AUGUST 2, 2011
FIFTH STAFF DRAFT DELTA PLAN

This is the fifth of five (5) staff draft versions of the Delta Plan that will be presented to the Delta Stewardship Council prior to the release of the Draft Environmental Impact Report (EIR) in August 2011. Two additional staff drafts will be released following the public comment period on the Draft EIR. The staff draft versions will be released in the following order:

- **February 2011:** First Staff Draft Delta Plan was posted on February 14, 2011 and discussed at Delta Stewardship Council meetings on February 24 and 25, 2011 and March 10 and 11, 2011.
- **March 2011:** Second Staff Draft Delta Plan was posted on March 18, 2011 and discussed at Delta Stewardship Council meetings on March 24 and 25, 2011 and April 14 and 15, 2011.
- **April 2011:** Third Staff Draft Delta Plan was posted on April 22, 2011 and discussed at Delta Stewardship Council meetings on April 28 and 29, 2011 and May 12 and 13, 2011.
- **June 2011:** Fourth Staff Draft Delta Plan was posted on June 13, 2011 and will be discussed at Delta Stewardship Council meetings on June 16, 23, and 24.
- **August 2011:** Fifth Staff Draft Delta Plan posted (includes policies and recommendations to be analyzed in the Draft EIR).
- **Late August 2011:** Draft EIR is circulated with Fifth Staff Draft Delta Plan.
- **November 2011:** Sixth Staff Draft Delta Plan.
- **December 2011:** Seventh Staff Draft Delta Plan to be considered for adoption with Final EIR.

After circulation of the Draft EIR, comments obtained on the Draft Delta Plan and Draft EIR will be considered. Delta Stewardship Council staff will prepare written responses to comments received on the Draft EIR; those responses will become part of the Final EIR. The Delta Plan will be finalized in light of the comments and Final EIR. By December 2011, the Delta Stewardship Council will consider the Final EIR for certification under CEQA, and then consider the final Delta Plan for adoption.

At each stage of the development of the Staff Draft Delta Plan there will be public meetings at the Delta Stewardship Council meetings for the purpose of receiving information and comments and for Delta Stewardship Council deliberation. All Delta Stewardship Council meetings are public and simulcast on the Delta Stewardship Council website at www.deltacouncil.ca.gov.

In addition, public comments are welcome during the entire process and will become a formal part of the record. The Delta Stewardship Council encourages written public comments to be submitted to deltaplancomment@deltacouncil.ca.gov. **All comments received by Friday, September 30, 2011**, will be considered for revisions made in developing the Sixth Staff Draft Delta Plan. All comments received are posted to the Delta Stewardship Council web site: http://www.deltacouncil.ca.gov.

RELEVANT POINTS TO THE AUGUST 2, 2011 FIFTH STAFF DRAFT DELTA PLAN

- Some graphics remain under development and are not included in the Fifth Staff Draft Delta Plan.
- Technical editing of all information in the Staff Draft Delta Plan versions, including fact-checking, grammatical, and style changes, and inclusion of additional citations and references will be ongoing.
- A comparison table of the policies and recommendations contained in the Fifth Staff Draft Delta Plan compared to the Fourth Staff Draft Delta Plan will be posted separately.
- A comment matrix with comments on Fourth Staff Draft Delta Plan received by June 24, 2011 will be posted separately to indicate that the comments were incorporated into the Fifth Staff Draft Delta Plan.

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Contents: Delta Plan Policies and Recommendations

First character pair indicates the subject and typically the corresponding chapter title of the policy or recommendation (e.g. WR, ER.) Second character pair indicates policy or recommendation and sequential identification number within the Delta Plan chapter. "P" indicates regulatory policy (e.g. P1, P2.) "R" indicates recommendation (e.g. R1, R2.)

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Preface

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Preface

Achieving the Coequal Goals: A Worthy Challenge

California is a land of great abundance and great variability, and its residents have been arguing about water resources for at least as long as they have been part of the United States.

Californians also have a long history of solving problems. When local water resources were deemed inadequate, local agencies and later the federal and State governments helped to bring water from areas of seeming abundance. To counter nature's variability, we built dams to store water to help manage floods, and we built an intricate system of canals to convey irrigation and drinking water throughout the year with greater reliability. In the process, we created great agricultural and manufacturing economies, and some of the world's great cities.

Only lately—in the last 30 or 40 years—have Californians insisted that our actions be harmonious with our environment. Reaching this point has engendered great debate, especially over the resources provided by the unique delta formed by the confluence of the state's two largest rivers, the Sacramento and the San Joaquin.

As a water source for some people and as a water conveyance system for many others, California's Delta has long been a battleground for the many competing interests that have a stake in how it is used—and abused. Yet, despite broad agreement on its problems—described for decades in countless government and academic documents, news articles, and opinion pieces—efforts in recent years have yielded only incremental progress toward a comprehensive solution. Conflict over what to do, when to do it, and how to pay for it continues to embroil the Delta in controversy.

In a rare bipartisan effort, passage of the Delta Reform Act of 2009 and companion legislation set forth groundbreaking new State policy. Foremost was the Delta Reform Act's establishment of coequal goals:

> *Coequal goals means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. (Water Code section 85054)*

Governance changes to implement the coequal goals, including the creation and empowerment of the Delta Stewardship Council to develop a legally enforceable Delta Plan, represent California's most recent attempt to fix the Delta.

Therefore, this Delta Plan seeks to achieve the coequal goals through a mix of near-term actions with equivalent focus on each of the coequal goals, and longer-term actions that help California meet goals and objectives over the course of this century. The actions must be mindful of those who live, work, and recreate in the Delta region, and must be in concert with local, regional, and other statewide efforts to ensure the state's water supply reliability. To fix the Delta, Californians must set aside regional and partisan bickering to solve problems as they have done before; threats to the current water supply and an ecosystem in decline cannot be ignored much longer. Failure to act will imperil resource availability for future generations.

The Delta Plan: What Is It?

The foundation of the Delta Reform Act was the adoption of the coequal goals and direction to the Delta Stewardship Council (Council) to adopt an enforceable Delta Plan no later than January 1, 2012 that will achieve those goals.

Accordingly, the Council presents a Delta Plan that is foundational, adaptable, practical, and enforceable.

Foundational: The 2012 Delta Plan is a historic effort to address intertwined challenges and establish foundational actions for Delta management throughout this century. It lays the groundwork for near-term actions for improvement and focuses on the immediate avoidance of further harm or increased risk to the Delta. The Plan shines a spotlight on urgently needed Delta habitat projects and the significant potential for local and regional water supply development. Similarly, the Plan seeks to immediately halt practices known to be detrimental to the sustainability of the Delta's many functions and services.

Adaptable: The Delta Plan is intended to be adaptable over time. It will build on other plans and new information as it becomes available, and portions of the Plan that do not adequately meet or make progress toward stated goals over time will be refined or revised. The Plan will be updated at least every 5 years.

Practical: The Delta Plan aims to be practical. It does so by building on years of planning and by incorporating actions, recommendations, and strategies developed by other entities—governmental and non-governmental—that have already invested countless hours on Delta issues and have specialized expertise.

Enforceable: The Delta Plan is different from other government plans because it contains a set of integrated and legally enforceable regulatory policies that apply to certain proposed plans, programs, and projects by local and state agencies known as "covered actions." The Delta Reform Act requires State or local agencies that propose to undertake covered actions to certify with the Council, before acting, that their proposed plans, programs, or projects are consistent with the Delta Plan. If anyone appeals the certification within 30 days, the Council will determine whether the covered action is indeed consistent with the Delta Plan.

It is inevitable that this Delta Plan will generate controversy. This Delta Plan draws upon existing State and federal laws and policies and ongoing programs to chart a course to achieve the coequal goals. The Council is one of many agencies with an interest in the Delta. The Council was not granted unlimited authority over actions related to water supply and the environment. However, specific and targeted authority and actions were included by the Delta Reform Act; these form the basis for the Delta Plan.

Shifting Focus from Treating Symptoms to Treating Problems

For decades in California, government has worked to treat symptoms of natural resource issues. Dozens of agencies, task forces, and working groups have been created in a string of efforts to find the right combination of bureaucracy and leadership to provide clean, reliable water; prevent harmful water use practices; and protect our environment. Fortunately, it is easy to find examples of success in each category, and we have models upon which to build. However, despite the many positive efforts underway, much work remains to be done. We must focus our efforts and expedite a transition into a new era of managing water in a way that protects the environment and provides reasonable assurances of reliability for users.

