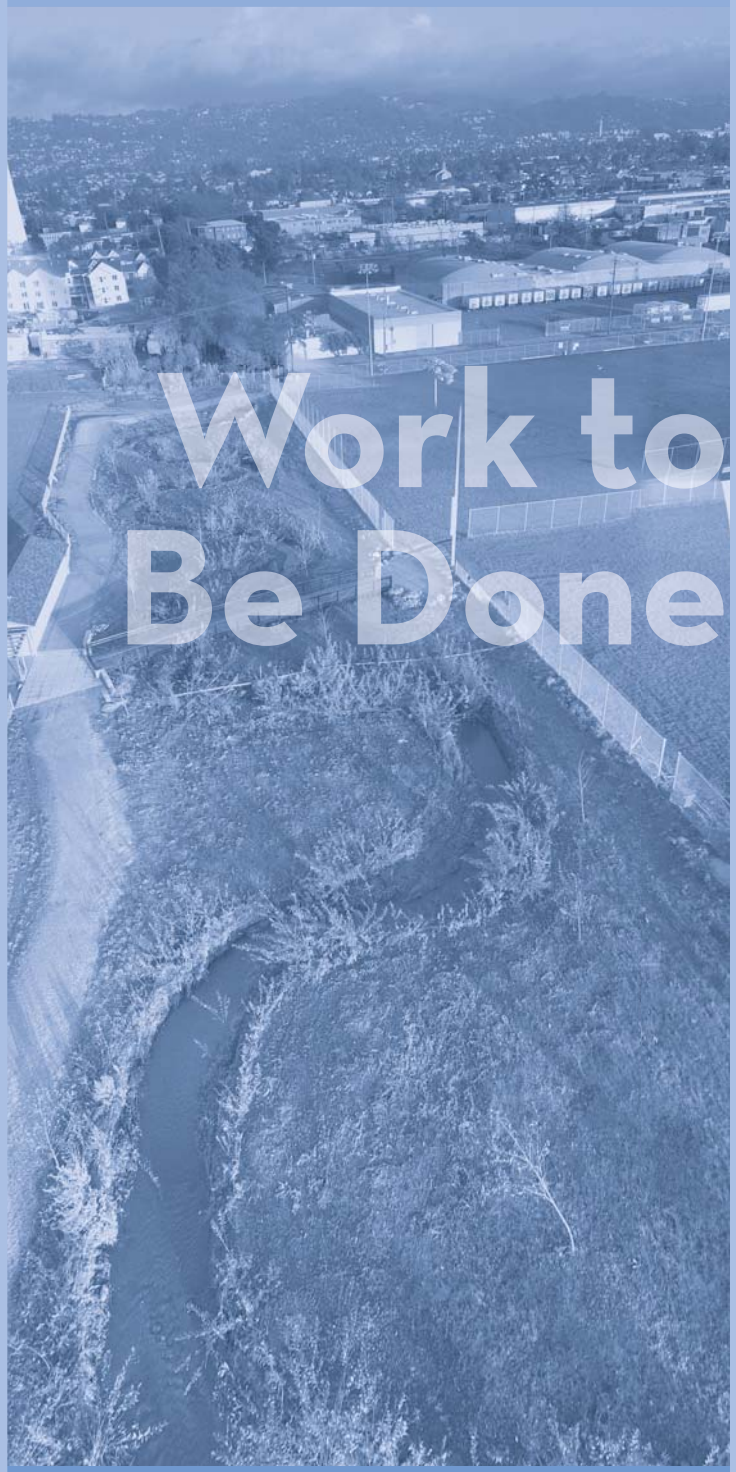
Work to Be Done

"The future of the Bay and its Baylands depends on watershed restoration to control the quantity and quality of local water and sediment supplies vital to the Bay and Bayland ecosystems. The challenge is to put the Bay, its Baylands, and watersheds together again."

—Josh Collins, SFEI

"We need to better explain, in economic terms, why protecting the natural environment is important to solving [our] other problems. Our job is to become the evangelists who put the environmental ethic into the economic equation."

—Will Travis, BCDC



Kite photo of the newly graded Codornices creek channel by Chris Benton

California's Marine Invasive Species Program

MAURYA FALKNER
CALIFORNIA STATE LANDS COMMISSION

In October 1999, California enacted the first statewide mandatory ballast water management law designed to prevent or reduce the introduction and spread of nonindigenous aquatic species via ships' ballast water into California state waters. While the program's initial focus was on foreign ballast water management, during the 2003 Legislative session the law was reauthorized and is evolving into a multi-faceted program that more comprehensively pursues the prevention of nonindigenous aquatic species via the commercial shipping vector. The program melds education and outreach with enforcement efforts, resulting in compliance rate levels exceeding 90 percent. Stakeholder involvement has become integral to policy development. Technical Advisory Groups (TAGs) consisting of scientists, regulators, and shipping industry representatives are regularly convened to inform management strategies. Two TAGs are currently formulating recommendations on new issues for the program; ballast water treatment technology standards; and management of aquatic nuisance species through vessel fouling. In areas where priority information gaps have been identified, the program provides limited logistical and financial support. Projects have included onboard testing of ballast water treatment technologies, research on open ocean exchange verification, and research on the vessel fouling risk for the Pacific Coast. Finally, the program maintains a database that has tracked ballasting practices of vessels entering California since 2000. The system contains a valuable time series of data that can be used to advance the management of invasives and research in the field.

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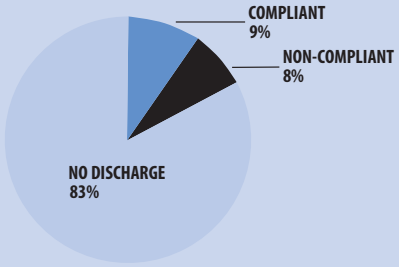
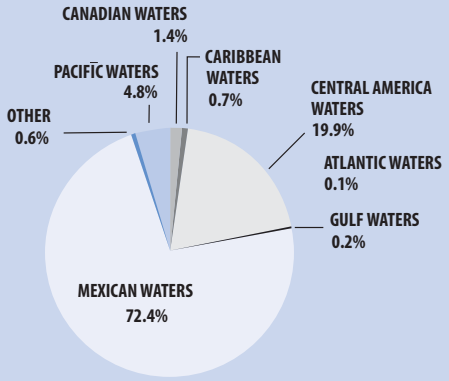
MARINE INVASIVE SPECIES PROGRAM MONITORING COMPLIANCE

REPORTED BALLAST WATER MANAGEMENT - 2004



SOURCES OF NONCOMPLIANT BALLAST WATER - 2004



TAKE HOME POINTS

- **The potential for expanding invasions is high.**
- **We are particularly concerned about voyages within the Pacific Coast region because of the potential for spread of the Chinese mitten crab, the chameleon goby, the Asian clam, and the striped barnacle.**
- **Looking to the future, we hope to improve compliance, improve performance standards, focus on non-ballast water ship-mediated vectors, and continue research into treatment technologies.**

THE MARINE INVASIVE SPECIES ACT OF 2003

"The purpose of the Act is to move the state expeditiously toward the elimination of the discharge of nonindigenous species into the waters of the state or into waters that may impact the waters of the state, based on the best available technology economically achievable."

Are We Preventing the Introduction of Exotic Species?

ANDREW COHEN
SAN FRANCISCO ESTUARY INSTITUTE

Exotic species have altered the species composition, habitats, food webs, population dynamics, and other aspects of the San Francisco Estuary. Exotics comprise most of the species, individuals, and biomass across many habitats, making this one of the most invaded estuaries in the world. A 1995 review found that hull fouling, ballast water discharges, aquaculture activities, and fisheries releases were the most important mechanisms introducing exotic species to the Estuary, with lesser contributions from bait imports, biocontrol releases, restoration activities, and others.

Studies have also shown that in recent decades, exotic species have been arriving and becoming established in the Estuary at an increasing rate, with ballast water discharges responsible for an increasing share of the introductions. Have our efforts to implement mechanisms for preventing the introduction of exotic species into the Estuary worked? Has significant progress been made? While the reports are reassuring, if you read the fine print, many ships are exempted from the new ballast water exchange laws. There is no good method of testing a ship's ballast water at the end of a voyage. At best, we may be removing 70 to 85 percent of the organisms in the ballast water, but a true figure might be closer to 25 to 50 percent. Hull fouling is another big problem. In one study, a large tuna fishing ship from Africa that came through the Panama Canal was covered from stem to stern with hundreds of species of hydroids. We have not begun to tackle this enormous problem. Aquaculture is also good at moving diseases, parasites, and pests. Decisions about how to manage aquaculture should not be left to the industry; we need to involve more effective stakeholders.

