economic analyses sometimes have different regional analysis perspectives, and (c) water management projects and programs have become more complex."[53]

"Water resource projects are increasingly becoming more complex, requiring more difficult economic analyses. Projects now tend to have multiple purposes and affect many diverse stakeholders. … [T]raditional methods of performing economic analysis often do not provide reliable means for quantifying important categories of benefits that these projects may provide (such as, ecosystem restoration)."[54]

The *Guidebook* describes economics as "critical" to describing the environmental consequences, social effects, and costs and benefits of water-management alternatives. Environmental issues include the tradeoffs between "natural" and "human" demands on water resources and should take into account the economic effects of water uses that benefit the natural environment, even if this use adversely impacts agricultural and urban water users. Economics can also help describe effects on social equity or

[51] California Department of Water, 2005D, p.35-36.

[52] California Department of Water Resources (CDWR). 2008. *Economic Analysis Guidebook*. The State of California. January.

[53] CDWR (2008), p.vii.

[54] CDWR (2008), p.1.

environmental justice. Economic costs and benefits include monetary and non-monetary effects. [55]

Methods of economic analysis described in the *Guidebook* include cost-effectiveness, benefit-cost, and socioeconomic-impact analysis. As the name implies, cost-effectiveness analyses identify the least-cost option of achieving a given goal. A benefit-cost analysis compares changes in costs to society with changes in benefit and calculates the net change, or net benefits of a proposal or proposals. A socioeconomic-impact analysis describes how a policy change affects factors such as population, employment, income, etc.

[55] CDWR (2008), p.viii.

SECTION 5: THE PRINCIPLES OF BENEFIT-COST ANALYSIS

In Section 1 of this report, we summarize our understanding of the State's objective to find a balance between the public-trust use of the Bay-Delta flows and, namely, the other beneficial uses of the Bay-Delta flows. In Section 2, we identify benefit-cost analysis (BCA) as the most widely used tool for evaluating alternative approaches to such a balance. In this section, Section 5, we focus on the principles by which the State should calculate and report the benefits and costs of these alternative approaches.[56]

A. Identify the Alternatives

At its most basic level, BCA is simply a tool for comparing alternatives. Whether one is already using one of the alternatives—in which case that alternative serves as the gauge or standard—or not, applying the principles remains the same. One begins by identifying all the alternatives and describing all the elements of each alternative.[57]

Today, the State does not seem to suffer too few alternatives. Rather, its challenge lies in identifying and clarifying the elements of each alternative. That said, prudence dictates ensuring the list of alternatives avoids errors of omission, because the alternatives selected for the BCA could affect the outcome of the analysis. By the same token, elements omitted from the description of an alternative could affect its ranking among the alternatives State evaluates.

B. Identify the Relevant Scope

At the beginning of any BCA, the State should identify the relevant scope of the analysis. That is, the analyst should specify which benefits and costs matter, to whom, over what geography and over what period of time.

> "Before you conduct an economic analysis, it is necessary to define its scope (i.e., identify who and what should be included in the analysis and who and what should be excluded)."[58]

Once the State has identified the relevant scope, it then should maintain each of the scope's dimensions throughout the BCA.

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[56] For portions of this Section 5, we relied on material Ed Whitelaw and others at ECONorthwest prepared in a matter involving Methanex Corporation, Claimant/Investor, and the United States of America, Respondent/Party; *In the Arbitration Under Chapter 11 of the North American Free Trade Agreement and the UNCITRAL Arbitration Rules Between Methanex Corporation and United States of America*. The arbitration occurred in 2004.

[57] Field, B.C. 1997. *Environmental Economics*, 2nd Edition. San Francisco: McGraw-Hill Company, Inc. p.116-117; U.S. Environmental Protection Agency (EPA). 2010. *Guidelines for Preparing Economic Analyses*. Report No. EPA-240-R-10-001. December. p.A-8.

[58] U.S. Environmental Protection Agency (EPA). 1993. *Guide for Cost-Effectiveness and Cost-Benefit Analysis of State and Local Ground Water Protection Programs*. U.S. Environmental Protection Agency, Office of Water, and Office of Ground Water and Drinking Water. April. p.11.

C. Assemble Information and Account for Risk and Uncertainty

Given the relevant scope, the analyst should assemble information on the full range of costs and benefits. Even on topics for which extensive research exists, the published findings would still reflect different levels of understanding. Researchers have grouped these different levels into risk, uncertainty, and ignorance. Risk refers to conditions under which the range of possible outcomes and their probabilities are known. Uncertainty refers to conditions under which the range of possible outcomes is known, but their probabilities are not.[59] Ignorance applies when we do not know the possible outcomes.

The more that analysts differ on estimates or ranges of important categories of costs and benefits, the more the State should account for the uncertainty clearly and consistently.[60]

> "Estimates of costs, benefits and other economic impacts should be accompanied by indications of the most important sources of uncertainty embodied in the estimates, and, if possible, a quantitative assessment of their importance… Ideally, an economic analysis would present results in the form of probability distributions that reflect the cumulative impact of all underlying sources of uncertainty. When this is impossible, due to time or resource constraints, results should be qualified with descriptions of major sources of uncertainty."[61]

In interpreting the benefits and costs associated with those elements of the various alternatives that affect environmental assets and ecosystem services, the State should not assume Californians would perceive numerically equal upside and downside risks neutrally. That is, when it comes to environmental matters, individuals tend to exhibit risk aversion.

> "…it seems reasonable to advocate that environmental policymakers approach their decisions in a risk-averse manner."[62]

> "If people are risk averse, then we should expect them to give extra weight to measures that avoid environmental disasters … It seems sensible to many people to take measures today to avoid the possibility of catastrophe in the future, even if the worst-case scenario has a relatively low probability."[63]

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[59] Knight, F.H. 1921. *Risk, Uncertainty and Profit*. New York, NY: Sentry Press.; Integrated Risk Information System. 2011. *IRIS Glossary*. U.S. Environmental Protection Agency. May 16. Retrieved July 27, 2011, from http://www.epa.gov/risk_assessment/glossary.htm#u.; Camerer, C. and M. Weber. 1992. "Recent Developments in Modeling Preferences: Uncertainty and Ambiguity." *Journal of Risk and Uncertainty* 5: 325-370.

[60] U.S. Environmental Protection Agency (EPA). 2000. *Guidelines for Preparing Economic Analyses*. September. p.27.

[61] EPA, 2010, p.11-12.

[62] Lesser, J.A., D.E. Dodds, and R.O. Zerbe, Jr.. 1997. *Environmental Economics and Policy*. p.406.

[63] Goodstein, 1999. E.S. *Economics and the Environment*. p.150.

> "There are many cases in environmental pollution control where risk-aversion is undoubtedly the best policy …"[64]

For the State to consider such risk aversion makes economic sense. It should request that in the displays of the usual ranges and probability distributions of the elements of the alternatives, the analysts present not only the expected values or, in the jargon, the central tendencies, but also the downside and upside risks.

> "[An evaluation of benefits and costs should] reflect the full probability distribution of potential consequences. Where possible, present probability distributions of benefits and costs and include the upper and lower bound estimates as complements to central tendency and other estimates."[65]

Often, sufficient data simply are not available for fully quantifying certain categories of the costs and benefits of the alternatives. Accepted principles of benefit-cost analysis also prescribe that analysts take into account non-monetized costs and benefits.[66] In such cases, the analyst should identify the likely sign and size of the effect. For natural assets for which the professional literature offers no direct calculations of value, economics offers the benefit-transfer technique.[67] With benefit-transfer, the analyst, with appropriate adjustments, imputes to the subject asset values calculable for other assets.