Despite the cheerful optimism of past governance efforts to assert that when it comes to matter of the Delta "we can all get better together," the Council has reached another conclusion. True effort to achieve the coequal goals will in fact bring tradeoffs that will be neither popular nor clear-cut.

Many of these actions necessary to treat the problems in the Delta have been known and discussed for decades. The Delta Plan focuses on actions to:

- Improve Water Supply Reliability and Reduce Reliance on the Delta
- Restore the Delta Ecosystem
- Reduce Risk

It is time to make tough decisions and take action. Failure to do so means failure to achieve the coequal goals.

Improve Water Supply Reliability and Reduce Reliance on the Delta

The Delta Plan establishes that water supply reliability does not mean "as much water as you want, whenever you want, forever." Water supply reliability means the expansion and more efficient management of California's water resources so that the Californians can more predictably match their water use to the amount of water available.

The reliability of water exports from the Delta watershed should not be assessed based on current contract amounts. Instead, reliability should be a range of expected diversion amounts based upon annual precipitation and dictated by the ecosystem's safe yield, as determined by science and by our infrastructure's capacity to manage wet year and dry year flows. The expectation that each year—wet, dry, or average—should yield the same quantity of water exported from the Delta watershed is unrealistic, contrary to the coequal goals, and creates false expectations among those who desire the water.

The Delta Plan recognizes that Delta water deliveries can be made more reliable only through significant ecosystem and infrastructure investments. Making progress with the state's decision making for Delta water flow objectives, ecosystem restoration, and improving Delta conveyance is a priority.

Reduced reliance on the Delta can be achieved by those who rely on Delta exports through a variety of methods:

- Enhanced conservation and water efficiency

- Development of additional local and regional water supplies such as water recycling, groundwater, stormwater capture, advanced treatment of usable water sources, and surface storage
- New water storage and conveyance improvements that are integrated with and increase management flexibility to local, regional, and statewide water supplies

Over the years, California has passed numerous progressive water management laws. A core tenet of the Delta Plan is that full implementation of these existing laws is the first step toward improving statewide water supply reliability. Responsible water planning is occurring throughout the state in urban and rural areas. These water planning efforts must be celebrated and expanded. Suppliers who rely upon water from the Delta must also demonstrate that they are using available resources and tools to reduce their reliance on the Delta. Restructuring the pricing of these water supplies where needed so that end-users make the most efficient use of California's water resources should become the norm.

Restore the Delta Ecosystem

The Delta Plan does not pretend that the Delta ecosystem will be restored to its pre-settlement state. An expansive system of water diversion and storage infrastructure has permanently altered the watershed and natural hydrograph. Hundreds of thousands of acres of habitat have been destroyed. To the extent possible, we now must work to operate our water infrastructure in a way that mimics a more natural hydrograph. If modified operations and future new flow standards are to effectively support species, we must start immediately with high-priority habitat restoration projects, land use planning that ensures that future ecosystem restoration and floodplain expansion are not precluded, and continue to reduce the impacts of other actions that stress the Delta ecosystem, such as pollution, nonnative species, and more.

Planning and analysis for alternatives to the current Delta conveyance system must be completed, and the State must proceed with determining the right approach for improved system reliability and ecosystem restoration.

Reduce Risk

A largely disconnected array of local ordinances, state policy, and federal law make flood protection in the Delta all but incomprehensible. Most federal flood protection law is based on reimbursement standards in the event of a flood, which assumes a premise that the levees will fail. The Delta Plan emphasizes the need to enforce minimum standards for flood protection for new development in the Delta. However, the Council encourages shifting toward a new approach that establishes protection levels based upon consequences and probability.

Requirements for flood protection in the Delta, overlaid with newly enforceable policies for the protection of habitat lands in the Delta Plan, make it unlikely that much new large-scale development outside of existing urban areas will occur in the Secondary Zone of the Delta.

What the Delta Plan Does Not Do

The Delta Plan does not make recommendations regarding water rights or reform of the water rights system. Although imperfections in California's dual water rights system clearly play a role in water supply reliability, this highly polarizing issue would likely yield little near-term progress toward reaching California's water management goals. However, the existing system of water rights complicates California's ability to manage our water supplies as a fully integrated system. Lacking information about water rights quantities and usage further limits how effective the state and regional water managers can be when attempting to deliver supplies reliably. In the Delta Reform Act the Legislature gave the Council specific authority that did not include the ability to regulate those who exclusively use water upstream of

the Delta. Although these users clearly influence the system, the Delta Plan's policies are only recommendations for these upstream users.

The Delta Plan does not establish targets for additional water conservation beyond existing state law and the 2020 deadline. It is clear that additional targets for urban conservation and agricultural water use efficiency will be necessary, but these will be addressed in future updates to the Delta Plan.

Except for the suggested development of a centralized Flood Risk Management Assessment District, the Delta Plan does not address governance reform. However, future Plan updates are likely to explore the topic of governance reform.

Delta Plan Chapter Summaries

The Delta Plan has a long-term scope. It is intended to serve as California's guiding policy document for the next 88 years, with frequent updates. The Delta Plan's chapters are organized around findings, supporting information, problem statements, and regulations and recommendations aimed at achieving the coequal goals and other objectives. Here are the highlights:

- **Science and Adaptive Management for a Changing Delta (Chapter 2)** describes the importance of science in achieving the coequal goals and the role of adaptive management.
- **Governance: Implementation of the Delta Plan (Chapter 3)** tells readers how to use the Delta Plan, and explains the authority of the Council (G P1).
- **Improves Water Supply Reliability (Chapter 4)** through statewide implementation by urban and agricultural water agencies of existing water planning and conservation laws along with expansion of water supply reliability elements that prepare for potential catastrophic interruption of Delta exports and implement local and regional water supply projects and rate structures that reduce reliance on the Delta in meeting California's future water supplies (WR P1). Other key recommendations include:
  - Improve the state's groundwater management (WR R8, WR R9, WR R10)
  - Support the timely development and implementation of new, updated flow objectives for the Delta and the completion of the Bay Delta Conservation Plan to improve the reliability of water exports from the Delta (ER P1, ER R8)
  - Identify near-term surface and groundwater storage, conveyance improvements and enhanced opportunities for water transfers that can be implemented in the next to 10 years while the Surface Water Storage Investigations, Bay Delta Conservation Plan, and other on-going Delta storage, conveyance, flood control, and ecosystem habitat evaluations are being completed (WR R6, WR R7)
  - Promote coordinated implementation of a statewide integrated database that will provide the basis for tracking and evaluating the State's progress in improving statewide water supply reliability (WR R11)
  - Condition contracts and transfer agreements using Delta water upon compliance with the State's water planning, conservation, and reporting policies (WR R12)
- **Restores the Delta Ecosystem (Chapter 5)** by ensuring that Delta habitat restoration projects comply with the multiagency Ecosystem Restoration Program's Conservation Strategy, and that other actions taken in the Delta do not preclude opportunities for future habitat restoration and

floodplain expansion nor increase stressors on the Delta (ER P2, ER P3, ER P5). Other key recommendations include:

- Develop, implement, and enforce new, updated flow objectives for the Delta (by 2014) and high-priority tributaries in the Delta watershed (by 2018) that are necessary to achieve coequal goals by (ER P1)
- Implement habitat restoration projects in priority areas of the Delta (ER R1)
- Reduce stressor impacts on the Delta ecosystem (ER R7, ER R6)
- Complete Bay Delta Conservation Planning process by 2014 (ER R8)
- Secure appropriate exemption for Delta levees from levee vegetation policies (ER R4)
- Coordinate large-scale ecosystem restoration planning through the Delta Conservancy (ER R2)

♦ **Improves Water Quality (Chapter 6)** by promoting and coordinating completion of core State policies, regulations, and projects. Key recommendations include:

- Complete Central Valley Drinking Water Policy by 2013 (WQ R1)
- Complete North Bay Aqueduct Alternative Intake Project as soon as possible (WQ R2)
- Complete regulatory processes setting water quality objectives for nutrients, salts, pesticides, selenium, and methylmercury (WQ R6), and promote programs that reduce contaminant loads to the Delta (WQ R5, WQ R8, WQ R9)
- Develop and implement a coordinated Delta Regional Monitoring Program for water quality (WQ R7)

♦ **Reduces Risks in the Delta (Chapter 7)** by preventing encroachment or diminishment of floodways, requiring compliance with minimum flood protection standards, and requesting an expansion in the scope of the "Framework for Department of Water Resources' Investments in Integrated Flood Management" to guide State investments for levee operation, maintenance, and improvement (RR P1, RR P2, RR P3, RR P4). Other key recommendations include:

- Promote emergency preparedness in the Delta (RR R6), including the creation of a Delta Flood Risk Assessment District that will provide local authority to sustainably fund and implement a regional plan of flood management, levee inspections, risk assessments, and coordinated emergency response (RR R10)
- Complete studies on the San Joaquin River to reduce potential flooding near Paradise Cut (RR R1)
- Promote appropriate dredging in the Sacramento River Deep Water Ship Channel and the Stockton Deep Water Ship Channel and other waterways, as appropriate (RR R2)
- Develop criteria for future setback levees in the Delta and Delta watershed and require inclusion of adequate area to accommodate setback levees (RR R4)
- Promote flood management policies that reduce subsidence (RR R11) and encourage upstream flood control management procedures (RR R12),
- Seek legislation to provide specific immunity for public safety flood protection activities (RR R8) and require adequate level of flood insurance in flood-prone areas (RR R9)

- **Promotes Delta as Place (Chapter 8)** by recommending elements to be included in the Economic Sustainability Plan (DP R1) and supporting designation of the Delta and Suisun Marsh as a National Heritage Area (DP R2)

- **Identifies Funding Options (Chapter 9),** including allocation of existing bond funds (Propositions 1E and 84) to support core flood management, risk reduction and habitat restoration recommendations (FP R2, FP R3, FP R4, FP R8), approval of fees for public utilities with infrastructure in the Delta to invest in flood protection (FP R1), and creation of user fees, stressor fees, and/or a public goods charge or other broad-based user fee for water to support the coequal goals and the Delta Plan (FP R6, FP R11). Other key recommendations include:

  - Seek legislation to clarify assessment authority for local water agencies, and specifically amend AB 3030 and SB 1938 to allow local agencies to assess fees for groundwater management under Proposition 218 (FP R7)

  - Develop incentives and sources of revenue through carbon offsets (FP R9)

  - Encourage preparation of infrastructure assessments to identify priority State investments in water supply, ecosystem restoration, and flood management and levee operation infrastructure (FP R5, FP R13).

Moving Forward

The Delta poses one of the most complicated environmental and natural resource issues of the modern era. The unmatched challenge of balancing the coequal goals in the context of such a highly altered landscape amid complex multi-generation debates over water supplies for people, industry, and the environment will require unprecedented effort, creativity, and compromise.

Foundational problems manifested as ecosystem decline, water supply uncertainty, and dire flood risks have brought the Delta to an unacceptable level of risk. Climate change will bring rising sea levels and increasingly unpredictable precipitation patterns in the coming century. More unpredictably, a levee-damaging earthquake could strike at any time. For the State of California, and the people who live in and rely upon the Delta, the risks are intolerably high and must be addressed.

The Council believes that the State must move immediately on near-term actions to improve water system reliability, and must concurrently improve and protect the Delta ecosystem. Threats to the current water supply and ecosystem are severe, and we cannot afford wait for “the perfect solution” to every problem. Longer-term solutions, such as large storage or conveyance projects, may be more than a decade away from implementation.

Water legislation passed in 2009 marked a paradigm shift for water management in California, and the Council, through this Delta Plan, now has the responsibility for charting the course through the remainder of the century. Achieving the coequal goals and various objectives of the Delta Reform Act will take many years of focused and purposeful work. Projects will be built, future plans will be implemented, and knowledge will expand and change. Undoubtedly, the future will bring challenges and trade-offs, some of which are not yet apparent. The Delta Plan will therefore be a living document that will adapt along with the system it seeks to manage.

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Chapter 1
The Delta Plan

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The Delta Plan

The Delta Stewardship Council (Council) was established as an independent State agency by the Sacramento–San Joaquin Delta Reform Act of 2009 (Delta Reform Act).

The Council's primary responsibility is to develop, adopt, and implement by January 1, 2012, a legally enforceable, comprehensive, long-term management plan for the Sacramento–San Joaquin Delta and the Suisun Marsh—the Delta Plan—that achieves the coequal goals. "Coequal goals means the two goals of providing a more reliable water supply for California and protecting, restoring and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource and agricultural values of the Delta as an evolving place" (Water Code section 85054).

Achieving the coequal goals is the primary and fundamental purpose of the Delta Plan. Additionally, the Delta Reform Act states that the policy of the State is "to achieve the following objectives as inherent in the coequal goals for the management of the Delta:

> *(a) Manage the Delta's water and environmental resources and the water resources of the state over the long term.*
>
> *(b) Protect and enhance the unique cultural, recreational, and agricultural values of the California Delta as an evolving place.*
>
> *(c) Restore the Delta ecosystem, including its fisheries and wildlife, as the heart of a healthy estuary and wetland ecosystem.*
>
> *(d) Promote statewide water conservation, water use efficiency, and sustainable water use.*
>
> *(e) Improve water quality to protect human health and the environment consistent with achieving water quality objectives in the Delta.*
>
> *(f) Improve the water conveyance system and expand statewide water storage.*
>
> *(g) Reduce risks to people, property, and state interests in the Delta by effective emergency preparedness, appropriate land uses, and investments in flood protection.*
>
> *(h) Establish a new governance structure with the authority, responsibility, accountability, scientific support, and adequate and secure funding to achieve these objectives"* (Water Code section 85020 et. seq.) .

These core objectives form the foundation of the Delta Plan's policies and recommendations, which recognize the importance of science and a commitment to adaptive management for a changing Delta. This overall framework will be supported by a proposed Finance Plan to be implemented with legislative action.

Under the Delta Reform Act, it is now State policy to reduce reliance on the Delta to meet California's future water supply needs. Although the Delta will remain an important part of California's statewide water supply, the Legislature has recognized the great potential for developing water supplies that reduce negative impacts to the Delta ecosystem and provide greater supply reliability to California's farms, homes, and businesses. The Delta Reform Act specifically calls for reducing "reliance on the Delta through a statewide strategy of investing in improved regional supplies, conservation, and water use efficiency. Each region that depends on the water from the Delta watershed shall improve its regional self-reliance for water through investment in water use efficiency, water recycling, advanced water technologies, local and regional water supply projects, and improved regional coordination of local and regional water supply efforts" (Water Code section 85021).

The Delta Plan builds on existing law and state and federal policy for improved water planning, such as the preparation of Urban Water Management Plans, Agricultural Water Management Plans, Groundwater Management Plans, and Integrated Regional Water Management Plans, and on pending State and local actions such as flood management and emergency response planning. The Delta Plan attempts to integrate with the diverse efforts of State and local agencies while being responsive to the mandates of Delta Reform Act, which requires linked actions to achieve a more reliable water supply while retaining regional flexibility and reducing overall reliance on the Delta. In this way, the 2012 Delta Plan promotes expedited statewide actions and investments while encouraging the actions of California's local agencies, which are vital to achieving water supply reliability and a protected and improved Delta ecosystem—all in a manner that respects the unique character of the Delta as evolving place.

The Council considered a broad geographic scope in development of the Delta Plan, encompassing the Delta and Suisun Marsh, the Delta watershed, and areas of the state that use water exported from the Delta watershed, as shown in Figure 1-1. Actions in these areas may significantly impact the Council's ability to achieve the coequal goals. The primary area considered is the legal Delta and Suisun Marsh, shown in Figure 1-2. The Council's authority over actions these areas is discussed in Chapter 3.

Context for the Delta Plan

In California, water is an exceedingly complex topic. The Delta, the "switchyards" of freshwater for millions of Californians and millions of acres of irrigated agriculture, is at the very heart of that complexity. The Delta is important in countless ways to many different people and species. The 1,300-square-mile mosaic of water channels and levee-protected islands between the San Francisco Bay Area and the Central Valley provides critical economic and environmental functions and services upon which much of our state depends.

- The 45,600-square-mile Delta watershed provides all or a portion of surface water or groundwater supplies to more than 96 percent of residents in California (based on population estimates by city and county, Department of Finance 2011).
- Approximately 14 percent of the state's water supply is exported through the Delta (DWR 2009).
- The Delta and Suisun Marsh support more than 55 known fish species and more than 750 plant and wildlife species. Of these species, approximately 100 wildlife species, 140 plant species, and 13 taxonomic units of fish are considered special-status species and are afforded some form of legal or regulatory protection (CNDDB 2010, USFWS 2010, CNPS 2010).
- The Delta and Suisun Marsh is home to more than a half million residents living in dozens of communities, including portions of 17 incorporated cities such as Stockton and Sacramento, and supports over 146,000 jobs (DPC 2010).