On the positive side, because we have made such little progress in controlling invasives, there is a lot we can still do. There has been agreement for a long time that exotics were a big problem—but not agreement in a forum where decisions are made about what to do.

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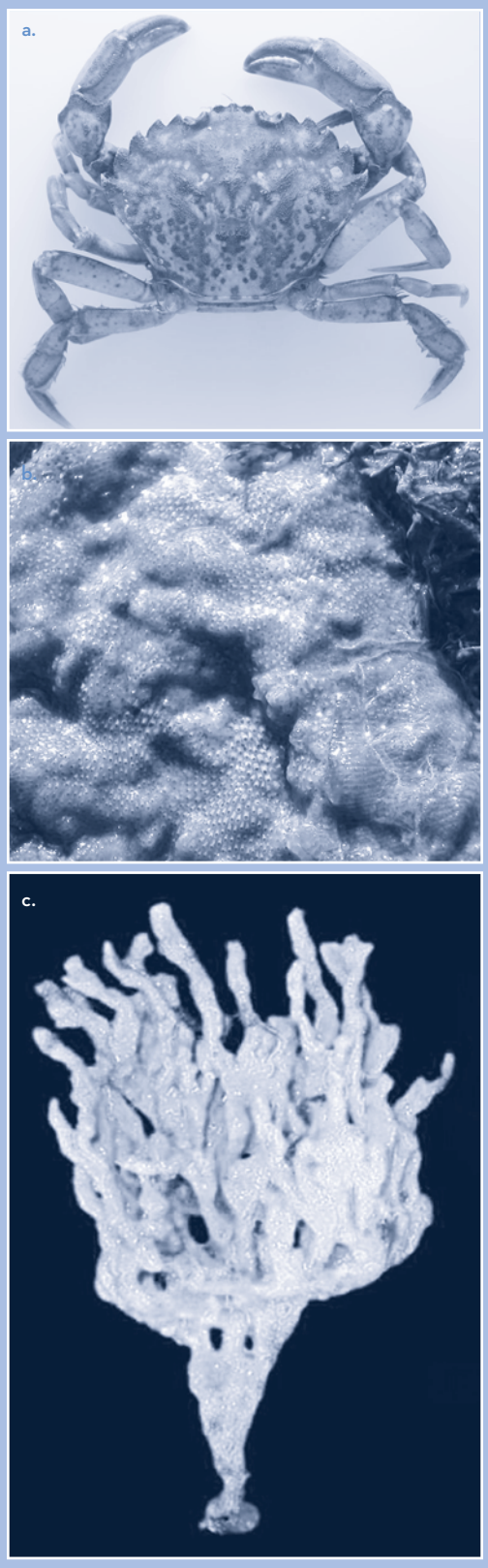


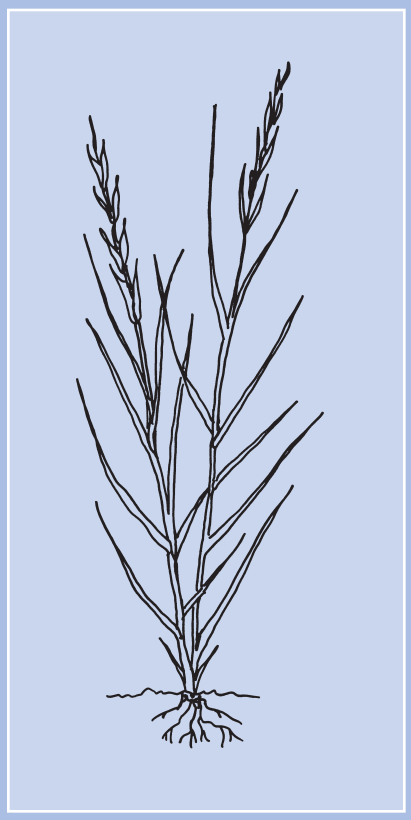
a) Green Crab, *Carcinus maenas*
b) Bryozoan, *Cryptosula pallasiana*,
c) Red Beard Sponge, *Clathria prolifera*

Non-native Spartina Control in the Estuary

ERIK GRIJALVA
SAN FRANCISCO ESTUARY
INVASIVE SPARTINA PROJECT

Introduced in the 1970s to control erosion, Atlantic cordgrass (*Spartina alterniflora*) spread rapidly throughout the Estuary, hybridized with Pacific cordgrass (*Spartina foliosa*), and today threatens thousands of acres of tidal marshes and restoration projects around the Bay. At the outset of the 2005 *Spartina* control season in the San Francisco Estuary, the Invasive Spartina Project (ISP) mapped and delineated 132 individual areas of varying sizes infested with non-native *Spartina*. In sum, over 1,200 net acres of *Spartina* were targeted for control, spread over roughly 11,000 acres of tidal marshland. At least 32 of these infested sites are restored marshlands, and many of the other sites are remnant or historic marshes that are assumed to serve as native propagule sources for planned restoration efforts in the Bay.

Building upon the knowledge gained through the successes and setbacks of the 2004 Spartina control season, the 3rd International Spartina Conference held in San Francisco in November 2004, the ISP's 2003 Spartina Monitoring Report, and work to date in other *Spartina*-infested areas worldwide, the ISP determined that aggressive targeting of all Spartina-infested areas within the Estuary in 2005 was warranted. This control effort was preceded by a comprehensive survey of the infested habitats for populations of endangered California clapper rails and an analysis of the potential impacts of the various proposed treatment methods on each individual site. The results of this work informed the timing and strategy of treatment planning efforts, while providing pre-treatment baseline information as a comparison for post-treatment effects on the systems involved.



Lisa Krieshok

In the 2005-2006 treatment season, the ISP switched to imazapyr (Habitat), recently registered for use in California. A recent report from Leson and Associates that summarizes laboratory and field studies describes imazapyr as both more effective and less hazardous than glyphosate. Among the report's findings: imazapyr degrades rapidly in water and inundated soil, leaving no detectable residue after two months; maximum planned application rates are not toxic to mammals, birds, or bottom-dwelling organisms; and exposure risks to workers applying the herbicide and to the general public are minimal.

The downside: accidental spraying of non-target plants carries a higher likelihood of damage than with glyphosate. Laboratory tests also indicated a slight risk to fish at highest concentrations. But based on the rates at which it will be used in an application, it is extremely unlikely that there is a risk to fish. Despite imazapyr's promise, cordgrass may still be a tough adversary, however. Some weed species, including perennial ryegrass and rigid ryegrass, have evolved resistance to the terrestrial version of the chemical, marketed as Arsenal and Chopper.

MORE INFO? ekgrijalva@spartina.org

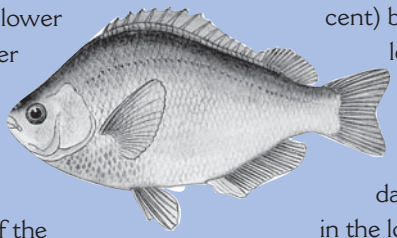
TAKE HOME POINTS

- **In 2004 surveys, we saw a 250 percent increase in non-native spartina from 2001-2003. The invasion consisted mostly of hybrids with varied and diverse genoytopes that can colonize anywhere.**
- **The greatest threats are to mudflats and restored tidal marsh.**
- **We have a chance to do something right now—to control it—before the invasion becomes even worse.**

Alien and Native Fish in the Lower San Joaquin River Watershed

LARRY BROWN
U.S. GEOLOGICAL SURVEY

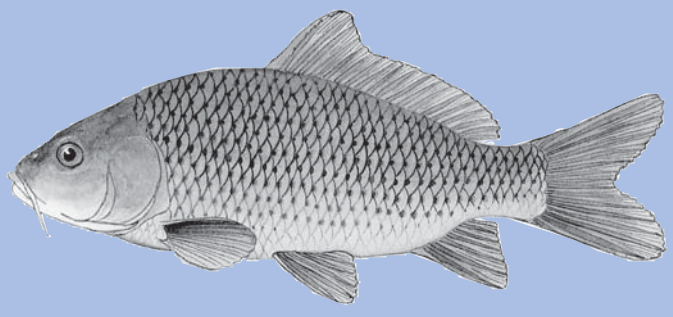
Changes in land and water use in the San Joaquin River watershed, as well as the deliberate and accidental introductions of alien species beginning in the mid-1800s, profoundly changed the aquatic flora and fauna in this region of California. Studies over the last decade in the lower mainstem San Joaquin River and its tributaries have provided much useful information on the fish assemblages of the region and have identified some of the environmental factors associated with their distribution and abundance. Those studies provide a basis for assessing possible outcomes of rehabilitation efforts.