If the information on which the calculation of costs and benefits depends is faulty, then, of course, the calculation itself is faulty. In the best cases, the academic and professional communities reach consensus on the direction and magnitude of a policy's impacts. In the worst cases, they do not, because the information available and the analyst's interpretations of it are faulty or still evolving. Under these conditions, high uncertainty persists. In such cases, the value of BCA is limited, and the analyst has an obligation to report this limitation prominently and the uncertainty causing it.

> "When important benefits and costs cannot be expressed in monetary units, BCA is less useful, and it can even be misleading, because the calculation of net benefits in such cases does not provide a full evaluation of all relevant benefits and costs. You should exercise professional judgment in identifying the importance of non-quantified factors and assess as best you can how they might change the ranking of the alternatives based on your estimated net benefits. If the non-quantified benefits and costs are likely to be important, you should recommend which of the non-quantified factors are of sufficient importance to justify consideration in the regulatory decision. This discussion should also include a clear explanation that support[s] designating these non-quantified factors as important. In this case, you should also consider conducting a threshold analysis to help decision makers and

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[64] Field, B.C. 1994. *Environmental Economics*. p.129.

[65] Office of Management and Budget (OMB). 2003. *Regulatory Analysis*. Circular No. A-4. October. p.18.

[66] See, Moore, J.L. 1995. *Cost-Benefit Analysis: Issues in Its Use in Regulation.* CRS Report for Congress 95-760 ENR. June 28. Retrieved July 22, 2011, from http://www.cnie.org/nle/crsreports/risk/rsk-4.cfm.; EPA, 2010, p.7-57.

[67] EPA, 2010. p.7-51.

other users of the analysis to understand the potential significance of these factors to the overall analysis."[68]

D. Best Practices for BCA

In preparing this Section 5 on the principles of BCA, we found we had accumulated various techniques or practices that, while perhaps not qualifying as general principles, have proved useful over the years. We view this list as illustrative, not exhaustive.

1. Compare conditions with the alternative to conditions without the alternative: A good BCA avoids comparing conditions before the alternative to conditions after the alternative.

   "Calculation of net present value should be based on incremental benefits and costs. Sunk costs and realized benefits should be ignored. Past experience is relevant only in helping to estimate what the value of future benefits and costs might be."[69]

   By comparing the conditions with each of the State's alternatives to the conditions without that alternative, the analyst can isolate the effects of the alternative alone and thereby increase the accuracy of the comparison among all the State Water Board's alternatives.

2. Report and Document Methods, Information, and Assumptions: A good BCA should rely on transparent assumptions and allow for straightforward replication by a third-party analyst.[70]

3. Apply Methods and Assumptions Consistently: the analyst should remain consistent throughout the analysis.[71] For example, the analyst should not account for the possibility of uncertainty in underlying assumptions in one aspect of the BCA and ignore it in another.

4. Economic Impacts and Economic Equity Are Complements to BCA: In Section 2, regarding Figure 1, we describe the three categories of economic effects each of the State's alternatives would cause, economic values (for which the primary tool of analysis is BCA), economic impacts and economic equity. The State should keep in mind that the second and third categories can serve as complements to BCA, but not as substitutes for it. Consider, for example, EPA's guidance.

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[68] Office of Management and Budget (OMB). 2003. *Informing Regulatory Decisions: 2003 Report to Congress on the Costs and Benfits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities*. Office of Information and Regulatory Affairs. February. p127

[69] Office of Management and Budget (OMB). 1992. *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*. Circular A-94. October. p.6.

[70] OMB, *Informing Regulatory Decisions*, 2003, p.134.

[71] Rossi, P. and H. Freeman. 1982. *Economics*, 13th Edition. New York: McGraw-Hill Book Company. p.275.

"Counting the number of jobs lost (or gained) as a result of a regulation generally has no meaning in the context of benefit-cost analysis."[72]

Each of the three categories of economic effects plays a distinct role in a comprehensive economic description and evaluation of the alternatives for improving the Bay-Delta flows. These roles should remain distinct.

5. Address externalities explicitly: In a market transaction, consider the buyer as the first party and the seller as the second party. A good BCA accounts the effects of the transaction on third parties, i.e., those who did not agree to experience the costs or benefits of the transaction.

"Identify the expected undesirable side-effects and ancillary benefits of the proposed regulatory action and the alternatives. These should be added to the direct benefits and costs as appropriate[73]."

[72] EPA, 2010, p.8-8. See also, OMB, 1994, p.6-7.

[73] OMB, *Regulatory Analysis*, 2003, p.3.

SECTION 6: OBSERVATIONS ON THE BURGEONING LITERATURE ON BAY-DELTA FLOWS

In preparing this report, we reviewed roughly 100 studies that address the economic issues associated with managing Bay-Delta flows. There are plenty more studies out there and the number is increasing. In this Section 6, we have chosen to draw the State's attention to some of the salient points raised in or illustrated by 12 of the studies.

We do not claim that the studies we have not yet reviewed are any worse or better than the ones we managed to acquire and review. Furthermore, we do not claim that the 12 studies on which we have based our observations represent the entire 100 studies. We do claim, however, that our observations help illustrate, though not exhaust, the challenges the State will face as it seeks a balance between the public-trust uses and the *other beneficial uses* and must choose among the proffered alternative approaches to managing the Bay-Delta flows.

A. BCA without Adequate Data Would Suffer Fatal Flaws

A widespread lack of basic data on California's water resources constrains the extent to which scientists, stakeholders and decision makers can develop fact-based water plans. Specific to the Board's benefit-cost analysis, describing the economic consequences of changing Bay-Delta flows would be much more challenging without baseline data on the Bay-Delta flows. The less adequate the data, the greater the uncertainty of benefit-cost analyses of the management alternatives.

The Delta Stewardship Council staff (Council Staff) propose achieving the Delta Plan's coequal goals of improving the quantity and quality of the water resources using the best available science.

> "Coequal goals means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem."[74]

> "The Council is required by law to use the best available science … as the basis for the Delta Plan. The Delta Plan must include 'a science-based, transparent, and formal adaptive management strategy for ongoing ecosystem restoration and water management decisions.' [citation omitted]"[75]

The Council Staff acknowledge, however, that the body of scientific information on the Bay Delta lacks adequate data on water resources. Council Staff, and others, also acknowledge that this lack hampers water-planning efforts for the Bay Delta Plan.

[74] Delta Stewardship Council Staff (Council Staff). 2011. *Fourth Staff Draft Delta Plan*. Delta Stewardship Council. June 13. p.3.

[75] Council Staff, 2011, p.19.

> "The Delta plan requires the development and submission of water use data and other data that are currently unavailable or inaccessible."[76]

The Public Policy Institute of California (PPIC) recently concluded the same.

> "Beyond an almost entirely non-technical California Water Plan Update developed by the Department of Water Resources every five years or so, there is little to no statewide organization, prioritization, and synthesis of technical and scientific activity applied to water problems."[77]

> "The state's fragmented water rights system has contributed to serious gaps in water measurement and accounting. Most groundwater users have not been required to report water use to the state. Although riparian and pre-1914 appropriative rights holders are required to report their diversions, there was no legal sanction for failure to file an annual statement of diversion and use until the legislature amended the Water Code in 2009 … Many did not report, and those who did tended to substantially overstate their diversions and use. These gaps have led to difficulties in tracking water use trends, and they impede more effective management of water resources for economic and environmental purposes [citation omitted]."

> "As water becomes increasingly scarce, it will become ever more important to measure and keep track of physical stocks and flows and their uses."[78]

> "California is almost unique among western states in not collecting information on such diversions. California also lacks water quality information on many of its aquifers and waterways."