- Approximately 57 percent of the Delta and Suisun Marsh, over 480,000 acres of agricultural land, currently supports a highly productive agricultural industry that is valued at hundreds of millions of dollars annually (DWR 2007a, DWR 2007b, DOC 2008, DPC 2010).
- The Delta and Suisun Marsh levees and lands support interstate and state highways and railroad tracks that support intrastate and interstate California traffic, more than 500 miles of major electrical transmission lines, 60 substations, and over 400 miles of major natural gas pipelines that provide energy throughout Northern California, and critical pipelines that provide transportation fuels from Sacramento to airports and other fuel depots throughout the San Francisco Bay Area. (DPC 2010, DWR 2009).
- The Delta and Suisun Marsh have more than 1,335 miles of levees that protect over 800,000 acres of land and which play a role in protecting the freshness of water supplies conveyed through the Delta.
- The Delta experiences over 6 million visitor days annually from those who recreate in the form of boating (DBW 2002).[1] Fishing, hunting, birdwatching, and camping draw even more visitors to the area.

The Delta serves as the hub of California's two largest water distribution systems: the Central Valley Project (CVP), operated by the United States Bureau of Reclamation (Reclamation), and the State Water Project (SWP), operated by the California Department of Water Resources (DWR). In the 1960s, both projects began operations to divert water from the Delta and deliver supplies to two-thirds of California's population and millions of acres of irrigated farmland. Water for the projects is stored in a network of federal and state reservoirs upstream of the Delta and transported through the San Joaquin and Sacramento rivers to pumping facilities in the southern Delta.

A Legacy of Delta Ecosystem Deterioration

Ecosystem deterioration in the Delta is not a recent phenomenon; it is the collective consequence of over a century of failed natural resource policy, complicated by inconclusive scientific information, land-use patterns, and intense competition over water supplies.

Regarding matters of the Delta, the media tends to report on water supply shortages, droughts, flood risk, and the decline of fisheries. While notable and consequential, these events are all symptoms of a greater resource problem. Not unlike other policy areas, when it comes to natural resource issues, California has long attempted to manage symptoms rather than treating core problems. For example, when flooding occurred as a result of hydraulic mining practices over a century ago, California's response was to construct narrow flood channels with high levees on either side to create a velocity high enough to wash out mining debris. In doing so, we did away with 90 percent of the state's riparian habitat. This massive-scale destruction has had lasting consequences for ecosystem health, and in turn, declining ecosystem health has had direct consequences for water supply operations. As another example of symptom treatment, in the late 1800s the federal government incentivized the "reclamation" of "nuisance" swampland to reduce threats of vector-borne disease and to gain productive land for farming, only to effectively destroy most of California's wetlands, again with lasting environmental impacts. Many of our previous attempts to address symptoms have merely compounded the core resource problem.

Within the Delta, seasonally and tidally flooded land impeding agricultural development led similarly to land reclamation and channelization, and subsequent habitat loss. Over a century ago, with little or no engineering analyses and limited construction tools, Delta residents began to build an intricate levee system to channel water and reclaim land, which converted hundreds of thousands of acres of seasonally

[1] The Sacramento–San Joaquin Delta Boating Needs Assessment estimated 6.4 million annual boating-related visitor days and 2.13 million boating trips to the Delta in 2000 (DBW 2002).

Figure 1-1
Delta Plan Study Area

The primary area addressed in the Delta Plan is the legal Delta and Suisun Marsh. Implementation of the Delta Plan may also affect other areas of California, including the Delta watershed area (shown including the Trinity River watershed), and areas outside the Delta in which exported water is used.

and tidally flooded wetlands into fertile agricultural land. By 1930, over 441,000 acres of the historical Delta were leveed and drained for agriculture (Lund et al. 2010). Today, as a result of continued land use change and urbanization, 95 percent of the historical tidal marsh in the Delta has been lost. Riparian habitat has also been extensively eliminated.

In the twentieth century came the era of large water projects, dams, and canals to store and convey water to cities and farms and to protect against flood flows. The largest of these projects, the CVP and SWP, were designed and built to operate in the Sacramento–San Joaquin Delta estuary, which is used today to convey water supplies to pumping plants in the south Delta to provide irrigation and drinking water to the drier south. This system is unique, because it is unusual to use an estuary—which is normally subject to variable flows dictated by the tidal cycle and by the volume and timing of its tributaries—as a highly regulated conveyance system transporting large amounts of water to meet seasonal demands.

While supporting one of the world's most complex and least-understood aquatic ecosystems, the Delta has been forced into the role of reconciling three major water imbalances:

- Seasonal snow and rain fall in the winter, but water demand is higher in the summer.
- Snow and rain fall in the north, but demand for water is greater in the south.
- Volatile climatic patterns cause periods of peak flows and prolonged drought.

From 1987 to 1992, a 6-year drought drastically reduced water deliveries, negatively affected water quality, and began a startling trend of fisheries decline that continues today. Two fish species unique to the Delta—the delta smelt and winter-run Chinook salmon—were recognized as being at-risk, and their long-term survival remains in question and the subject of ongoing regulation and litigation.

The Advent of Uncertainty: California's Water Supply Reliability

Myriad factors currently threaten California's water supply reliability. Some are unique to the Delta, but others apply statewide. Levee stability, variable precipitation and long-term climate change, regulatory changes, and litigation are among the largest factors affecting the reliability of supplies conveyed through the Delta.

Delta levees have been characterized as "the hardest-working levees in the world" because most of them hold back water 24 hours a day, 365 days per year as they protect subsided land many feet below sea level. Levees in other parts of the nation and world hold back water during flood-stage events only. In most of the world, Delta levees would be classified as dikes or dams. Consequently, the Delta, its residents, and the freshwater supply conveyed through the Delta face a constant threat of flooding. An earthquake could severely damage Delta levees, causing islands to flood and saltwater to inundate Delta water supplies for 6 to 36 months, resulting in severe economic impacts and threatening health and safety for regions dependent on water supplies conveyed through the Delta.

Precipitation in California can be characterized as volatile, and this volatility is expected to increase in the future. Climate change is expected to affect California's water supply in several ways:

- Precipitation and runoff patterns are changing.
- Natural snow pack storage in the Sierra Nevada mountain range is declining and expected to continue this trend.
- Sea level is rising, threatening aquifers and Delta water supplies.
- Extreme climatic events, such as droughts, will become more frequent.