Tule Perch
Illustration: Bill Crary

In a comparison of 20 major rivers across the United States, the lower San Joaquin River had the highest percentage of alien fish species (70 percent) and the highest percentage of alien fish captured (over 90 percent) based on data collected from 1993 to 1995. Detailed analysis of a comprehensive data set from 20 sites in the lower San Joaquin River watershed sampled during the same time period indicates the presence of four major fish assemblages, with native fishes most abundant in the reaches of tributary rivers just below the large foothill dams. Environmental conditions below the dams were more similar to conditions in the streams favored by many of the native fishes, compared to environmental conditions in downstream reaches. Analysis of annual monitoring data collected from 1987 to 1997 from eight sites on the lower Tuolumne River indicated that the abundances of native and alien fishes captured at a site were associated with springtime flow conditions and distance from the San Joaquin River. Alien fishes accounted for a greater percentage of the catch when flows in the previous year were relatively low and at sites closer to the San Joaquin River. In contrast to the lower San Joaquin River watershed, the lower Sacramento River watershed still supports relatively large populations of native fishes, possibly because the river channels are used as throughput water delivery systems, thus maintaining higher, cooler flows than in the San Joaquin River watershed, where water is diverted from river channels for off-channel uses. These studies suggest some level of predictability in the response of fish assemblages to environmental change. However, there are likely unknown interactions between alien and native fishes, between fishes and non-fish species, and between fishes and environmental conditions that make predictions regarding rehabilitating native fish populations uncertain.

Sacramento Sucker, Illustration: Bill Crary



Carp, Illustration: Bill Crary

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TAKE HOME POINTS

- **The lower San Joaquin River watershed is highly invaded—both compared to other rivers throughout the United States and throughout California.**
- **Native species persist below the dams.**
- **The success of invasive species is related to a number of environmental factors, including flow, temperature, and land use.**
- **The potential for increasing native fish populations seems high, but there is also a high potential for unexpected outcomes because of unanticipated interactions between native and alien species.**

What Do The Next Forty Years Hold For The Estuary?

JOE BODOVITZ
CALIFORNIA ENVIRONMENTAL TRUST

The state of the Estuary is, literally, the state of California. San Francisco Bay and its twin, the Delta, both lie within one state jurisdiction. But they are by no means identical twins, and we have not treated them as if they were.

We have made greater progress with the Bay than with the Delta. In 2005 we marked the fortieth anniversary of the beginning of the San Francisco Bay Conservation and Development Commission. And we note the work of the CALFED Bay-Delta program to resolve some of the most difficult issues in California—how to protect and restore the Delta while simultaneously providing water for agriculture and for the expanding population of urban California.

CALFED needs the same broad public support and understanding that the Save San Francisco Bay Association brought to the campaign to stop the uncoordinated filling of San Francisco Bay in the 1950s and early 1960s. Most residents of the Bay Area now understand the importance and value of the Bay. Unfortunately, most residents of California do not have the same understanding of the Delta.

Nobody can look forty years ahead and tell us what to expect. But we can already see the shapes of some things to come: the possible effects of global climate change; the possible effects of rising sea levels; the continuing struggles over water supply and water quality; and the need for better governance of the common resources of the Delta.

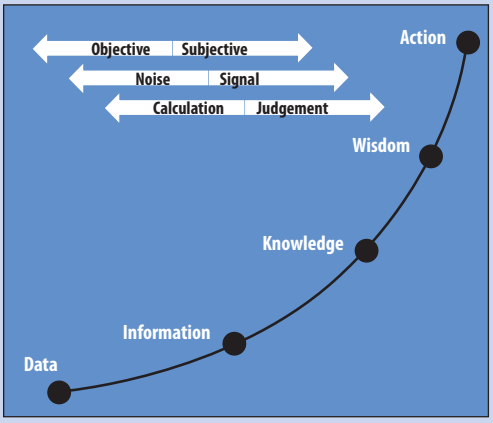
Stewards and Scientists: the Imperative for Collaboration

JERRY SCHUBEL
AQUARIUM OF THE PACIFIC

For most of my professional career I have attempted to identify, develop, and apply strategies to facilitate the collaboration of scientists with the decision-makers and stakeholders who are so critical to environmental sustainability. The investments of hundreds of millions of dollars in major coastal clean-up and restoration initiatives too often have failed to meet stated goals and stakeholders' expectations. It is clear that new institutional mechanisms are needed. There is a better way—one successful model that has emerged over my more than three decades as a student and practitioner is an "environmental decision value chain" that has the following elements:

- Proper valuation of the resources at risk
- A regional approach to finding solutions, that is:
  - Scalable to fit the issues
  - Inclusive and transparent
  - Futuristic in its orientation
- Functional institutional mechanisms at the regional level, and
- An informed, involved, concerned public.

ENVIRONMENTAL DECISION-MAKING VALUE CHAIN



MORE INFO? **jschubel@lbaop.org**

TAKE HOME POINTS

- **Restoration and conservation of the Bay-Delta are not limited by a lack of scientific understanding, but by a lack of a clear and compelling vision, and institutional mechanisms to exploit the data and knowledge we have.**
- **The evolution of our scientific understanding has outstripped our ability to apply it.**
- **We need a compelling vision, a proper valuation of resources, a regional approach that is futuristic, and appropriate institutional mechanisms.**
- **We need new approaches and new institutional mechanisms for harvesting what we know.**
- **We spend over $100 million a year telling the public why agriculture is important but less than 10 percent of that on why oceans and estuaries are important.**
- **Solutions to our current environmental problems depend on our ability to imagine and shape the future.**
- **Policies are experiments. We've made a lot of mistakes. We need to learn from them and move on.**

Where Are We Headed in the Next Ten Years?

NADINE HITCHCOCK
CALIFORNIA COASTAL CONSERVANCY

Thanks to the passage of several voter-approved state bond acts in recent years, public agencies have been able to work in partnership with non-governmental organizations, citizen groups, and private foundations to acquire over 30,000 acres of historic Baylands in the San Francisco Estuary. Planning and engineering is now well underway to determine how to restore these areas to provide habitat for endangered species, waterfowl, shorebirds, and other native wildlife, to improve water quality, and to provide wildlife-oriented recreational opportunities to the public. During the same period, much attention has been focused on the need to look up into the watersheds and out into the ocean to address water quality, species protection, flood management, hydrology, ocean conservation, and other issues if we are to meet restoration and protection goals for the Estuary. With the creation of the California Ocean Protection Council, the development of new incentives to integrate water resources management on a regional scale, and a greater interest in working collaboratively with new partners, we have an unprecedented opportunity to take a more seamless look at how to manage the Estuary, its watersheds, and the ocean resources to which it is connected.

How will we fund future restoration work estimated to cost over $300 million in the next decade alone when federal funding is on a downward projection? New bond acts and local/regional funding initiatives will be required. The Napa River/Rutherford benefit assessment district is a good example of such a local /regional initiative.