> "To aid analysis and enforcement, greater and more systematic state efforts are essential to assemble data from local, state, and federal agencies within a coherent framework."[79]

> "[W]ithout better reporting, California's water accounting and water rights enforcement will remain approximate at best—an increasingly difficult handicap for policy discussions and water management in a water-scarce state."[80]

Other stakeholders in the Bay Delta agree. For example, the California Roundtable on Water and Food Supply recently reported,

> "A clear picture of the factors affecting water distribution and use in California is important to decision-making at the policy and farm levels, but is currently lacking.

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[76] Council Staff, 2011, p.19.

[77] Hanak, E., et al. (PPIC). 2011. *Managing California's Water from Conflict to Reconciliation*. Public Policy Insistute of California. p.128.

[78] PPIC, 2011, p.330.

[79] PPIC, 2011, p.353-54.

[80] PPIC, 2011, p.87.

> There is a need for better data collection and demonstration of water supply and distribution at basin scale, and better baseline data on water use to guide decision-making."[81]

Developing science-based water-management plans in the Bay Delta without the missing data on water resources would be challenging. The recent review of the scientific support for the Draft Bay Delta Conservation Plan (BDCP) by the National Research Council of the National Academies (Research Council) illustrates this point. The Research Council criticized the Draft BDCP for lacking basic information on affected water volumes. The Research Council described this as a "major shortcoming" of the Draft BDCP.

> "The lack of clarity concerning the volumes of water to be diverted is a major shortcoming of the BDCP. In addition, the BDCP provides little or no information about the reliability of supply for such a diversion or the different reliabilities associated with diversions of different volumes. There is no indication of how the amount of water to be diverted and its associated reliability are to be determined. It is nearly impossible to evaluate the BDCP without a clear specification of the volume(s) of water to be diverted, whose negative impacts the BDCP is intended to mitigate."[82]

The missing information impedes well-informed planning and management decisions, and scientists and policy makers would have difficulty developing a science-based Delta Plan without the missing data. This lack of fundamental data on water resources would also likely increase the uncertainty of analytical results from benefit-cost analyses of water-management alternatives.

B. Assessing the Analytical Veracity of Past Studies of Conveyance Structures

The literature on economic analyses of management alternatives for the Bay Delta includes a number of assessments of conveyance structures, such as a peripheral canal or tunnel. Among the most widely cited works in this literature are those by the PPIC. This literature, however, does not include a full benefit-cost analysis of conveyance structures or their alternatives. Most studies focus on certain costs and do not include many of the relevant benefits. In spite of these conditions, these studies illustrate the challenge the Board would face should they conduct a benefit-cost analysis of conveyance structures. We give two examples.

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[81] The California Roundtable on Water and Food Supply. 2011. *Agricultural Water Stewardship: Recommendations to Optimize Outcomes for Specialty Crop Growers and the Public in California*. June. p.3.

[82] National Research Council of the National Academies (Research Council). 2011. *A Review of the Use of Science and Adaptive Management in California's Draft Bay Delta Conservation Plan*. The National. In the PPIC report, *Comparing Futures*, the authors concluded that a peripheral canal would be the least-cost option for maintaining water exports out of the Delta, and that ending exports would have the highest probability of saving threatened or endangered fish in the Bay Delta.[82] Academies Press: Washington, D.C. May 5, page 4.

In the PPIC report, *Comparing Futures*, the authors concluded that a peripheral canal would be the least-cost option for maintaining water exports from the Bay Delta, and that ending exports would have the highest probability of saving threatened and endangered fish.[83] They estimated that the peripheral canal had an average annual cost of between $0.25billion and $0.85billion. The three other alternatives—1) continuing through-Delta exports; 2) dual conveyance of peripheral canal and through-Delta exports; or, 3) no exports—all had higher economic costs. The no-export option had the highest likelihood of achieving viable populations of delta smelt and fall-run Chinook.[84]

Dr. Jeffrey Michael of the University of the Pacific, critiqued some of the major assumptions, data and conclusions described in *Comparing Futures*.[85]

- Regarding the use of discount rates, PPIC did not "… utilize the conventional, scientifically accepted present discounted value approach …"[86]
- PPIC ignored the market and non-market values of affected fishery species. (In a later report, the PPIC described the importance of including non-market values—or as they describe, the values of ecosystem benefits—in benefit-cost analyses.[87])
- PPIC relied on out-dated and second-best estimates of population growth, which overestimated population growth and water demand over the time of the analysis (through 2050).
- PPIC also overestimated the costs of water recycling and ignored recent trends in water conservation.
- PPIC did not conduct their analysis in the context of water scarcity. They assumed no advances in water-conservation or desalination technology over the next 40 years. That is, the PPIC assumed a static analysis of an economy with fixed technology rather than a dynamic analysis of an economy that responds to price signals.
- The PPIC results are highly sensitive to analytical assumptions, and thus are not robust.

In another critique, the Research Council had harsh criticism for the quality of the biophysical information in the Draft BDCP in support of a peripheral canal. The Research Council concluded that the analysis underlying the Draft BDCP relied on incomplete or unsupported data, unrealistic assumptions, ignored relevant trends, and, like the PPIC's analysis, the underlying analysis ignored the concept of water scarcity.

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[83] Lund, Jay, aet al. 2008 (PPIC 2008). *Comparing Futures for the Sacramento-San Joaquin Delta*. Public Policy Institute of California. Chapter 6 and p.ix.

[84] PPIC, 2008, Table S.1, p.ix.

[85] Michael, Jeffrey. 2011. *First Administrative Draft Economic Sustainability Plan for the Sacramento-San Joaquin Delta*. Submitted to the Delta Protection Commission. June 16; Michael, Jeffrey. 2008. *The Economics of Ending Delta Water Exports Versus the Peripheral Canal: Checking the Data of the PPIC*. University of the Pacific. December 15.

[86] Michael, 2011, p.65.

[87] Hanak, Ellen, et al. (PPIC). 2011. *Managing California's Water From Conflict to Reconciliation*. Public Policy Institute of California. Pages 99 and 207.

> "The BDCP cannot be properly evaluated if is does not clearly specify the volume of water deliveries whose negative impacts are to be mitigated. The draft BDCP suggests that the water requirements are based on the amount of acreage and crops that contractors have grown, or on the maximum deliveries specified by the SWP [State Water Project] contracts … There is no mention that quantities diverted may be constrained by various provisions of California water law, by possible changes in the extent of irrigated agriculture south of the Delta, and by potential changes in cropping patterns fueled by globalizing forces of supply and demand for food. The draft BDCP also fails to identify and integrate demand management actions with other proposed mitigation actions. A conservation plan should address issues of water use efficiency and should account for future trends in other variables that drive the demand for agricultural and urban water supplied. … The BDCP's lack of attention to these issues constitutes a significant omission, given the intensifying scarcity of water in California."[88]

> "The lack of an appropriate structure creates the impression that the entire effort is little more than a post-hoc rationalization of a previously selected group of facilities, including an isolated conveyance facility [peripheral canal] …"[89]

A peripheral canal or tunnel has proponents and detractors. Some of the critiques to date, however, raise serious concerns regarding the veracity of analyses that support a canal or tunnel as the preferred management alternative. Any new analyses of a conveyance structure's benefit and costs would likely be considered incomplete if they do not address the analytical deficiencies raised by these analyses.

C. Addressing Environmental Justice Consequences of Water-Management Alternatives

Past planning efforts in the Bay Delta have not effectively dealt with environmental justice (EJ) aspects of water use and distribution in California's Central Valley. The Delta Plan is an opportunity to change this. Informational resources exist that can help analysts address EJ issues in benefit-cost analyses in meaningful ways so that they go beyond the typically superficial treatment of EJ issues in past analyses.