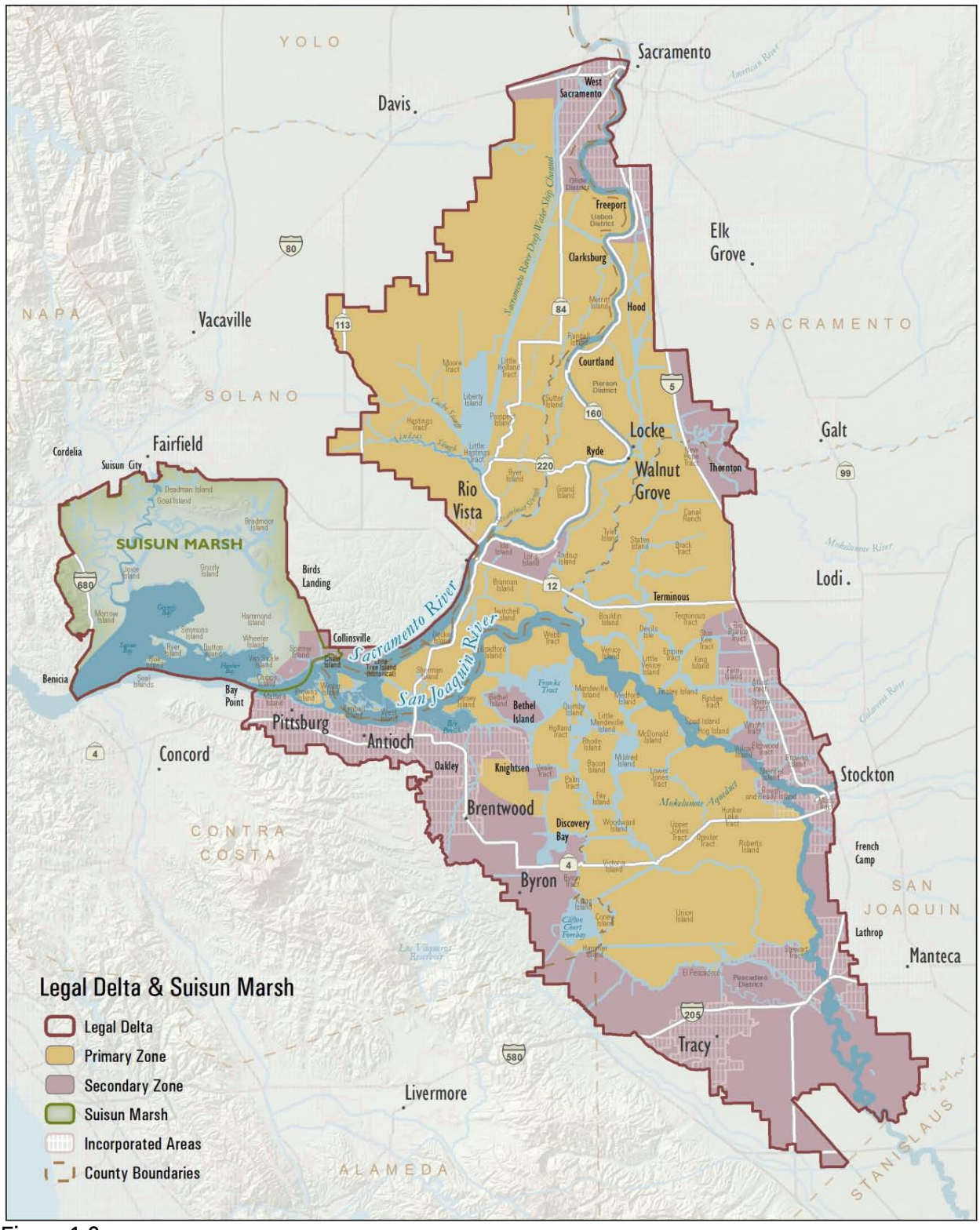

Figure 1-2
Legal Delta and Suisun Marsh
The legal Delta is defined by Water Code section 12220. The Suisun Marsh is defined by Public Resources Code section 29101 and protected by Division 19, commencing with Section 29000).

Uncertain Long-term Water Project Operations and Effects on Delta Species

Consultation Requirements

Section 7 of the federal Endangered Species Act requires any federal agency proposing to authorize, fund, or carry out an action that may affect listed species or their designated critical habitat to consult with the National Marine Fisheries Service (NMFS) for marine and anadromous species, or the United States Fish and Wildlife Service (USFWS) for freshwater and wildlife species. Typically, the federal agency taking the action prepares a biological assessment to determine whether the proposed action is likely to adversely affect listed species or designated critical habitat. The NMFS and/or USFWS will evaluate the biological assessment and other information to determine whether the federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. If jeopardy or adverse modification is found, NMFS's or USFWS's biological opinion (BiOp) will suggest reasonable and prudent alternatives (RPA) that the agency or applicant could take to avoid jeopardy or adverse modification. If the agency or applicant agrees with these, NMFS and/or USFWS will issue an incidental take statement, which exempts the take of the listed species from certain ESA provisions. However, if the agency or applicant cannot agree, the applicant risks violating the ESA if it proceeds with the project as proposed.

Biological Opinions on Long-term Operations

NMFS and USFWS recently reviewed the long-term operations of the CVP and SWP and published their findings in two separate biological opinions. In both documents, continued long-term water operations were determined to jeopardize the continued existence of listed species in the Delta:

- On December 15, 2008, USFWS issued a BiOp on the Long-Term Operational Criteria and Plan (OCAP) for coordination of the CVP and SWP. The RPA applies to delta smelt and focuses primarily on managing flow regimes to reduce entrainment of delta smelt, the extent of suitable water conditions in the Delta, and on habitat restoration.
- On June 4, 2009, NMFS issued its Biological and Conference Opinion on the OCAP, which provides RPA actions to protect winter-run and spring-run Chinook salmon, Central Valley steelhead, green sturgeon, and killer whales from water project effects in the Delta and in upstream areas. The RPA addresses actions related to flow and temperature management, gravel augmentation, fish passage and reintroduction, gate operations and installation, fish screen funding, floodplain and habitat restoration, hatchery management, export restrictions, CVP and SWP fish collection facility modifications, adaptive management, monitoring and reporting, and others.

Ongoing Uncertainty

Both opinions are subject to ongoing litigation, which creates uncertainty about their implementation and about the reliability of water supplies from the Delta. In May 2010, federal judge Oliver Wanger found that both BiOps included actions not supported by the best available science, and that Reclamation needs to complete a NEPA analysis of the BiOps before adopting them to consider the impacts to humans and the human environment. In January 2011, Judge Wanger directed the USFWS to address the identified deficiencies in the delta smelt opinion.

These findings may alter CVP and SWP operations, and DWR and Reclamation are studying the effects and operations that would meet the BiOp requirements.

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An array of adaptive water management strategies, such as those outlined in this Delta Plan, must be implemented to better address the risk and uncertainty of changing climate patterns.

CVP and SWP water contracts also contribute to perceptions about reliability. These contracts were signed in the mid-twentieth century based on contemporaneous projections and assumptions regarding the scope of the projects and how they would operate. Originally, the State planned to divert water from several rivers on the northern coast of California, add a peripheral canal around the Delta, and add water storage south of the Delta. For a variety of reasons, some of these facilities were never built and, consequently, water contractors receive less water than what was originally contracted.

Over the years, improved understanding about water quality needs and environmental protection in the Delta launched an era of complex regulation that today governs SWP and CVP water supply operations. Litigation over a host of issues related to the CVP and SWP has created a recent spate of water management decisions guided by courtroom decisions. Incomplete understanding about how water project operations, pollution, invasive species, and other factors affect native Delta fish species has resulted in a regulatory scheme affecting water supplies that is characterized by uncertainty. Changing rules to curtail pumping and increase Delta outflow has compounded water supply uncertainty for agencies that use water from the Delta.

A History of Delta Reform Efforts

In the past 30 years, several notable events and efforts represent critical milestones in the debate over the Delta ecosystem and the management of water supplies moving through the Delta. Decades of political debates, statewide ballot measures, and many statutory and regulatory attempts to solve the Delta's problems have led us to the current situation. What follows is by no means an exhaustive history, but an attempt to provide contemporary context for the development of the Delta Plan.

Referendum Vote on the Peripheral Canal

In response to the 1980 passage of State legislation to authorize a $5 billion dollar expansion to the SWP, a group of Californians gathered signatures to allow the public to vote on the issue in a statewide referendum. At the controversial heart of the measure was construction of a peripheral canal, originally envisioned as part of the SWP, to route water from the Sacramento River to the State and federal pumping plants in the southern Delta, near Tracy. Details regarding environmental mitigation for the peripheral canal ironically united strange bedfellows in opposition (environmental advocates and Central Valley farmers, the former believing the mitigation requirements to be too lax, the latter believing them to be too onerous and expensive). The 1982 referendum failed in a stark north-south state split, and the project was temporarily shelved.

The 1987–1992 Drought

Beginning in 1987, California experienced a drought of memorable severity that lasted 6 years in duration. Tied with 1929–1934 for the longest drought in California's modern recorded history, runoff was about half of average during this period, resulting in major water supply shortages. Californians were reminded that water supply reliability was not a given in the Golden State. While nearly all Californians were affected by the drought, agriculture and the environment were hardest hit, and water supplies from the Delta began to receive increased statewide attention.

Central Valley Project Improvement Act

In 1992, Congress approved the Central Valley Project Improvement Act (CVPIA). Among its provisions, the CVPIA had the outcome of dedicating 800,000 acre-feet of water to the environment annually. Specifically, the CVPIA's purposes were to protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California; address impacts of the

CVP on fish, wildlife and associated habitats; and improve the CVP's operational flexibility. The CVPIA was a turning point in water project history because its passage proclaimed the federal government's intention to operate the CVP in a manner consistent with a healthy Delta ecosystem and that achieved a reasonable balance among competing demands for use of its water.

CALFED

Following the CVPIA, an effort to increase coordination across federal and state agencies operating in the Delta took formal shape in 1994. Along with stakeholders, a group of government agencies developed a document entitled "Principles for Agreement on Bay-Delta Standards between the State of California and the Federal Government". Known as the Bay-Delta Accord, this agreement initiated a long-term planning process called CALFED aimed at improving the Delta ecosystem and increasing the reliability of its water supply. The objectives of the CALFED program were water supply reliability, improved water quality, ecosystem restoration, and levee system integrity. To mixed reviews, the effort yielded a 10-year period of intense meetings, public outreach, the development of State and federal programmatic environmental planning documents and a series of focused grant programs.