MORE INFO? nhitchcock@scc.ca.gov

LIKELY DELTA RESTORATION PROJECTS BY 2015 WITH NO NEW STATE BONDS

TAKE HOME POINTS

- **In the next 10 years, more significant historic tidelands will be restored and enhanced, but there will be minimal new acquisitions.**
- **There will be more desalination facilities built.**
- **There will be an increased focus on subtidal areas—efforts include the Subtidal Goals Project, new tools to battle aquatic invasives (ballast water exchange and treatment), eelgrass restoration, and native oyster restoration.**
- **Much more eelgrass habitat could be restored in the Bay. We could restore an estimated 22,000 acres; we now have only 2,600 acres. The Coastal Conservancy is funding several pilot restoration projects.**
- **A race is taking place around the Bay between people acquiring land for preservation and those acquiring it for development.**
- **The funding outlook for the next 10 years is grim. More needs are going to be completing for less funds. Politically, ecosystem restoration is often thought of as competing with traditional engineering projects, and there is increased support right now for funding levee repair and flood control projects due to earthquake predictions as well as the recent natural disasters such as Hurricane Katrina.**
- **Despite the poor funding outlook, we need to continue to do restoration projects in disadvantaged communities such as the restoration of Yosemite Slough in Hunter's Point, San Francisco.**
- **We need to develop a regional vision for the landscape that identifies local and regional funding sources.**
- **There is a general trend toward ocean ecosystem-based planning and management. The California Ocean Protection Council established in 2004 will have funding for "ocean" projects, including subtidal restoration in the Bay.**
- **Another general trend will be toward watershed ecosystem-based planning and management. The Bay Area Watershed Plan—www.bayareawatershedplan.net—will guide watershed restoration efforts.**

California Water Plan 2005: a Framework for Action

KAMYAR GUIVETCHI
CALIFORNIA DEPARTMENT OF WATER RESOURCES

The Department of Water Resources (DWR) has changed the process for preparing the California Water Plan and the information it contains. The Water Plan has become a strategic document that describes the role of state government and the growing role of California's regions in managing the state's water resources.

In preparing Update 2005, DWR sought the participation of California's water communities, responded to new state laws, and, by working with an advisory committee, developed a new approach to planning California's water future. DWR significantly expanded the public forum for updating the California Water Plan by establishing a 65-member advisory committee and a 350-person extended review forum, and seeking input from 2,000 other interested members of the public.

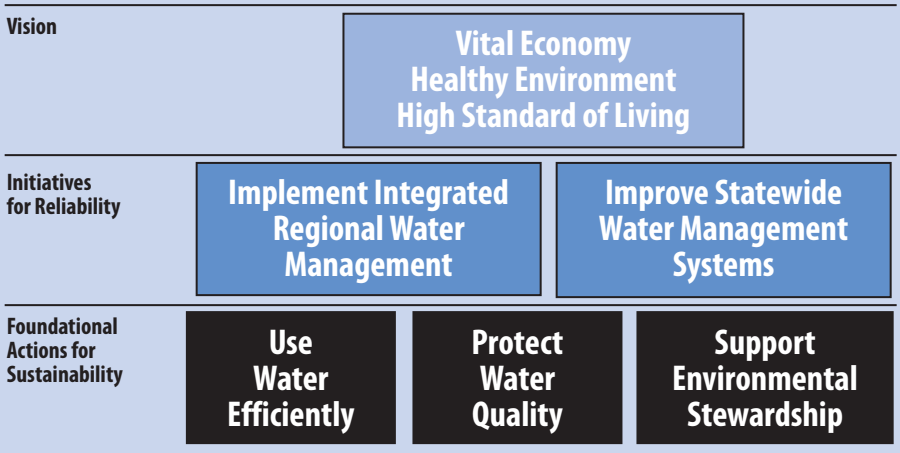
Water Plan 2005 provides California's water communities with a vision, mission, and goals for meeting challenges of sustainable water use through 2030 in the face of uncertainty. It has recommendations for decision-makers, resource managers, water suppliers, and water-users. And for the first time, the water plan includes a proposal for carrying out its recommendations. The plan provides a Framework for Action to stimulate progress now to ensure a sustainable and reliable water supply in 2030. This framework will focus and prioritize state government's water planning, oversight, and technical and financial assistance on several foundational actions and initiatives. The Framework for Action also identifies a number of essential support activities needed to accomplish its foundational actions and initiatives.

Water Plan 2005 contains water data, information, and studies used to develop the strategic plan. It outlines today's water challenges and evolving water management responses; it presents benefits and costs of 25 resource management strategies; it reports regional water conditions and activities; it considers multiple future scenarios and their water demands; and it describes an approach to improve data management and analytical tools for future plan updates.

Water Plan 2005 is summarized in the Highlights document and presented in five volumes: (1) Strategic Plan, (2) Resource Management Strategies, (3) Regional Reports, (4) Reference Guide, and (5) Technical Guide. The final California Water Plan Update 2005 was released in January 2006.

MORE INFO? kamyarg@water.ca.gov, www.waterplan.water.ca.gov

PLAN GOALS, STRATEGIES, AND ACTIONS



Linking Wetlands to Watersheds

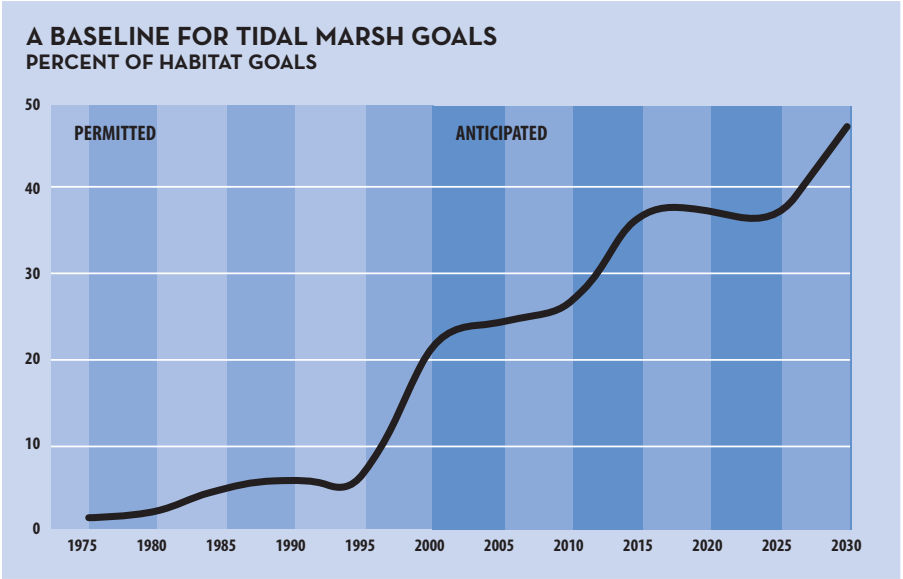
JOSH COLLINS
SAN FRANCISCO ESTUARY INSTITUTE

Habitat stewards and scientists have been working together to achieve the Baylands habitat goals set in 1999. The size of Bayland restoration projects has increased, the fragmentation of habitats seems to be decreasing, the suite of target habitats has broadened, and the amount of collaboration on project design and assessment has grown.

This collaboration has fostered new ideas about tracking wetland health and restoration progress. Multi-disciplinary teams of technicians and managers are more likely than before to give advice on and review the conceptual designs and monitoring plans for restoration projects. This is expected to improve project performance. A three-tiered approach to comprehensive wetland assessment is emerging to support project design and tracking. Regional habitat inventories comprise level one. Cost-effective rapid assessments of ambient condition and selected projects comprise level two. Standardized intensive monitoring to address critical concerns and test specific hypotheses comprises level three. Public information management that enables data sharing among regional centers is also envisioned. The ongoing State Wetland Inventory, the California Rapid Assessment Method, the growing number of intensive monitoring protocols adopted by the Bay Area Wetland Monitoring Group, and the continuing development of the Wetland Tracker for coastal watersheds indicate significant progress toward implementing the assessment framework.

This approach to regional habitat assessment—setting shared goals and developing a tiered approach to tracking progress toward the goals—is being adopted in other regions, including Elkhorn Slough, Humboldt Bay, and the Great Salt Lake Ecosystem. It is also being used to begin integrating the assessments of Baylands and watersheds in the Bay Area. Through the Napa Watershed demonstration project, habitat inventories, probabilistic surveys of ambient condition, and intensive assessments of restoration performance are being integrated into a single report of overall wetland health at the watershed scale.