The Bay Delta Conservation Plan describes EJ as,

> "The fair treatment and meaningful involvement of all people regardless of race, color, national origin, educational level, or income with respect to the development, implementation, and enforcement of environmental laws. EJ seeks to ensure that minority and low-income communities have access to public information relating to human health and environmental planning, regulations, and enforcement. EJ ensures that no population, especially the elderly and children, are forced to shoulder a disproportionate burden of the negative human health and environmental impacts of pollution or other environmental hazard."[90]

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[88] Research Council, 2011, p.31-32.

[89] Research Council, 2011, p.43.

[90] California Natural Resources Agency. 2010. *Highlights of the Bay Delta Conservation Plan*. December. p.84.

As described by the California Natural Resources Agency, EJ communities in the Central Valley share a number of characteristics and conditions including:[91]

- Mostly minority and low-income households
- Excluded from environmental policy setting
- Subject to disproportionate impacts from environmental hazards
- Residents experience disparate implementation of environmental regulations, requirements, practices and attributes.

A study published in July of 2008, by OxFam America and the Rockefeller Foundation, reported that the 20th U.S. Congressional District, which encompasses Westlands and the southwestern side of the San Joaquin Valley, was the poorest congressional district in U.S.[92] EJ communities in the San Joaquin Valley face challenges including unsafe drinking water, poor air quality and high incidence of childhood asthma.[93] The *Fourth Staff Draft Delta Plan* reported that nitrates and other pollutants contaminate drinking water supplies from groundwater for many low-income communities in the San Joaquin Valley.

> "The high cost of accessing water from alternative sources, coupled with the low earnings of these households, often makes safe drinking water in these communities unaffordable [citation omitted]."[94]

A recent report by the Pacific Institute concluded the same.

> "Despite the acute health effects of nitrate contamination, some communities in the state have been waiting for more than a decade for measures to restore the safety of their drinking water. … These communities … tend to be low-income and have a high percentage of Latino households. Although costs to community water systems and the households they serve are significant and directly tied to nitrate contamination of groundwater, public policy and regulatory programs have to-date failed to incorporate those costs in their policy and regulatory programs."[95]

As described in the Pacific Institute report, the high costs of addressing nitrate contamination and limited available funds means a significant backlog of unfunded

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[91] California Natural Resources Agency. 2003. *Environmental Justice Policy*. www.resources.ca.gov/environmental_justice_policy_20031030.pdf.

[92] Burd-Sharps, S., K. Lewis, and E. Borgess Martins. 2008. *The Measure of America: American Human Development Report 2008-2009*. OxFam America and the Rockefeller Foundation.

[93] Pacific Institute. 2011. *The Human Costs of Nitrate-Contaminated Drinking Water in the San Joaquin Valley*; Carger, Lloyd. 2010. *Reaping Riches in a Wretched Region: Subsidized Industrial Farming and Its Link to Perpetual Poverty*, 3 Golden Gate U. Envtl L.J., http://digitalcommons.law.ggu.edu/cgi/viewcontent.cgi?article=1033$context=ggueli.

[94] Delta Stewardship Council Staff. 2011. *Fourth Staff Drat Delta Plan*. June 13. p.111.

[95] Moore, E. and E. Matalon. 2011. *The Human Costs of Nitrate-contaminated Drinking Water in the San Joaquin Valley*. Pacific Institute. March. p.7.

projects. The California Department of Public Health currently has a waiting list of 100 community water projects, with a total cost of $150 million.[96]

A number of benefit-cost experts describe methods of combining EJ objectives including equity considerations with the economic-efficiency objectives of a benefit-cost analysis.[97] Such an approach in the Bay Delta could help avoid negative EJ impacts of water-management decisions and promote more equitable distribution of environmental benefits to communities that currently suffer from inequitable distribution of contaminated water resources.

D. Describing the Relevant Economies as Dynamic, Not Static

Economies are dynamic. They grow, develop, change and react over time in response to local, regional, national and international forces and trends. Consumers, workers and business owners make decisions based on how these forces and trends affect them. For example, as gas prices increase, consumers change their driving habits, purchases more fuel-efficient cars, or take mass transit. As the price of apples increases, some consumers will switch to other, less expensive fruits.

The dynamic nature of economies is important to the State Water Board's benefit-cost analysis of their balancing decision for two reasons. The first is because the affected economies will change for reasons unrelated to the new management alternatives. Attributing economic consequences from outside forces to the Bay Delta management alternatives would yield inaccurate results and mask the true consequences of the alternatives.

Recent reports on the Bay Delta describe some of the relevant outside forces likely to affect the region's economy. The PPIC report, *Managing California's Water*, lists what the authors describe as "drivers of change," which will affect future water supply and demand. These drivers include environmental, economic and demographic changes.[98]

- Rising sea levels will cause seawater intrusions into coastal aquifers.
- Climate-change induced warming will reduce snowpacks, increase winter runoff, decrease spring and summer runoff, and increase stream temperatures.[99]
- New urban developments will likely use less water per capita than existing homes.
- Urbanization will increase discharges of urban runoff.[100]

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[96] Moore and Matalon 2011, p.8.

[97] See for example, Banzhaf, H. S. 2010. *Regulatory Impact Analyses of Environmental Justice Effects*. National Center for Environmental Economics. Working Paper # 10-08. U.S. Environmental Protection Agency. August; Haveman, Robert. 1965. *Water Resources Investment and the Public Interest*. Nashville: Vanderbilt University Press; and Johansson-Stenman, Olof. 2005. "Distributional Weights in Cost-Benefit Analysis—Should we Forget About Them?," *Land Economics*, Vol. 81.

[98] PPIC, 2011, p.135-136.

[99] PPIC, 2011, p.135-136.

- Urbanization of agricultural lands will reduce agricultural water use.[101]
- Population growth has been, and is expected to continue as, the most important demographic driver of water demand.[102]
- Continued reduction in agriculture's share of the state's economy.[103]
- California's agricultural producers will continue shifting to more permanent and higher-valued tree and vine crops in response to global market forces.[104]

Anticipated changes in local and state regulations will also affect future water supply and demand. For example, a recent report by the California Department of Water Resources describes an upcoming change that will affect urban water use. Beginning in 2016, water suppliers must comply with water conservation requirements established by the Water Conservation Bill of 2009 to be eligible for State water grants or loans.[105]

One of the challenges of conducting a benefit-cost analysis of Bay Delta management alternatives will be controlling for the economic consequences attributed to the types of biophysical, economic and other forces and trends described above that are unrelated to the management alternatives.

The second reason why the dynamic nature of economies is important to a benefit-cost analysis of Bay-Delta alternatives is that the affected economies will likely respond to the management alternatives. That is, the analysts should not assume a static economy, frozen in time and technology. The management alternatives will affect different sectors of the state's economy differently. Some sectors may experience higher costs, others may have increased employment or revenues. Consumers, workers and business owners will respond to these first-round changes. For example, in response to an alternative that reduces irrigation flows, some growers may idle their land. Others, however, will likely continue producing by switching to less water-intensive crops, increasing irrigation efficiency, engaging in water trades, or all three.

Authors of a recent retrospective analysis of the economic impacts of reduced flows to the San Joaquin Valley describe such reactive behavior.[106] The analysis focused on the changes in agricultural production in response to reduced water supplies from the Bay Delta caused by drought and restrictions on pumping due to environmental concerns.

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[100] PPIC, 2011, p.164.

[101] PPIC, 2011, p.137.

[102] PPIC, 2011, p.164.

[103] PPIC, 2011, p.137.

[104] PPIC, 2011, p.166.