Critics of the process claimed that CALFED was not reaching its goals, and in 2006, the State's Little Hoover Commission, an independent oversight agency, issued a report essentially declaring the joint State and federal effort a failure. Shortly thereafter, the CALFED program was administratively disbanded, and a few years later, its original authorizing statute was formally repealed.

Delta Vision

Notwithstanding the dissolution of the CALFED effort, interest in fixing the Delta did not wane. In partial response to the Little Hoover Commission Report, a Delta Vision Blue Ribbon Task Force was formed with members appointed by the governor in 2006. The Task Force issued a Strategic Plan in 2008 that built on CALFED's objectives but went a step further by introducing the concept of coequal goals for the Delta—water supply reliability and ecosystem health—and recommending that a new governance structure be established. The Task Force's Strategic Plan outlined a number of specific actions necessary to achieve the coequal goals, much of which formed the basis for the Sacramento–San Joaquin Delta Reform Act of 2009.

The Delta Reform Act and Legislative Water Package of 2009

Signed into law in 2009, the Delta Reform Act was part of a larger package of legislation related to improving California's water supply. The Delta Reform Act created two new governance bodies, the Sacramento–San Joaquin Delta Conservancy, and the Delta Stewardship Council. The Conservancy was created to work in collaboration and cooperation with local governments and interested parties. Importantly, it was created to be a primary state agency to implement ecosystem restoration in the Delta, with additional responsibilities to focus on economic sustainability for the Delta. The Delta Stewardship Council was established in recognition of the need to coordinate and collaborate across the myriad government agencies, including the new Conservancy, each of which has various roles and responsibilities in the Delta. The Delta Stewardship Council's foremost undertaking is to develop and implement this Delta Plan.

Table 1-1

Agencies with Responsibilities in the Delta

Protecting water resources has traditionally been addressed in California through separate programs and agencies. Many of today's challenges can only be addressed through sophisticated multi-agency coordination and cooperation.

Agencies with Responsibilities in the Delta

State	
Department of Fish and Game	Fish and wildlife protection responsibilities, including issuance of permits and actions to restore habitats.
Department of Water Resources	Operates the State Water Project which stores water upstream and conveys water through the Delta, has emergency response and flood planning responsibilities, holds water quality/supply contracts with Delta water agencies, and coordinates overall statewide water planning.
Delta Protection Commission	Prepares a comprehensive long-term resource management plan for land uses within the approximately 500,000 acre Primary Zone of the Delta. Local government plans must be consistent.
Delta Conservancy	Designated primary state agency to implement ecosystem restoration in the Delta and to also assist/ protect the agricultural, cultural, economic, and historical value of the region
State Water Resources Control Board	Required to develop and adopt criteria describing the flows deemed necessary to maintain water quality standards and protect public trust resources in the Delta. Enforce water rights and ensure proper allocation/diversion of water in and out of Delta.
California Emergency Management Agency	Plan, prepare emergency response, and coordinate the activities of all state agencies in connection to an emergency in the Delta and provide resources if local agencies are overwhelmed.
Central Valley Flood Protection Board	Plans flood controls along the Sacramento and San Joaquin Rivers and their tributaries in cooperation with the U.S. Army Corps of Engineers
California Environmental Protection Agency	Develop and set water quality standards consistent with state and federal law to maintain desirable aquatic species in the Delta.
Office of Delta Watermaster	Created in 2009 to oversee the day to day administration of water rights, enforcement activities, and reports on water right activities regarding diversions within the Sacramento - San Joaquin Delta
California Natural Resources Agency	In coordination with a group of local water agencies, environmental, and conservation organizations, state/federal agencies, and other interest groups, developing the Bay Delta Conservation Plan, a conservation strategy to be compliant with ESA and NCCPA, to be implemented over the next 50 years.
Other state agencies	Have roles or responsibilities in the Delta including Department of Transportation, State Parks, Boating and Waterways and more.
Federal	
U.S. Bureau of Reclamation	Operates the Central Valley Project, primarily serving agriculture, which pumps water through and out of the Delta and maintains more 700 miles of Delta levees
U.S. Fish and Wildlife Service	Develops plans for the conservation of public trust natural resources and addresses the variable needs of fish and wildlife in the Delta pursuant to ESA.
U.S. Army Corps of Engineers	Maintains, regulates, and funds repairs to almost 400 miles of the 1100 miles of Delta levees.
National Marine Fisheries Service	Operate salmon and steelhead hatcheries, restore access over impassible dams, and develop plans for the conservation, survival, and recovery of salmon in the Delta to the point at which ESA measures are no longer necessary.
Local	
Hundreds of local reclamation districts, water districts, city and county governments, etc.	

Current Conditions: Today's Delta

As recognized by the California Legislature, the Delta is "a distinct and valuable natural resource of vital and enduring interest to all the people" (Water Code section 85022(c)(1)). "It serves Californians concurrently as both the hub of the California water system and the most valuable estuary and wetland ecosystem on the west coast of North and South America." (Water Code section 85002).

Today, valued elements of the Delta are, by almost any measure, in serious decline. Multiple factors are collectively degrading water availability and water quality and threatening the survival of multiple native fish species:

- Reduced freshwater flows into the Delta
- Water pumping facilities exporting water from the Delta
- Invasive species
- Altered waterway geometry
- Urban growth
- Urban and agricultural pollution

A detailed description of current ecosystem conditions and additional factors contributing to Delta ecosystem decline is included in Chapter 5, Restore the Delta Ecosystem.

The Legislature declared the Delta "inherently flood-prone" in 1992 (Public Resources Code section 29704). Despite ongoing maintenance of the levee system, communities that have grown up behind these levees face the ever-present threat of flooding and, in some cases, potentially catastrophic flooding.

Agricultural practices on some Delta islands have led to average land subsidence of 10 to 15 feet below sea level, and in a few areas up to 25 feet below sea level, creating tremendous pressure on the levees to act as dikes—to hold back water constantly rather than only during peak flow periods (Lund et al. 2010). The cost of maintaining, improving, or repairing these levees may be more than the assessed value of the use of the land they protect in some cases (Sumner et al. 2011). This creates an uncertain future for Delta agriculture and for the associated Delta economy and those residents who depend upon it today.

Although the Delta is at the heart of the state's largest water collection and delivery systems, strongly variable precipitation determines California's water supply in any given year (Dettinger et al. 2011). Precipitation in the state ranges between 100 million acre feet (MAF) in dry years and 200 MAF in wet years (Western Regional Climate Center 2011). Over the past century, average annual precipitation has been about 200 MAF, with about 50 to 60 percent unavailable to users, returned to the atmosphere as evapotranspiration or flowing out to sea (DWR 2006, DWR 2009).

Most of the state's annual precipitation occurs in only 5 to 15 days combined, and recent scientific analysis concludes that "larger variations in California necessitate heroic levels of management of the State's water resources to accommodate wider swings of wet and dry years than in any other state" (Dettinger et al. 2011). To serve as a buffer against the state's natural susceptibility to floods and droughts and supplement numerous local storage projects, the SWP and CVP systems of reservoirs upstream of the Delta store, divert, and release water, some of which eventually flows to the pumping and conveyance facilities in the south Delta.

The river systems flowing into the Delta drain about 40 percent of the land in California and carry about half of the state's total annual runoff (DWR 2009). The Sacramento River provides about three-quarters of the flow into the Delta, and the San Joaquin River and east side tributaries supply the rest (LAO 2008). Unimpaired flows into the Delta average about 30 MAF per year, or 36 percent of California's average annual water supply of 83 MAF (Chung and Ejeta 2011). Of the total water flowing into the Delta, about half is diverted upstream for agricultural (87 percent), urban (8 percent), and environmental (5 percent)

uses (DWR 2009). A portion of the diverted flows are returned to the rivers. Annual diversions from CVP and SWP facilities in the Delta (Delta exports) vary from 3 to 6.5 MAF. Delta exports represent as little as 10 percent of all Delta outflows during wet years and more than 40 percent of all Delta outflows during dry years (DWR 2011).

The Delta's miles of natural and human-made waterways serve as the hub for moving water supplies from Northern California to the San Francisco Bay Area, Central California, and Southern California. Nearly two-thirds of the state's population (approximately 25 million people) depends on water conveyed through the Delta for some portion of its water supply, as does more than 2 million acres of farmland made more productive by water supplied for irrigation. Although water exported through the Delta is an important part of the state's overall water supply, serving 14 percent of the state's water needs, it is not the predominant part. Local and regional water resources including surface diversions, groundwater, local imports, and water reuse comprise 86 percent of the State's developed supply and play an essential role in meeting California's water needs (DWR 2009). Today California imports 4.4 MAF from the Colorado River, down from the high of 5.1 MAF imported in the 1990s (Hanak et al. 2011). To store and distribute these various sources of surface water, California has more than 1,400 dams and reservoirs with about 43 MAF of surface storage capacity. The final component of California's water supply is groundwater. In an average water year, groundwater represents about 20 to 30 percent of the state's total water use, and it can be almost 40 percent of the total in dry years (Newton et al. 2008).