MORE INFO? **josh@sfei.org**



TAKE HOME POINTS

- **We need to embrace the idea that the Baylands really are the edge of the Bay (right now they are a kind of "no man's land"): they have fallen between watershed science and Bay science.**
- **The future of the Bay depends on watershed processes.**
- **Sediment storage and transport are very important. Off-channel wet meadows once played a large role in sediment storage and transport, but we have lost most of them.**
- **The natural functions of alluvial fans and off-channel wetlands may need to be restored.**
- **Our challenge is to put the Bay, Baylands, and watersheds back together again. Efforts to restore each part will otherwise fail expensively.**
- **We need to set goals for restoring riparian habitat just like we did for wetlands — a "Riparian Habitat Goals" project.**
- **Setting riparian goals could serve to integrate the science and policy of watersheds, wetlands, and estuarine protection.**
- **Understanding the interactions between fluvial and tidal processes will be increasingly important.**
- **The interaction of fluvial and tidal processes affects creek erosion, flooding, sediment delivery to the Baylands and the Bay, dredging, fish passage, and the biodiversity of the system as a whole.**
- **Watershed restoration will need to focus on sources, transport, and storage of sediment as well as water.**
- **We need to reconnect our watersheds with the Bay.**

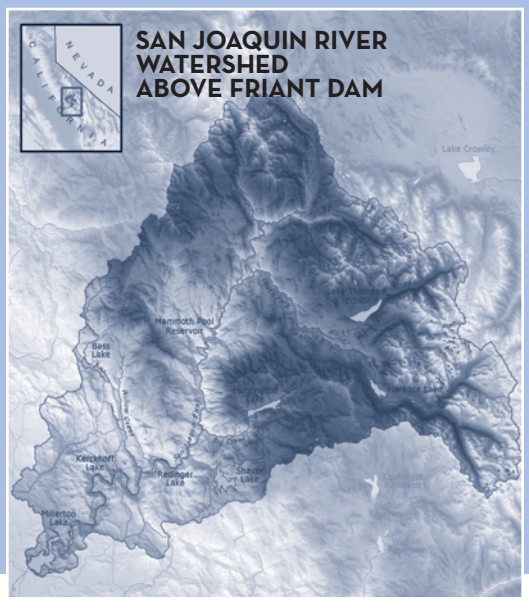
San Joaquin River Restoration Challenges

RON JACOBSMA
FRIANT WATER USERS AUTHORITY

The San Joaquin River between Friant Dam and the confluence of the Merced River can be broken up into five sections, each with unique challenges for restoration. There is a live river for 37 miles below Friant Dam. You hear that water users divert 98 percent of the water, but that's not the case. On average 15 to 20 percent of the water is released below the dam, much of it during flood flow years. Non-flood flow releases average approximately 116,000 acre feet per year out of an average run-off of approximately 1,700,000 acre feet per year. Flood flows average in excess of 200,000 acre feet per year. In late summer and early fall, more water is released from Friant Dam than would occur in nature.

Reach 1, the live river, has been impacted by gravel mining operations; there are temperature, sedimentation, and predator issues. Reach 2, a very porous area, dries up; most of the water flows through a bypass during flood events. A fish ladder would have to be put in at Mendota Dam to restore that reach. Reach 3 looks like a river, but replacement water from the Delta comes in there to meet the exchange agreement with the historical San Joaquin River water users, the Exchange Contractors. Parts of Reach 4 are basically an overgrown ditch with some agricultural drainage water coming in. Reach 5 has floodplain habitat opportunities, but again there are temperature issues—it's a flat-gradient system in the hottest part of the Valley.

The economy is a big concern to our area, having relied on that water supply for so long. Twenty-eight districts in the Central Valley Project contract for Friant water. We serve about one million acres, 15,000 small family farms in the top three agricultural counties of the nation. Forty percent of the city of Fresno's water supply comes from the Friant diversion, and smaller cities like Orange Cove and Lindsay are even more dependent. We deliver about 1.4 million acre feet per year to our contractors, leaving 100,000 acre feet to that 37 miles of river. Class 1 districts along the foothills with little or no groundwater have a firm supply; Class 2 districts further down the valley have active conjunctive use programs.



Friant is not the only dam on the system; there are eight others, most built earlier. The upper reservoirs are maintained by Southern California Edison, the bottom two by PG&E. Friant came into being after groundwater levels dropped drastically and tens of thousands of acres of fertile farmland were taken out of production. Friant was a cornerstone of the California Water Plan, which ended up being built and structured with federal assistance. By the time Friant Dam was to be built, in the early 1940s, salmon counts were down to 3,000-5,000 per year. Friant's first long-term contract, in 1949, was a 40-year commitment to make water available for irrigation. There was conscious recognition that there would be sections of dry river and that salmon would be extirpated from the upper San Joaquin. This was reaffirmed by a State Water Board decision in 1959 as being in the public interest. The California Department of Fish and Game revisited the issue in the 1970s and recommended focusing resources on improving existing salmon runs elsewhere instead of the upper San Joaquin.

There are no easy answers to the tensions on the San Joaquin River. NRDC's lawsuit began in 1988. We worked with the plaintiffs for four years to find a way to restore the river without adversely impacting Friant water supplies. We had some pilot projects but did not reach a settlement. A back-of-the-envelope analysis projected that around $650 million would be needed for river improvements, even before developing alternate water supplies. One option would be on-stream storage upstream of the dam. Our concerns are a loss of 20 to 50 percent of our water supply and water development costs potentially in excess of $1 billion.

Without getting into the lawsuit, Friant is engaged in a lot of activities, including a possible water quality exchange program with Metropolitan. We want to work with river groups to improve the water quality on the lower San Joaquin River. We want to look at upper San Joaquin River storage basins. And we are very much interested in restoration opportunities that won't devastate our regional economy.

MORE INFO? **rjacobsma@friantwater.org**

Low Dissolved Oxygen in the Tidal San Joaquin River

ALAN JASSBY, ET AL.
UNIVERSITY OF CALIFORNIA, DAVIS

The Stockton Deep Water Ship Channel, a stretch of the tidal San Joaquin River, is frequently subject to low dissolved oxygen conditions and annually violates regional water quality objectives. Hypoxia is most common during June through September immediately downstream of where the river enters the ship channel. Underlying mechanisms are examined here using the long-term water quality data, and the efficacy of possible solutions using time-series regression models.

At the annual scale, ammonium loading from the Regional Wastewater Control Facility has the largest identifiable effect on year-to-year variability. The longer-term upward trend in ammonium loads, which have been increasing over 10 percent per year, also corresponds to a longer-term downward trend in dissolved oxygen during summer. At the monthly scale, river flow, loading of wastewater ammonium, river phytoplankton, ship channel temperature, and ship channel phytoplankton are all significant in determining hypoxia. Over the recent historical range (1983–2003), wastewater ammonium and river phytoplankton have played a similar role in the monthly variability of the dissolved oxygen deficit, but river discharge has the strongest effect.

Model scenarios imply that control of either river phytoplankton or wastewater ammonium load alone would be insufficient to eliminate hypoxia. Both must be strongly reduced, or reduction of one must be combined with increases in net discharge to the ship channel. Model scenarios also imply that decreasing the impact of exports on San Joaquin flow into the ship channel—for example, by preventing discharge down Old River with a barrier or by using an isolated conveyance facility to supply the water projects—markedly reduces hypoxia in the ship channel.

Upgrades to the Regional Wastewater Control Facility, to be completed in 2006, will not eliminate the impact of wastewater loading but should significantly reduce the incidence of low dissolved oxygen. Although activities are also underway to identify and manage nonpoint sources of nutrients fueling algal growth in the San Joaquin River, very challenging levels of reduction will be required to have an impact on summer-fall hypoxia in the ship channel.

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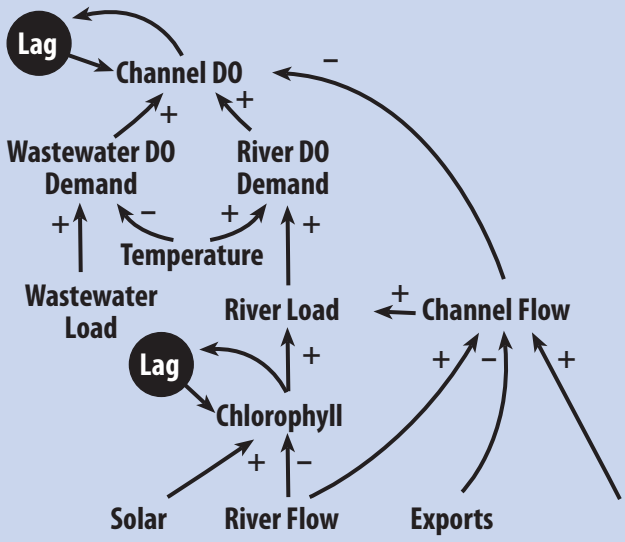
MAIN MECHANISMS CONTROLLING STOCKTON SHIP CHANNEL DISSOLVED O_2 IN TIME SERIES MODEL



Managing Water Quality in the San Joaquin River Basin

NIGEL QUINN AND TRYG LUNDQUIST
BERKELEY NATIONAL LABORATORY

Adaptive real-time water quality management is a strategy for improving water quality conditions in an impaired water body by providing real-time (immediate) access to flow and water data, disseminating river assimilative capacity forecasts using computer-based simulation models and implementing control strategies. The technique is particularly relevant to the San Joaquin River Basin where water quality objectives and regulatory constraints on flow and contaminant loads are often in conflict and lead to sub-optimal utilization of river assimilative capacity. In the case of contaminants such as dissolved solids, boron, and selenium these inefficiencies have led to frequent violation of Regional Water Quality Control Board objectives, especially during dry and critically dry years.