[105] Pezzetti, Tonianne. 2011. *Guidebook to Assist Urban Water Supplirs to Prepare A 2010 Urban Water Management Plan*. State of California, Natural Resources Agency, Department of Water Resources. March. p.xiii.

[106] Michael, J., et al. 2010. *A Retrospective Estimate of the Economic Impacts of Reduced Water Supplis to the San Joaquin Valley in 2009*. September 28. p.1-3.

The authors report that growers reacted to the water reductions by engaging in water trades and changing their growing practices.

> "[A] significant increase in the amount of water transfers was critically important to reducing the negative impacts of water scarcity. … Building on these successful transfers will be important in minimizing the losses from future water shortages."[107]

> "Across the entire San Joaquin Valley, virtually the entire decline in net harvested acreage was in lower-value field and seed crops as farmers rationally directed more of their scarce water resources to protecting high value fruit and nut orchards."[108]

Water scarcity in California is not a new phenomenon. Water users react to this scarcity by adjusting their use and adopting new technologies and practices. This trend is expected to continue. A benefit-cost analysis that assumes a static economy, frozen in time and fixed in technology would not reflect the reality of how local and regional economies in the Bay Delta function.

E. Describing the Complex Competition for Bay Delta Water Resources

Much of the debate over Bay-Delta water resources pits in-stream or habitat use against agricultural or municipal use. Some describe this as the "jobs vs. fish" argument. Implicit in this characterization is the assumption that consumptive use of water—water use that supports "jobs"—is more important or has greater economic value than in-stream use—water for "fish." As the PPIC describe in their recent report, *Myths of California Water – Implications and Reality*, the competition for Bay-Delta water resources is much more complex.[109]

> "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 improvement in the quality of life in California."[110]

In most times and places there are insufficient resources to satisfy all the demands for all of the goods and services provided by Bay-Delta water resources. Hence, there is competition for the water and, when it is used to produce one set of goods and services, the demands for others go unmet. The characteristics of this competition provide useful insights into the economic consequences of current and future decision-making for Bay-Delta water resources.

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[107] Michael et al., 2010, p.1-2.

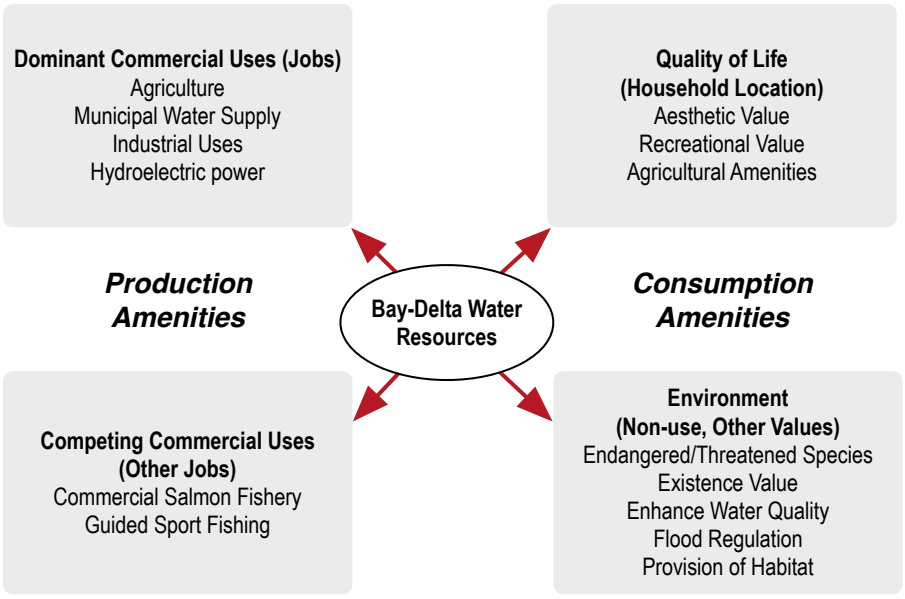
[108] Michael et al., 2010, p.3.

[109] Hanak, Ellen et al. 2010 (PPIC 2010). "Myths of California Water—Implications and Reality." *West-Northwest*, Vol. 16, No. 1, Winter. p.20-22.

[110] PPIC, 2010, p.21.

One could categorize the competition any number of ways, but we employ a taxonomy that distinguishes among four types of demand, as illustrated in Figure 2. Two of these are called demands for production amenities, i.e., those goods and services that are, or could be, inputs to processes that produce other goods and services. The other two represent demands for consumption amenities, i.e., those goods and services that directly enhance the well being of consumers.

Figure 2. The Competing Demands for Bay-Delta Water Resources



Source: ECONorthwest

Competition for Production Amenities. Demand for Bay-Delta agricultural, municipal, industrial, and hydroelectric production, represented on the left side of Figure 2, comes from private and public enterprises, as well as households, that rely on water resources to conduct commercial activities. We separate the demands for production amenities into two groups—dominant and competing demands—to show that, sometimes, negative effects on other commercial sectors, which are represented in the bottom left of Figure 2, can offset the positive consequences arising from others. Using water for commercial production of crops may, for example, prevent it from being used to support guided sport fishing.

Competition Directly from Consumers. On the left side of Figure 2, water resources are economically important because they are inputs in the production of other things, notably crops and livestock, that consumers want to have. On the right side, the connection to consumers is more direct. Here, consumers consider Bay-Delta water resources economically important for how they directly contribute to their well-being. In economic parlance, these are known as consumption amenities.

Some ecosystem goods and services, such as recreational opportunities and scenic vistas, contribute directly to the well-being of people who have access to them. Their

contribution to consumers' well-being makes them economically important in their own right, but they have additional economic importance when they also influence the location decisions of households and firms. We show the demands for consumption amenities that influence location decisions of households sensitive to spatial variation in the quality of life, in the upper right portion of Figure 2. In general, the nearer people live to amenities, the lower their cost of using them. Thus, consumers can increase their economic well-being by living in a place that offers recreational opportunities, pleasant scenery, wildlife viewing, and other amenities they consider important.

Quality-of-life values can be powerful. All else equal, if the Bay-Delta's consumption amenities improve, some people already here would tend to stay and additional people would tend to move in. Degradation would have the reverse impacts. One consequence is that the amenities lead to higher demand for housing and consumer-oriented commercial products. The higher demand raises land value for these uses higher than otherwise would exist.[111] Differences in quality of life also explain about half the interstate variation in job growth during periods of economic growth.[112] This relationship also has been found at sub-national perspectives.[113] Some in the Bay-Delta undoubtedly could enjoy higher earnings living elsewhere, but choose not to do so because their overall economic welfare—the sum of their earnings plus quality of life—is higher here. Some aspects of this quality of life—the strength of communities, schools, and churches, for example—are not directly related to water resources, but others are: scenic views, ways of life, and opportunities for fishing and boating, to mention a few.

The lower right portion of Figure 2 represents demands associated with economic values that do not necessarily entail a conscious, explicit use of ecosystem goods and services. We call these environmental values. There are two general categories: non-use values and values of goods and services that generally go unrecognized. Non-use values arise whenever people place a value on maintaining some aspect of the environment, even though they do not use it and have no intention to do so. Research has documented non-use values for maintaining salmon populations, for example, whose survival in the Bay-Delta depends on adequate water flows. Studies have shown that regardless of direct interaction with salmon populations, many Californians hold a positive willingness to pay to ensure the long-term survival of salmon.[114]

Environmental values also can be important when water resources provide valuable services that people generally consume without being aware of them. Some of these are part of the so-called web of life. Others, such as the ability of wetlands to purify water

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[111] Roback, J. 1982. "Wages, Rents, and the Quality of Life." *Journal of Political Economy* 90: 1257-1278; 1988. "Wages, Rents, and Amenities: Differences among Workers and Regions." *Economic Inquiry* 26: 23-41.