The dependence of the state's major regional economies on water supplies from the Delta has grown while the reliability of water supplies from the Delta has begun to deteriorate. As one illustration, the 2009 SWP Delivery Reliability Report notes that future water deliveries from the Delta will average 60 percent of maximum contract amounts, down from 63 percent in 2007. As native fish populations decline, regulatory and court-imposed constraints on Delta water system operations are triggering legal issues that result in reductions in water supply reliability, impacting urban and agricultural water users, and negatively affecting the economic vitality of the state.

Data for actual water use and water quality suffers from significant gaps, which may affect the ability of California's water managers to make timely decisions. Since 1914, the State Water Resources Control Board (SWRCB) has issued permits to post-1914 appropriative water diverters in the Delta, but actual annual diversion amounts are not currently known. Owners and operators of nearly one-third of irrigated lands in the Delta watershed do not participate in programs to meet water quality standards, and their compliance with State law is unclear. Although groundwater and surface water are often interconnected, the SWRCB has limited authority to regulate groundwater. Groundwater is sustainably managed in some areas of the state, but other areas suffer from unsustainable overdraft (Famiglietti et al. 2011) and require improved management efforts. Groundwater monitoring across California is improving, but is still insufficient for understanding statewide groundwater use and regional water balances and their effect on water supply reliability.

Compounding the complexity of these problems is the increasing volatility of Delta water supplies as a consequence of climate change, including more rain and less snow, earlier snowmelt, and higher winter and lower spring-summer runoff patterns (Knowles and Cayan 2004, Knowles et al. 2006). The potential for catastrophic levee failure in the Delta and the risk to its residents and water delivery infrastructure posed by floods, sea level rise, earthquakes, and land subsidence is real, growing, and has outpaced the state's ability to manage and fund risk-reduction measures.

What the Delta Plan Will Achieve by 2100

The Delta Plan must achieve the coequal goals and its inherent objectives in the face of dramatically changing conditions. The Delta of 2100 likely will be very different from the Delta of today. Some of the changes will be intentional or predictable, and others will be unintended and surprising. Changes are

likely or expected to result from population growth, climate change and sea level rise, land subsidence, and earthquakes—most beyond human ability or willingness to control. Human-made changes in land use and water use are also expected to continue.

The Delta Plan lays out 12 regulatory policies and 61 recommendations that start the process of addressing the current and predicted ecological, flood control, water quality, and water supply reliability challenges. As required by statute, the Delta Plan adopts a science-based adaptive management strategy to manage decision-making in the face of uncertainty (Water Code section 85308(f)). All of these changes—some foreseeable, some not—will create a dynamic context in which the Delta Plan must adapt.

Table 1-2 summarizes the range of changes anticipated by 2050 and, in some cases, by 2100. These are the expected changes, allowing consideration of new policies and investments. The Delta Plan also must prepare California for the possibility of large, unexpected changes.

Restoring the Delta ecosystem and providing a more reliable water supply to California will require a broad range of linked actions, most of which will need to be developed and adapted over time as new information is developed and as additional resources are made available. These actions will have to anticipate likely changes (see Table 1-2) and adjust to unexpected changes.

Table 1-2
Summary of Anticipated Changes Affecting the Delta by 2050 and 2100

Anticipated Change	Change Predicted by 2050	Change Predicted by 2100
Population of California[a]	Increase from 39.1million in 2010 to 59.5 million, a 52% increase	Continued increase in population
San Francisco Bay/East Bay Area earthquake affecting Delta by 2032[b]	63% probability of at least one magnitude 6.7 or greater earthquake	
Probability of island flooding from high water, relative to 2005 conditions[c]	In range of 200% increase (medium risk scenario)	In range of 450% increase (medium risk scenario)
Increased weather variability, including longer-term droughts[d]	Models and analyses of tree rings and other evidence back to the year 800 suggest greater variability and long periods of drought, especially for the Colorado River basin, a current source of some water to California.	
Sea level rise, relative to 2000[e]	14 inches	40 to 55 inches
Snow pack, relative to 1956–2000 average of 15 MAF[f]	Reduction of 25% (4.5 MAF) to 40% (6 MAF)	Continued reduction expected

a California Department of Finance 2007
b 2007 Working Group On California Earthquake Probabilities 2008
c California Department of Water Resources 2008
d For examples, see research by Richard Seager, Columbia University, available at http://www.ldeo.columbia.edu/res/div/ocp/drought/, or the California Global Climate Change Portal, available at http://www.climatechange.ca.gov/background/index.html
e California Ocean Protection Council 2011. Other sources include higher projections.
f California Department of Water Resources 2007

The guiding vision for the Delta Plan—the achievement of the coequal goals and inherent objectives—is intended to result in the following outcomes by 2100:

- The coequal goals of restoring the Delta ecosystem and providing a more reliable water supply for California are the foundation of all State water management policies. No water rights decisions or water contracts that directly or indirectly impact the Delta are made without consideration of the coequal goals. Over time, balanced application of the Public Trust Doctrine

and California's Constitutional Article 10, Section 2 (requirements for beneficial use, reasonable water use, and no waste) have produced maximal optimization of water use, including high levels of water use efficiency and protection of public trust resources throughout the state. California has a comprehensive, fully integrated system for tracking and evaluating actual water use and water quality for both surface water and groundwater supplies.

SIDEBAR TO BE PROVIDED ON CALIFORNIA WATER RIGHTS

- California has more reliable water supplies through enhanced conservation and water efficiency and through the development of additional local and regional water supplies, and by achieving improved regional water balance, water quality protection, and improved storage and conveyance facilities.
- Regions reliant on receiving some portion of their water from the Delta watershed as part of their overall supply have reduced their reliance on these deliveries and improved their self-reliance through increased conservation and diversification of their local and regional sources of supply.
- The reliability of SWP and CVP deliveries from the Delta watershed has improved through enhanced storage and conveyance that is consistent with Delta ecosystem protection.
- Large areas of the Delta have been restored in support of a healthy estuary. A diverse mosaic of interconnected habitats—open water, tidal marsh, floodplain, riparian, and upland areas—is reestablished in the Delta and its watershed. Migratory corridors for fish, birds, and terrestrial wildlife have been largely protected and restored. Actions have been taken to ensure that sufficient freshwater flows following a more natural hydrograph are now dedicated to support a healthy ecosystem. Actions have reduced the impacts caused by invasive species, poor water quality, loss of habitat, and urban development, resulting in improved conditions for native species of fish, birds, and wildlife that depend on the Delta and its watershed.
- Delta agriculture remains an important and dynamic part of the Delta. In addition to traditional agricultural pursuits, new frontiers in terms of environmental stewardship and mixed agricultural and environmental innovation may include development of new markets and technologies to sustain and rebuild Delta soils, enhance wildlife, and improve air and water quality. Visitors from around the world are drawn to the Delta for recreation and to experience its beauty, ecosystem, and agricultural bounty. The Delta is a place where agricultural, recreational, and environmental uses are uniquely integrated and continue to contribute in important ways to the regional economy.
- The Delta—while evolving in response to sea level rise, earthquakes, floods, and major urbanization around the outside—remains a socially and environmentally distinctive and culturally significant region that is overwhelmingly rural. Within that context, the Delta remains a vibrant, changing, and evolving place. Local, State, and federal agencies have worked together to adapt and prepare for future changes caused by natural forces. Land use policies and levee improvements are consistent with the protection of human, property, and statewide interests in the Delta. Although continued changes are expected, progress toward achieving the coequal goals will protect the uniqueness of the Delta and provide a strong foundation for enhancing the resources and cultural and agricultural values of the Delta as an evolving place for the next century.

Figure 1-3
Target Outcomes for the Delta Plan [UNDER DEVELOPMENT]

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Organization of the Delta Plan

The Delta Plan is organized around the specific subgoals, strategies, actions, and measures set forth in the Delta Reform Act. As mentioned at the beginning of this chapter, Water Code section 85020 provides the general framework for the organization of the Delta Plan chapters.