We have conducted several experiments over the past decade using adaptive real time water quality management. These experiments have been interagency collaborations that have clearly demonstrated that improved cooperation and coordination of agricultural, municipal, and wetland drainage return flows with east-side reservoir releases has unrealized potential for improving river water quality. As the Water Quality Subcommittee of the San Joaquin River Management Program, we conducted the first phase of experimentation, which concentrated on the main stem of the San Joaquin River and its major tributaries, and continued for a period of five years. During this period a number of supplemental projects were initiated that focused on major contributing watersheds among the west-side tributaries to the San Joaquin River. Those included selenium-affected agricultural land as part of the Grassland Bypass Project and seasonal wetland drainage in CALFED-sponsored projects located in the Grassland Water District and San Luis National Wildlife Refuge. The latest implementation of the adaptive real-time water quality management strategy is contained in the Stockton Dissolved Oxygen TMDL and CALFED Directed Action Project. These projects have, for the first time, created an opportunity for basin-wide water quality modeling and forecasting to minimize real-time excursions of the dissolved oxygen concentration in the Stockton Deep Water Ship Channel. The long-term goal of this effort is to replace the piecemeal and conflicted TMDL approach to water quality management

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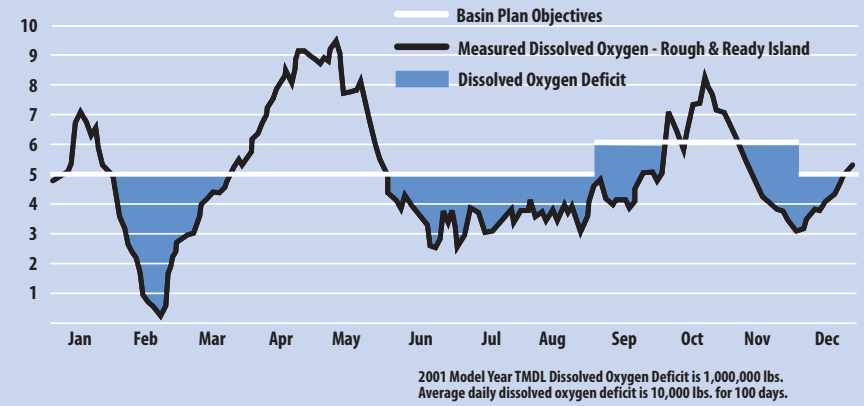
STOCKTON DEEP WATER SHIP CHANNEL O2 DEFICIT



2001 Model Year TMDL Dissolved Oxygen Deficit is 1,000,000 lbs.
Average daily dissolved oxygen deficit is 10,000 lbs. for 100 days.

TAKE HOME POINTS

- **When given an incentive, agricultural districts can decrease their pollutant loads.**
- **One way to do this is to temporarily store contaminant loads, releasing these contaminants during higher flow when there is adequate river assimilative capacity.**
- **Forecasts of river water quality are necessary for real-time water quality management to be practiced – this can help to guide real-time remedial actions.**
- **Agricultural districts implementing real-time water quality management should collaborate with regulatory entities to develop interim targets and load objectives—creating a transition period during which the districts can adapt to the new program.**
- **We need additional monitoring stations, more timely and accurate information from local managers, a decision support coordinator for the watershed, and agreements that recognize the experimental and cooperative spirit of a real time water quality management system.**
- **Current real-time management projects may be the model for future basin water quality management.**

Climate Change Impacts on the San Joaquin River Basin

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UNIVERSITY OF CALIFORNIA BERKELEY

Climate change has the potential to impact hydrology and water resources throughout the world—and California. Some regions in California, like the Sierra Nevada mountains, are especially vulnerable to these impacts due to their dependence on snow accumulation and snowmelt, two processes especially susceptible to changes in temperature. This potential risk looks even more relevant if we consider changes in the timing of streamflow that are already happening in the Sierra Nevada as suggested by various studies.

The prediction of future climate change impacts on California hydrology and water resources is based primarily on the use of General Circulation Models (GCMs), which predict future changes in temperature, precipitation, and other climatic variables based on the interactions between the land, atmosphere, and oceans. Hydrologic models then use these changes to predict climate change impacts on natural runoff. Finally, water resources models are used to transfer these changes in natural runoff into changes in water deliveries and impacts to the water resources systems. There have been a vast number of research activities in the last 20 years that have attempted to assess the impacts of climate change on California's hydrology and water resources systems. These studies have used different GCMs and hydrologic or water resources models at various levels of complexity, but all of them consistently predict a change in timing in streamflow runoff due to a consistent increase in temperature. However, changes in the winter runoff are still uncertain, mainly due to uncertainties in precipitation predictions. The message taken from these studies is simple: there will be more water when we don't need it and less when we need it.

When comparing the relative impacts of climate change for different regions in California, most of these studies have shown that the impacts will be higher in the northern (e.g. American River) than in the southern (e.g. Merced River) Sierra Nevada. This is a result consistent with measured historical streamflow trends and relates to the relative altitude of the basins located in these two regions (the high altitude basins in the southern Sierra Nevada being less affected by increases in temperature). However, recent modeling results suggest that an opposite effect might happen: i.e., impacts could be much higher in the southern as compared to northern Sierra Nevada. The reasons behind these contradictory results are higher temperature predictions by the latest GCM runs and almost neutral changes in precipitation.

Using these latest GCMs results to run a hydrologic model (VIC) and a water resources model (CalSim) for California, we conclude that these changes will potentially affect the performance of the infrastructure in the San Joaquin River basin, limiting its availability to meet all water resources objectives, like water deliveries, energy generation, and environmental services in the Bay Delta and San Joaquin River.

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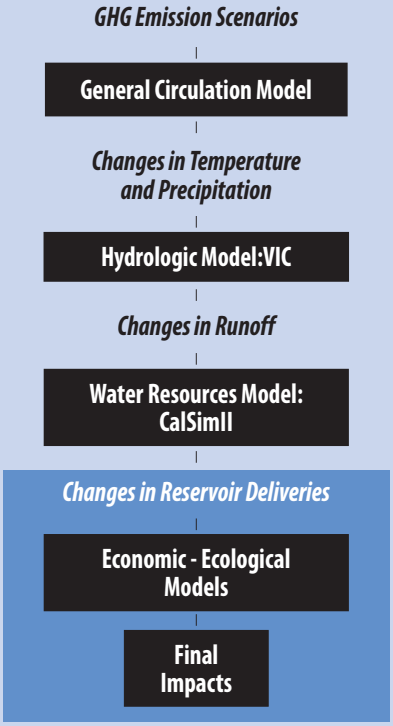
ASSESSING CLIMATE CHANGE IMPACTS IN WATER RESOURCES