[112] Partridge, M. and D. Rickman. 2003. "The Waxing and Waning of Regional Economies: The Chicken-Egg Question of Jobs Versus People." *Journal of Urban Economics* 53: 76-97.

[113] For a more thorough discussion of relevant research, *see,* for example, Power, T.M. and R.N. Barrett. 2001. *Post-Cowboy Economics: Pay and Prosperity in the New American West*. Island Press, and Kim, K.-K., D.W. Marcouiller, and S.C. Deller. 2005. "Natural Amenities and Rural Development: Understanding Spatial and Distributional Attributes." *Growth and Change* 36 (2): 273-297.

[114] Loomis, J., T. Brown, and J. Bergstrom. 2007. "Defining, Valuing, and Providing Ecosystem Goods and Services," *Natural Resources Journal* 47: 329-376.

and mitigate flood damage, have a more direct link to the well-being of California's residents. For example, San Francisco, which receives its water from the pristine Hetch Hetchy watershed, saves tens of millions of dollars per year in avoided water treatment costs.[115] Some scientists and economists believe many services have great economic value, even though people generally are unaware of their importance.[116] Environmental values typically increase as people learn more about the environment, the services it provides, and environmental degradation.[117] Many people today, for example, consciously consider the economic values associated with the services produced by the global climate in ways that were unknown, even to scientists, just a few years ago.

The demands associated with the consumer amenities represented on the right side of Figure 2 are typically harder to measure, or even to observe, than the commercial demands shown on the left side of the diagram. This difficulty does not diminish their value or impact on jobs and incomes, however. Instead, it merely reflects the lack of tools for measuring them.

As described in the PPIC Report, one of the goals and challenges of the Board's benefit-cost analysis of its balancing decision will be identifying and describing the full range of benefits and costs of the competing demands for Bay-Delta water resources.

> "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."[118]

[115] Null, S. and J. R. Lund. 2006. "Re-assembling Hetch Hetchy: Water Supply Implications of Removing O'Shaughnessy Dam," *Journal of the American Water Resources Association* 42 (4): 395-408.

[116] Daily, G.C. (ed). 1997. *Nature's Services: Societal Dependence on Natural Ecosystems*. Washington, D.C.: Island Press.

[117] Blomquist, G.C. and D.R. Johnson. 1998. "Resource Quality Information and Validity of Willingness to Pay in Contingent Valuation." *Resource and Energy Economics* 20:179-196.

[118] PPIC, 2010, p.21.

Letters to the Editor

State Water Project is the wrong solution for the Ojai Valley

By Carolee Krieger

As a resident of Santa Barbara County, I know from painful experience that state water is outrageously expensive and unreliable. Don't make the same mistake we did. Please reject the State Water Project.

In three essays, I'll share what every regional water district should consider when developing solutions aimed at ensuring a secure water future for their community and explain why the State Water Project is not a viable path toward that goal. I'll also present realistic alternative solutions to state water and how we can achieve sustainable and equitable water policy for all of California. The Casitas Municipal Water District is currently working with the Ventura County Flood Control District and other entities to construct a pipeline to hook up with the State Water Project through the Los Angeles Metropolitan Water District. This will be expensive and will not guarantee Ojai any new water as explained below.

PART 1: Paper water

Not reliable

In 1991, when Santa Barbara voted to contract with the State Water Project (SWP), we were told it would be 97 percent reliable. However, when we needed state water in times of drought, we usually received only a very small percentage of our contract allocation. For example, in 2014 all contractors received only 5 percent of what the SWP was obligated to supply. Since Santa Barbara began receiving state water in 1998, our four South Coast water districts have received an average of only 28 percent of our allocation.

Outrageously expensive

We were told our total cost of participating in the SWP would be $270 million. Santa Barbara ratepayers will have instead had to pay $1.7 billion. When you sign up for the SWP, you pay these bond costs whether or not you receive any water. Once you're under contract with the SWP, all costs associated with delivery are passed on to the ratepayers. Worse still, ratepayers have no voice: All decisions on expenditures are controlled by the California Department of Water Resources. If Ojai approves a contract with the SWP, you'll be obligated to pay for the proposed multibillion dollar Twin Tunnels, if approved. These tunnels promise no new water.

Paper water

When the state was asked how much water was available in the 20 rivers of the California Delta watershed that supply the SWP system, it said it didn't know. In 2009, the California Water Impact Network (C-WIN), a citizens group I founded in 2001, hired a technical hydrology consultant to find out.

It took three years — through Public Records Act and Freedom of Information Act requests — to quantify the amount of water available from the Delta watershed for export to SWP contractors. We found that the state has an average of 29 million acre-feet of consumptive water available, and that there are 153.7 million acre-feet of claims for that water, meaning there is 5.5 times more water allocated under contract than there is actual water in the Delta watershed. In 2012, the University of California at Davis completed a study corroborating our work and conclusions. The difference between what the state has allocated and reality is what the California Appeals Court has labeled "paper water": water that doesn't exist.

Two-thirds of California's consumptive fresh water comes from the California Delta watershed, serving half our state's population. The Delta Reform Act of 2009 mandated that California Delta water be managed to balance the "coequal goals" of restoring and protecting the Delta and ensuring a reliable water supply. The SWP has not quantified the water because it knows it can't justify new infrastructure projects — let alone meet its existing contract obligations and satisfy the Delta Reform Act mandates of providing reliable water and restoring the Delta. Until the problem of paper water is corrected, California ratepayers will continue to pay for water they will never get, and the health of California's largest source of fresh water will continue to decline.

Mismanaged water: Agriculture vs. urban

Drought or not, there's enough water to meet the needs of all Californians and the environment if it's managed equitably. Mismanagement of public water is undermining the economic stability and well-being of California's communities and environment. Paper water enables developers to build without real water and large agricultural users to sell so-called "excess water" back to the ratepayers who have already paid for it.

More than 80 percent of developed water in the state is used by agriculture. The subsidized low cost of most agricultural water gives growers little or no incentive to use water efficiently. The rule is "use it or lose it," for if water is not used, the right to it is threatened.

Unfortunately, it's legal to sell unused allocations and profit from the sale. These transactions are known as "water transfers." There was a time when water transfers mostly occurred between farms in the same district for no profit. More and more, "excess" agricultural water is being sold back to the urban water districts that never got the allocations they paid for … with the profits going to the seller.

A few large-scale farms in the San Joaquin Valley are behind the efforts to exert more control of the water being diverted from the California Delta and get California ratepayers to pay for it. The Department of Water Resources is seeking SWP "contract amendments" and new contracts like what Ojai is currently considering. If passed, the new amendments will lock in funding sources that have no public oversight or input.

We need water now

Because diverting more water from the Delta is essentially illegal, the ill-conceived Twin Tunnels project will be mired in lawsuits for years to come. Regional solutions are far closer to reality and much less expensive than the SWP. Regional water districts are already collaborating and combining resources to regain control and benefit their communities. Smaller and more nimble, these communities will see solutions come on line long before the SWP — with reliable solutions that provide real water. The city of Santa Monica is well on its way to being independent of SWP water by 2023.

In Part 2, I'll outline some of these solutions and talk about what's working in Santa Barbara. Since water is a public trust resource, we will examine the role of the Public Trust Doctrine in solving the paper water problem. The Doctrine successfully saved Mono Lake and guided sound water policy in Idaho and Colorado.

In Part 3, I'll share the road map to enacting into law the sustainable and equitable water polices California needs for a secure water future.