TAKE HOME POINTS

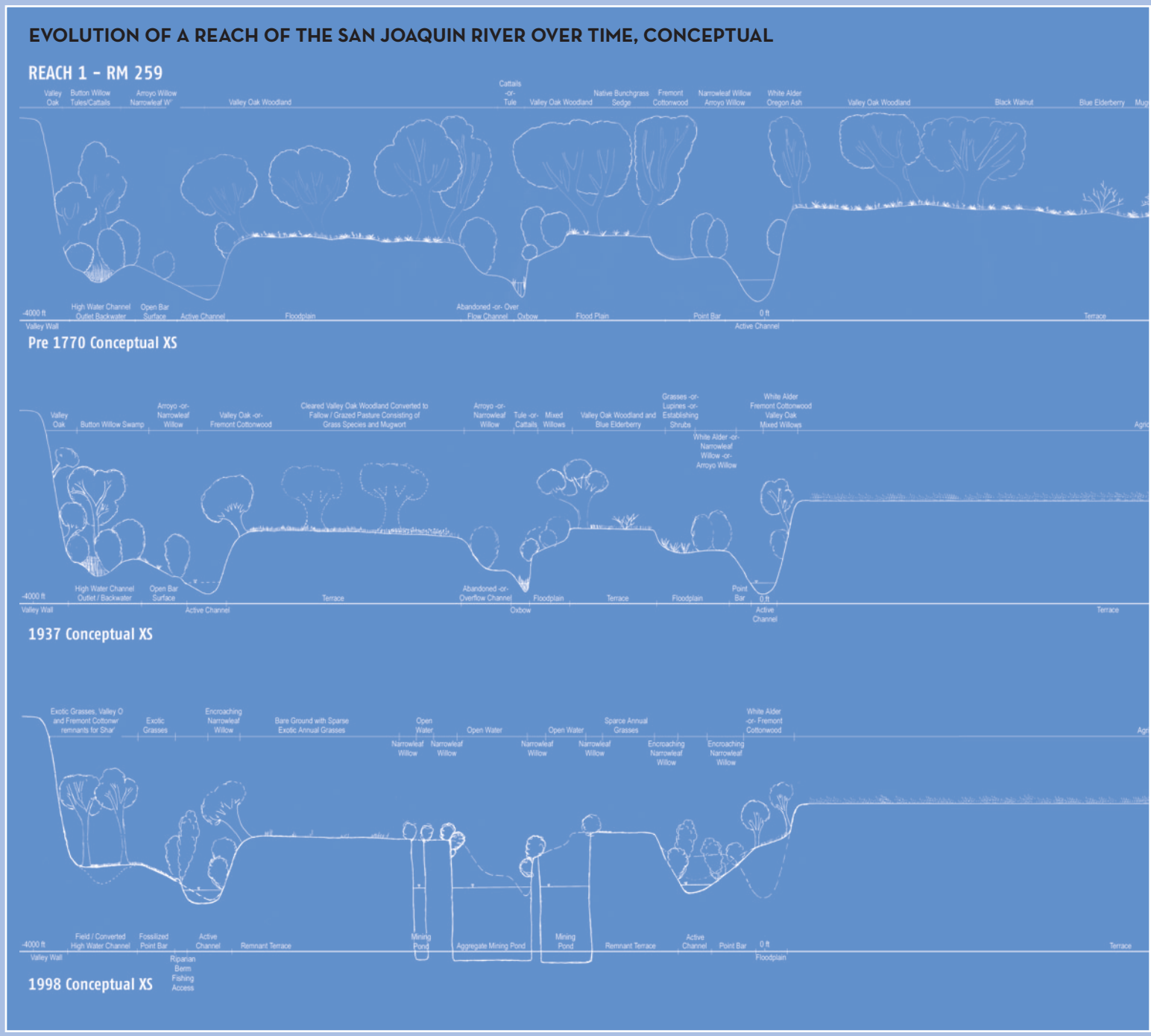
- **Climate change is already happening, as trends in hydrological conditions in the West show.**
- **The latest general circulation model output shows greater negative impacts on California hydrology and water resources than in previous assessments.**
- **Impacts will be higher by the end of the century and in the southern Central Valley.**
- **It is important to consider not just average results but also impacts during extreme conditions.**
- **Models show that we may have more water when we don't want it — early in the Spring —and less later on when we need it more.**
- **We need to take climate change into account in future management of the Estuary.**

Can We Restore Healthy River Functions to the San Joaquin?

SCOTT McBAIN
McBAIN AND TRUSH

Can the mainstem San Joaquin River downstream of Friant Dam, the southern Central Valley's complement to the Sacramento River, be restored to support a species assemblage that includes anadromous salmonids? It is a challenging task for a river that has experienced dramatic physical and hydrologic changes since the 1850s, because the cumulative effects of dams, diversions, and land use on the San Joaquin River have been more severe than on other Sierra Nevada rivers.

The snowmelt-dominated hydrograph characteristic of larger Sierra Nevada rivers once supported spring- and fall-run Chinook salmon, and likely other anadromous fish species. While floods still occur on



occasion under regulated conditions, most of the other natural hydrograph components have been eliminated, and in some reaches the aquifer has been severely depleted, water quality is poor, channel capacity reduced, and several reaches of the river are perennially dry. Sediment supply from the upper watershed has been eliminated, and the channel has been mined, confined, and bypassed. In one reach, the channel is indistinguishable from old sloughs, agricultural canals, and drains.

Anadromous salmonids can return, although the challenges will be considerable. Furthermore, improving healthy river function and the biota supported by that function faces many scientific and technical uncertainties. How do we reestablish under highly regulated conditions a cold water anadromous fishery that must migrate through a complex system of diversions, pumps, and flood bypasses? How do we rehabilitate geomorphic processes in a system with lower than average channel slope and sediment supply compared to other Sierra Nevada rivers? Answers to these questions will require additional predictive modeling, yet will also require more experimental releases and adaptive management. To provide the physical forces needed to restore natural processes, and consequently anadromous salmonid habitat, high flow releases will need to be re-operated. Solutions will also need to incorporate creative water operations, channel reconstruction, and other mechanical solutions.

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TAKE HOME POINTS

- **The restoration plan (developed as part of settlement negotiations in 2001-2003) was developed to "expeditiously evaluate instream and related measures that will restore natural ecological functions and hydrologic and geomorphic processes of the San Joaquin River below Friant Dam to a level that restores and maintains fish populations in good condition, including but not limited to naturally reproducing, self-sustaining populations of Chinook salmon."**
- **Rehabilitation of a riparian floodway has been done on other Central Valley streams; therefore, it can also be done on the San Joaquin River.**
- **Slope is a significant constraint to restoring geomorphic processes on the San Joaquin River in the gravel bedded reach immediately downstream of Friant Dam. Levees, land use, and changes to the groundwater table are significant constraints to restoring geomorphic processes in the sand-bedded reaches.**
- **Other scientific uncertainties include temperature modeling results and salmonid thermal tolerances, how to re-establish and route extirpated fish species, ecologically significant restoration scale (e.g., what size and shape does the riparian corridor need to be ecologically meaningful to key indicator species), and others.**

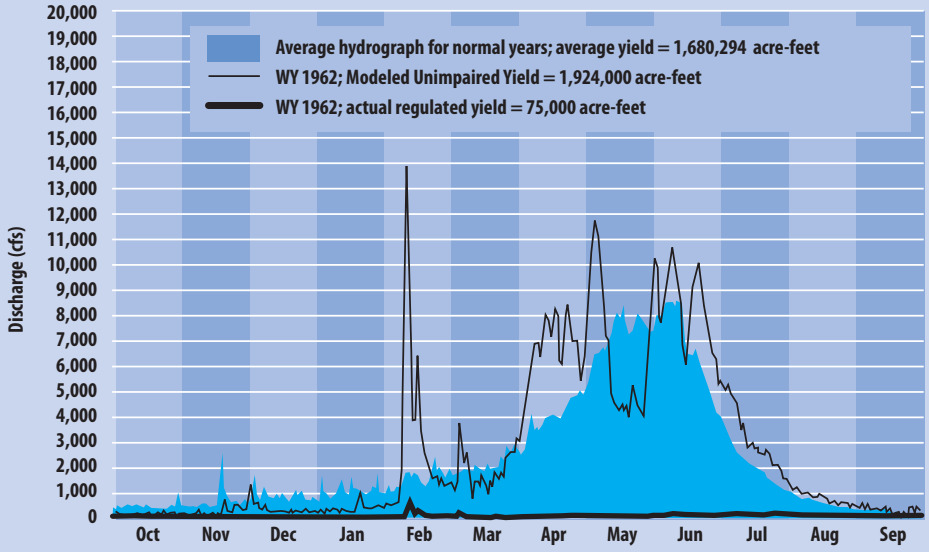
When, Not If

GARY BOBKER
THE BAY INSTITUTE

There was a time when the San Joaquin River dominated the southern half of the San Joaquin Valley and was a major contributor of inflow to the Delta. It is now a pale shadow of its former glory. Historically the main stem San Joaquin was a snowmelt driven system supporting some of the biggest salmon runs on the West Coast, up to 500,000 spring run spawners and 100,000 fall run spawners. Healthy runs persisted as late as the 1940s when Friant Dam was built. Both runs were extirpated in 1948 with the closure of the dam gates. After 1948, flow in a representative year dropped from 1.9 million acre feet to 75,000 acre feet of regulated yield. Below the confluence with the Merced, most of the water in the San Joaquin is agricultural drainage. The river's loss of assimilative capacity aggravates water quality issues—salt, boron, and dissolved oxygen.