— Longtime Santa Barbara resident Carolee Krieger leads C-WIN's efforts to design and implement collaborative and lasting solutions for California's fresh water resources. Santa Barbara 1st District Supervisor Naomi Schwartz named Krieger Woman of the Year in 1997. She has been featured in Mother Jones, Bloomberg and an Emmy-nominated PBS broadcast about the impact of almonds on water supply.

Further Reading

C-WIN's Delta Quantification study: www.c-win.org/s/CWIN-BayDeltaQUANTIFICATION-Final.pdf

C-WIN's Central Valley Paper Water Summary: www.c-win.org/s/C-WIN-CentralValleyQuantification-Summary.pdf

UC Davis Quantification study: www.c-win.org/s/UC-Davis-2014-Grantham-Water-Rights-in-CA.pdf

C-WIN's Santa Barbara Report: www.c-win.org/the-santa-barbara-report

Resources

C-WIN web site: www.c-win.org
Water Education Foundation: www.watereducation.org
Maven's Notebook: www.mavensnotebook.com

Voice Your Concerns:

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Administrative Assistant Steve Offerman: steve.offerman@ventura.org

Casitas Municipal Water District
Phone: 805-649-2251, www.casitaswater.org

City of Ventura
State Water Interconnection Project Engineer
Betsy Cooper: bcooper@cityofventura.ca.gov

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OPINION / Letters to the Editor

If it matters to you,it matters to us
letters@OjaiValleyNews.com

Ojai can learn from Santa Barbara's mistakes with state water

By Carolee Krieger

PART 2: Regional solutions, statewide reform

As a long-term resident of California concerned with the availability of water for all Californians, I'm sharing what Ojai residents need to know about the State Water Project before considering a contract with the SWP. This is Part 2 of a three-part series. In Part 1, I described how California's fresh water is mismanaged via something known as "paper water" and how the SWP uses it to extract exorbitant fees from regional SWP contractors (ratepayers like you and me) without supplying the water allocated to them in their contracts:

— Led to believe that we would receive 97 percent of our allocation at a total cost of $270 million, Santa Barbara County voted to become an SWP contractor in 1991. Since then, we've received an average of only 28 percent of our allocation for a cost to ratepayers of $1.7 billion. The Ojai Valley would find itself in the same situation should it become a SWP contractor. Ojai will lose local control over costs as the Department of Water Resources expands its infrastructure projects, the cost of which local contractors are obligated to pay.

— The Department of Water Resources and the SWP have allocated 5.5 times the amount of water known to exist in the California Delta watershed. This is what the California Court of Appeals has termed "paper water" — water that doesn't exist. The SWP does not have the endless supply of water it would let you believe.

— The source water for the SWP comes from the California Delta watershed. The 2009 Delta Reform Act requires Southern California SWP contractors to reduce their dependency on state water. This is in conflict with bringing new contractors into the SWP and ensures lengthy court battles for any new infrastructure projects relying on water from the Delta. The current Twin Tunnels project has been stuck in the courts for 10 years and counting.

On paper, the State Water Project may look like a good component of a diversified water security plan for the Ojai Valley, except that it's literally paper — not water. Very expensive paper.

Regional solutions

The current drought adds the burden of urgency to a difficult problem requiring strategic and creative solutions. Since state water is an overpriced myth, what can the Ojai Valley do to meet its needs?

My county of Santa Barbara has been grappling with this issue for many years, an issue that remains a worsening problem throughout the state. Many of the lessons learned in Santa Barbara County and elsewhere apply to Ventura County and the Ojai Valley.

For instance, there are still significant supplies of water to be mined from conservation. Regional agency cooperation in the form of Joint Powers of Authority is already on the table in the Ojai Valley: Partnering with the appropriate agencies would pool resources and broaden the scope of potential solutions. Smaller, regionally controlled reclamation and storm water capture infrastructure projects would be more efficient and timely, are often candidates for federal grants, and ratepayers would have a voice.

Areas throughout California are beginning innovative strategies to secure local sources of water. The city of Santa Monica has reduced its consumptive use of water and is scheduled to be free of SWP imports by 2023. The California Water Impact Network (C-WIN), a citizens group I founded in 2001, recently produced a white paper outlining potential solutions for the Montecito Water District. These and others are solutions Ojai and Ventura should consider:

Short term: One year

1. Continue conservation.
- Install drought-tolerant landscaping.
- Leak monitoring.
- Use of compost and mulch to retain water.
- Replace spray irrigation with drip systems.
- Irrigate only between 5 p.m. and 9 a.m.
- Public awareness initiatives.

2. MWD Desalination Partnership with the city of Santa Barbara

Medium and long term: 2 to 10 years

1. Incorporate recycled wastewater into a balanced water portfolio.
- Install state-of-the-art technology to treat wastewater to a potable standard.
- Treat wastewater to a high enough standard for safe use by large landscaping users.
- Treat wastewater to a high enough standard to safely recharge our aquifer and prevent seawater intrusion.

2. Desalination
- Innovation needed for an acceptable intake system.
- Innovation needed to lower energy costs.
- Innovation needed to minimize environmental footprint.
- Innovation needed to secure California Coastal Commission permits.

3. Local management and monitoring of groundwater basins and private wells.

4. Water and sanitary district consolidation.

5. Repair/replace aging systems and leaks.

6. State and federal grants.
- Drought preparedness.
- Water recycling.
- Groundwater sustainability.
- Reliable drinking water for small communities.
- Statewide operational improvements.
- Flood management.

Solutions such as those outlined above are realistic, effective, much more reliable, locally controlled and a far better use of limited resources.

Statewide reform

Paper water is a component of all of California's water conveyance systems, not just the SWP, and it's how Californians have been distracted from the real causes of our water problems. As districts struggle with empty promises and scramble to find alternatives to empty pipes, they're discovering truth.

Rejecting state water sends a strong message to Sacramento, but there's more to be done. As long as paper water exists, the potential for mismanagement will have devastating consequences for all Californians. We're in this together.

The good news is that the law is on the side of the people and the environment, and there is precedence and a clear path to equitable and sustainable distribution of water in California.

The state holds all our natural resources in trust, and is required by law to protect that trust. The Public Trust Doctrine — part of California's Constitution — states that, "No water… can be taken from a stream, lake or other natural resource without a careful assessment of the harm that might be done." As I mentioned in Part 1, the state has not done this assessment. Contracts and policies continue to be written without knowing the real consequences.

The Public Trust Doctrine saved Mono Lake, and it applies now to the state's largest single source of fresh water, the California Delta watershed.

In Part 3, I'll talk more about the Public Trust Doctrine and the steps needed to create an equitable and sustainable water policy for California.

— Santa Barbara resident Carolee Krieger leads C-WIN's efforts to design and implement collaborative and lasting solutions for California's fresh water resources.

Resources

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OPINION / Letters to the Editor

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Connecting to state water does not guarantee Ojai any new water

By Carolee Krieger

PART 3: The Public Trust

Currently, mismanagement of public water is far more dangerous than the drought to the economic stability and well-being of California's communities and environment. As the Ojai Valley community considers potential sources of reliable and secure fresh water, I'd like to share the relevant and telling experiences of my county of Santa Barbara — with the hope that Ojai residents may learn from our mistakes and see what's working for your coastal neighbors. This is the third of three essays outlining some of the serious problems with the State Water Project, why Ojai should reject it, what realistic solutions should be considered instead, and the path to the secure, equitable and sustainable water future all Californians are entitled to.

In Part 1, I explained how Santa Barbara County ratepayers are paying $1.7 billion for state water instead of the $270 million the SWP said it would cost, while receiving only 28 percent of our allocation, and how the state has over-allocated fresh water by a factor of 5.5 (the practice of "paper water"), and where the water is actually going and why.