In 1988, the Natural Resources Defense Council, the Bay Institute, and other groups filed suit to restore the San Joaquin salmon runs, citing Fish and Game Code language requiring sufficient water passing over, around, or through a dam to maintain fish populations below the dam. The courts have rejected claims that the state's liability to meet the Code requirements has been extinguished. After the US Supreme Court declined to hear the case, the plaintiffs entered settlement talks with Friant. These ended without agreement and the parties returned to court. Subsequent rulings held that the operation of Friant Dam violates the state Fish and Game Code and the Endangered Species Act. As this report went to press, the Judge was deciding whether to adopt a settlement or proceed to trial.

SAN JOAQUIN RIVER FLOWS WERE FLATLINED



Peter Moyle at UC Davis and Matt Kondolf at UC Berkeley have made a set of recommendations for restoring the San Joaquin that recognize that pristine conditions will not be reestablished and consumptive use of most of the river's water will continue. These include base flows of 350 cubic feet per second for most of the year with higher spring and fall pulses. The result, 15-20 percent of unimpaired runoff, would be comparable to current flows on the Merced, Tuolomne, and Stanislaus. Impact on Friant's customers could be addressed through groundwater banking and other strategies. Moyle and Kondolf also recommend some modifications to channels, levees, and fish ladders.

We're not going to get the old river back. But we're at a tipping point, and the thinking has changed. If the river is wet, fish will want to recolonize it. We are going to have people fishing, hiking, and canoeing on a restored San Joaquin.

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TAKE HOME POINTS

Strategies for replacing some of the water now diverted from the river include:

- **Implementing groundwater banking and conjunctive use**
- **Re-operating Friant and other reservoirs**
- **Using market transfers, including long-term, dry year options**
- **Increasing water use efficiency**
- **Recapturing water downstream of Friant Dam**
- **Expanding existing surface storage**
- **Building new surface storage**

Re-inventing the Delta: a Call for a New Vision

MARCI COGLIANESE
FORMER MAYOR OF RIO VISTA

Only five years after the CALFED Record of Decision was signed, key stakeholders in the water and environmental communities are calling for another new vision for the Delta, one that will endure. Assuming that it is possible to design and implement a long-term plan for an ecosystem as complex and dynamic as the Delta's, how shall we arrive at a durable new vision for the future?

Water, agriculture, recreation, and the environment, traditionally identified as key Delta interests, are well-represented in the statewide debate about the Delta's future and would all be expected to be a critical part of the new vision. But where do the dozens of Delta-area special districts, cities, and counties, along with local landowners, fit into the process? Not traditionally engaged as stakeholders, Delta-area local governments in six counties are making land use decisions without a common vision and without recognition of the potential impact to unique resources of statewide importance.

The Secondary Zone of the Delta, as defined in the 1992 Delta Protection Act, is urbanizing in response to the same growth and development pressures being experienced throughout the state. At one time largely undeveloped, it has served as the buffer between urban development and the essential resources of the Delta's Primary Zone. But since 1993, local governments have approved development on over 44,000 acres in the Secondary Zone, resulting in 94,000 new residential units (including thousands of new houses behind levees), and thousands of square feet of industrial, commercial, and retail space. Between 1990 and 2002 an additional 12,000 acres of Secondary Zone farmland (including 8,000 acres designated "prime") were converted to an urban land use designation.

When all currently approved development is built out, urban land uses in the Secondary Zone will have doubled, expanding from one-quarter of the zone's total acreage in 1993 to one-half. With the diminishing ability of the Secondary Zone to serve as a buffer, the Primary Zone will experience increasing "edge" conflicts along its ag-habitat-urban fringes, further threatening the delicate balances of a fragile ecosystem and impacting the continued viability of Delta agriculture.

Science has an important role to play in researching and illuminating the impacts of urban development upon Delta resources. Without scientific data, the politically charged issue of land use in and around the Delta cannot be successfully addressed nor can a durable new vision for the future be achieved. Delta local governments are necessary stakeholders in the visioning process.

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TAKE HOME POINTS

- **The Delta is no longer the remote, sparsely populated backwater it was 10 years ago when CALFED began. Urbanization is accelerating, fed by the need to house the state's burgeoning population.**
- **The Delta is a critical crossroads between the Bay Area and the Central Valley.**
- **Every day a "Tower of Babel" of government agencies influences the Delta without a shared vision or understanding of the Delta's problems.**
- **The time is ripe for a broader examination of all state policies affecting the Delta.**
- **We need a serious discussion of state and local growth policies such as permitting development behind levees and on floodplains.**
- **The fundamental problem with the Delta is that state government is not supplying the leadership needed to deal with hard problems. The six counties in the Delta have fallen through the cracks.**
- **The Delta needs a unifying force to bring us together. It is a region without a leader, without leadership.**
- **As the governor tries to refocus CALFED, I urge him to think broadly and bring local governments, state legislators, and scientists together with water interests.**
- **Solutions cannot be imposed on the Delta. They must be supported from within to be sustainable.**

Where Do We Go from Here?

WILL TRAVIS
SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION

Despite our progress in saving and restoring the Bay, we need to make a renewed commitment to continue these efforts in a language most people understand—economics. At a recent dinner I attended of the Bay Area Council—a coalition of the biggest employers in the region—there was no mention of the word "environment" except in the context of the "business environment." Nor was there any mention of the word "Bay"—except as in "Bay Area."

I wondered how the folks at the dinner could just ignore the Bay. Then I realized that it isn't so much that they have forgotten the Bay; it is that we spend all our time talking to ourselves. We insist in speaking in science—a language few people understand. As a result, we are marginalizing ourselves out of the regional political debate. It is inevitable that our region's population will grow by about a million people over the next 15 years. Those of us who are concerned about the Bay need to fully engage in the political process of deciding where these one million new residents will live and work, how to build housing they can afford, and how our new neighbors can travel from home to work to school without spending most of their lives in traffic jams. And in this political debate, we need to better explain, in economic terms, why protecting the natural environment is important to solving these other problems. Our job is to become the evangelists who put the environmental ethic into the economic equation.

Economically, the Bay is our region's most valuable resource. It is the highway for the ferries that can lace our waterfront communities together. The Bay is essential to our flourishing maritime industry. The Bay is the equivalent of a national park in our front yard where we can sail, swim, fish, kayak, and play. And it is essential to our tourist industry.

> "The decision to save the Bay in 1965 laid the foundation for the economic prosperity our region has enjoyed over the past four decades. The Bay is probably the best fringe benefit Bay Area employers can offer—the equivalent of a national park in our front yards where we can sail, swim, fish, kayak, and play."

The Bay is the heart, soul, and visual icon that gives our region its name, its unique quality, and its identity as a truly special place. The decision to save the Bay in 1965 laid the foundation for the economic prosperity our region has enjoyed over the past four decades. The Bay Area depends on bright, well-educated, innovative workers to make our economy hum. In competing with other regions for these workers our employers don't pay appreciably higher salaries even though the workers face outrageous housing costs, have to endure terrible traffic congestion, and have to tolerate so-so public schools.

Yet the workers continue to move here and stay here because it is a terrific place to live. It has a sensational quality of life, a lot of which comes from the abundant, beautiful, and healthy natural resources we environmentalists work so hard to protect. We are providing the best fringe benefit Bay Area employers can offer. We may not be able to charge them for it. But we can remind them how much it is worth.

TAKE HOME POINTS

- **We need to fully engage in the political process and explain how protecting the Bay-Delta environment is critical in making decisions about where new California residents will live, and how they will commute. We need to join groups like the Greenbelt Alliance in advocating for infill development and drawing the line on places where we simply cannot develop.**
- **We need to better explain, in economic terms, why protecting the natural environment is important to solving problems like traffic and housing. Otherwise, those concerned purely with economic issues are more likely to advance their campaigns than we are.**