Part 2 outlined a carefully considered list of viable alternatives to state water, many of which are already being successfully implemented in Santa Barbara County and elsewhere.

Here in Part 3, I'll talk about how the state of California can end the destructive practice of "paper water" (allocating water that doesn't exist), and manage our natural resources more equitably — to the benefit of all Californians.

Water belongs to the people

The California Constitution states that California's water belongs to the people. Included in both the U.S. and California constitutions, a clause known as the Public Trust Doctrine provides that the state holds natural resources like water "in trust" to safeguard them for the long-term benefit of the general public. The Public Trust Doctrine requires policymakers to assess all impacts of any project using our natural resources: "No water … can be taken from a stream, lake or other natural resource without a careful assessment of the harm that might be done."

The Public Trust Doctrine was applied in the historic case that saved Mono Lake. The 1983 ruling "National Audubon Society v. Superior Court" established protection of the lake in the public trust, requiring the Los Angeles Department of Water and Power to reduce diversion flows to ecologically sustainable levels: The state should "attempt, so far as feasible, to avoid or minimize any harm to those (public trust) interests."

More than half of all Californians (including many of us in the southern parts of the state) rely on California's single-largest source for fresh water: the California Delta watershed. All of the water in the State Water Project system comes from the Delta. Without quantification of the water in the Delta and an analysis of the impacts of proposed diversion scenarios, allocation targets cannot be set and no project that diverts that water can move forward legally.

Water is a valuable resource

In California, Public Trust responsibilities for water resources include protecting natural instream flows — and the ecological, habitat and recreational benefits these flows provide — as well as municipal, industrial and agricultural water uses. Balancing competing uses requires knowing the costs and benefits of increasing/decreasing water allocations to any and all of these users.

This is best done through the process of Public Trust assessment and analysis: an economic benefit/cost analysis of public trust resources. Benefit/cost analysis is simple in concept: Identify the user groups affected by the water allocation alternatives; calculate the costs to each group for each alternative; calculate the benefits to each group for each alternative; compare costs and benefits; select an alternative. Applying benefit/cost analysis, however, can be complex, especially when some of the trust resources at issue, e.g., instream flow and riparian habitats, are not traded in markets and so have no market prices with which to compare with other trust resources that are traded in markets, e.g., agricultural production. A complete analysis takes into account both market and nonmarket values and can describe the net economic effects of proposed scenarios. For example, the economic analysis in the Mono Lake case concluded that the economic benefits of preserving the public trust of instream flows for Mono Lake— the nonmarket values — outweighed the cost to Los Angeles of finding an alternative water source to Mono Lake — a market value — by a factor of 50.

We can stop paper water

If Ojai contracts for state water, that water will come from the California Delta. The decline of the Delta watershed is very well-documented. With the passage of the 2009 Delta Reform Act, the state wisely enacted into law the preservation of the Delta and specifically stated the need for the southern regions of the state to significantly reduce their reliance on Delta water. Paper water is what allows this destructive contradiction to persist, and why it's up to Ojai and all of us south of the Delta to be active in ending paper water for good.

Ojai citizens need to be aware that the Casitas Municipal Water Agency (Ojai water) is currently working with other local water agencies on a proposal to construct a pipeline to hook up to the State Water Project through the Los Angeles Metropolitan Water District.

A Draft Environmental Impact Report on the project is being prepared by the city of Ventura (Ventura water) and should be released to the public soon. The cost of the pipeline will be expensive, but not nearly as expensive as ongoing State Water costs associated with maintaining the SWP infrastructure (the Twin Tunnels, Oroville dam repair, etc.). These costs are determined by the Department of Water Resources and passed on to SWP ratepayers without their approval. Connecting to the SWP will not guarantee Ojai any new water, and as I have outlined in this series, the State Water Project is not sustainable in its current form.

The California Water Impact Network (C-WIN), a citizens group I founded in 2001 with Patagonia owner Yvon Chouinard, is leading the effort to end paper water. We are active participants in State Water Resources Control Board hearings and several lawsuits challenging the Twin Tunnels project. We have a proven track record of success toward our goal of sustainable and equitable water policy for California, and have created the road map to end paper water.

It includes these crucial steps:

• Quantification by the state of water available for export from the California Delta.

• A Public Trust assessment and analysis of export scenarios.

• Implementation of the 2009 Delta Reform Act standards, including non-renewal of and non-participation in new contracts with the SWP.

• Adjudication of the 20 rivers of surface water and groundwater in the Delta watershed.

C-WIN represents a statewide coalition of water agencies and activists who feel that ending paper water is one of the most important efforts of our time. We have assembled the team of court-designated experts needed to perform the quantification and Public Trust assessment, and are actively raising funds and awareness. But we are not asking you for a donation. We are asking you to help educate your neighbors and your local government representatives. We are asking you not to participate in the destructive mismanagement and abuse of California's fresh water, but instead seek regional solutions. We are asking you to share these three essays with every Californian you know. Not only will Ojai gain nothing in a contract with the SWP, it will lose the ability to serve its community's water needs and control its future.

Thank you for reading. Thank you for taking action.

— Santa Barbara resident Carolee Krieger leads C-WIN's efforts to design and implement collaborative and lasting solutions for California's fresh water resources.

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C-WIN Affiliations and Endorsements

We are a statewide organization with a significant constituancy.

ENVIRONMENTAL WATER CAUCUS (EWC)
Member Organizations:

AquAlliance
Butte Environmental Council
California Coastkeeper Alliance
California Save Our Streams Council
California Sportfishing Protection Alliance
California Striped Bass Association
California Water Impact Network
California Water Research Associates
Center for Biological Diversity
Citizens Water Watch
Clean Water Action
Desal Response Group
Earth Law Center
Environmental Justice Coalition for Water
Environmental Protection Information Center
Environmental Working Group
Food & Water Watch
Foothill Conservancy
Friends of the River
Karuk Tribe
Klamath Riverkeeper
North Coast Stream Flow Coalition
Northern California Council Federation of Fly Fishers
Pacific Coast Federation of Fishermen's Associations
Planning and Conservation League
Restore the Delta
Sacramento River Preservation Trust
San Mateo County Democracy for America
Save the American River Association
Save the Bay Association
Sierra Club California
Sierra Nevada Alliance
Southern California Watershed Alliance
The Bay Institute
Winnemen Wintu Tribe

ENDORSEMENTS

Environment:

Sierra Club
Center for Biological Diversity
Restore the Delta
Planning and Conservation League
Environmental Water Caucus
Southern California Watershed Alliance
AquAlliance
California Save Our Streams Council
Trinity Lake Revitalization Alliance
Environmental Protection Information Center

Consumer and Public Interest:

Food & Water Watch
Women's International League for Peace and Freedom
Earth Democracy Group

Fishing:

California Sportfishing Protection Alliance
Northern California Council Federation of Fly Fishers Fish Sniffer Magazine
California Striped Bass Association – Isleton-Delta Chapter

Farming and Agricultural:

California State Grange
Agricola Flora and Fauna Ranch

Community:

East Los Angeles Community Corporation
The River Project
Highland Park Neighborhood Council
Westwood Neighborhood Council
Rampart Village Neighborhood Council
Concerned Citizens Water Coalition
Westside Neighborhood Council
Northridge South Neighborhood Council
North Hollywood North East Neighborhood Council
Progressive Democrats of Santa Monica Mountains
Marin Water Coalition
San Mateo County Democracy for America
Palms Neighborhood Council
Dean Democratic Club of Silicon Valley
Marin Democratic Party

Business:

Cole Law Firm
BPF Investments
Dave Hieb Surveying