Chapter 2, Science and Adaptive Management for a Changing Delta, explores the topic of adaptive management, a core practice necessary to achieve the coequal goals. In the Delta Plan, adaptive management is a tool that will be used to evaluate the plan's success with meeting the coequal goals and will also be a required element for certain covered actions as described in Chapter 3. This chapter also explains the importance of science to the Delta and gives examples of the successful use of science in decision making.

Chapter 3, Governance: Implementation of the Delta Plan, describes some of the Council's processes and procedures with respect to their appellate role in judging consistency with the Delta Plan, and their responsibility for updating the Delta Plan. This chapter includes various exemptions for proposed actions. Importantly, this chapter includes a regulation required of all covered actions.

Chapters 4 through 8 are policy chapters:

- Chapter 4, A More Reliable Water Supply for California
- Chapter 5, Restore the Delta Ecosystem
- Chapter 6, Improve Water Quality to Protect Human Health and the Environment
- Chapter 7, Reduce Risk to People, Property, and State Interests in the Delta
- Chapter 8, Protect and Enhance the Unique Cultural, Recreational, Natural Resources, and Agricultural Values of the California Delta as an Evolving Place

Chapter 9 presents a Finance Plan framework for funding of flood management, water supply, and ecosystem investments, current and potential future funding sources, and recommendations to the California Legislature from the Council for future funding strategies.

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Chapter 2
Science and Adaptive Management for a Changing Delta

The Delta Reform Act seeks to provide a strong science foundation for decisions of the Council, seen in both provisions for a science program and an independent science board (Water Code sections 85280):

> *85280 (a) The Delta Independent Science Board is hereby established in state government*
>
> *85280 (a)(3) The Delta Independent Science Board shall provide oversight of the scientific research, monitoring, and assessment programs that support adaptive management of the Delta through periodic reviews of each of those programs that shall be scheduled to ensure that all Delta scientific research, monitoring, and assessment programs are reviewed at least once every four years.*
>
> *85280 (b)(4) The mission of the Delta Science Program shall be to provide the best possible unbiased scientific information to inform water and environmental decisionmaking in the Delta. That mission shall be carried out through funding research, synthesizing and communicating scientific information to policymakers and decisionmakers, promoting independent scientific peer review, and coordinating with Delta agencies to promote science-based adaptive management. The Delta Science Program shall assist with development and periodic updates of the Delta Plan's adaptive management program.*

The Delta Reform Act requires the inclusion of science-based adaptive management in the Delta Plan as defined and stated in Water Code sections 85308(f) and 85052:

> *85308(f) Include a science-based, transparent, and formal adaptive management strategy for ongoing ecosystem restoration and water management decisions.*
>
> *85052 "Adaptive management" means a framework and flexible decisionmaking process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvements in management planning and implementation of a project to achieve specified objectives.*

The Delta Reform Act also requires that the Delta Plan is based upon and implemented using the best available science:

> *85308 The Delta Plan shall meet all of the following requirements:*
>
> > *(a) Be based on the best available scientific information and the independent science advice provided by the Delta Independent Science Board.*
> >
> > *(e) Where appropriate, recommend integration of scientific and monitoring results into ongoing Delta water management.*
>
> *85302(g) In carrying out this section, the council shall make use of the best available science.*

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Chapter 2
Science and Adaptive Management for a Changing Delta

The Delta Reform Act requires a strong science foundation for Delta Stewardship Council (Council) decisions. This includes the ongoing provision of scientific expertise to support the Council and other agencies through the Delta Science Program and Delta Independent Science Board (Water Code section 85280). The Delta Reform Act also requires that the Delta Plan be based on and implemented using the best available science (Water Code sections 85308(a) and (e) and 85302(g)) and requires the use of science-based, transparent, and formal adaptive management strategies for ongoing ecosystem restoration and water management decisions (Water Code section 85308(f)).

Why does the Delta Plan emphasize science? First, science provides the basis of nearly all current understanding of the Delta's status (Healey et al. 2008, Lund et al. 2010). Second, new perspectives on science and policy in the Delta instill urgency for addressing the health of Delta ecosystems and the need for a more reliable water supply. Third, the interaction of multiple stressors must be understood if they are to inform policy decisions that will be effective in achieving a healthier Delta. See the sidebar "Science in the Delta" for examples of current and emerging science in the Delta.

Science plays an increasingly important role in contributing to how people perceive and respond to problems in the Delta. Our understanding of the Delta today is quite different from that of a few decades ago. The Delta is continually changing. Population growth, land subsidence, earthquakes, and climate change assure that the Delta of the future will be very different from the Delta of today. *The State of Bay-Delta Science 2008*, a science-based document intended to inform policy decisions, highlights new perspectives and a growing awareness critical for successful planning in the Delta (Healey et al. 2008):

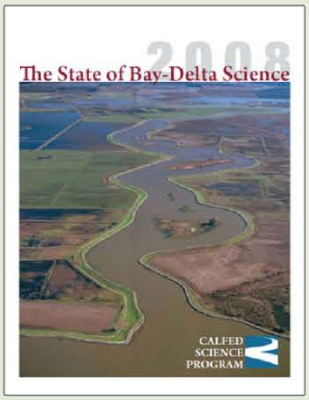
- Problems of water and environmental management are interlinked, and piecemeal solutions will not work.
- The capacity of the Delta water system to deliver human, economic, and environmental services is reaching or has already passed its limit.
- The best solutions in the Delta must be based on best-available science yet allow for adaptation to future change.

Science is important because it defines the scope of current problems facing the Delta and offers potential solutions to providing more reliable water supply for California. For example, the scale of groundwater overdraft in California has been quantified by new scientific studies using satellite technology. The process of updating flow criteria to help support the ecosystem and achieve a more naturally variable hydrograph will be fundamentally rooted in science. Successful restoration of the Delta ecosystem will require the fields of landscape ecology, environmental engineering, and hydrodynamics to work in concert. Improvements in Delta water quality will require our understanding of the transport and fate of

Science in the Delta

New Perspectives on Science and Policy in the Bay-Delta. Synthesized scientific understanding has led to looking at the Delta as a whole rather than in parts. The State of Bay-Delta Science 2008 (CALFED) summarized these changed perspectives of the Delta, including:

- The capacity of the Sacramento-San Joaquin water system to deliver human, economic, and environmental services is likely at its limit. To fulfill more of one of these water-using services we must accept less of another.
- The Delta is a continually changing ecosystem. Multiple factors drive this change. This means that the Delta of the future will be very different from the Delta of today.
- The problems of water and environmental management are interlinked. Piecemeal solutions will not work. The Delta Plan needs effective and ongoing integration of science, policy, and decision making.



Interdisciplinary science led to these changing perspectives and laid the groundwork for Delta Vision, the Delta Reform Act, and the Delta Plan.

The State of Bay-Delta Science 2008 is available online at:
http://www.science.calwater.ca.gov/pdf/publications/sbds/sbds_final_update_122408.pdf

Planning for Sea Level Rise. The CALFED Independent Science Board (ISB) synthesized existing science concerning global sea level rise and provided a recommendation to policy makers for planning and policy development. The ISB recommended that long term infrastructure planning and design should include the full range of variability and a higher upper limit reflecting emerging new research (55 inches by 2100). This recommendation has been echoed in Governor Schwarzenegger's Executive Order (S-13-08) directing State agencies to plan for sea level rise and climate impacts, the Ocean Protection Council's 2010 Resolution on Sea Level Rise, and has been widely accepted in policy planning and decision making.

More information is available online:

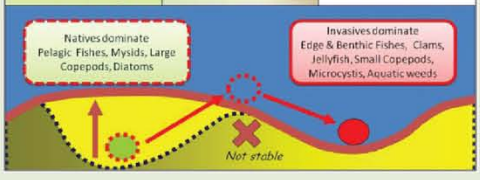
ISB recommendation on sea level rise and Delta planning (2007):
http://science.calwater.ca.gov/pdf/isb/meeting_082807/ISB_response_to_ls_sea_level_090707.pdf

Executive Order S-13-08: http://www.climatechange.ca.gov/publications/EXECUTIVE_ORDER_S-13-08.pdf

Ocean Protection Council's 2010 Resolution on Sea Level Rise:
http://www.opc.ca.gov/webmaster/ftp/pdf/docs/OPC_SeaLevelRise_Resolution_Adopted031111.pdf

Evolving Conceptual Models. The Interagency Ecological Program (IEP) has been investigating the pelagic organism (open water fish species) decline (POD) since 2005. Scientific monitoring and research by the IEP over time has resulted in evolving conceptual models to explain the POD. The evolving POD conceptual models highlight the change in thinking from a classical food web and fisheries ecology approach, to species-specific models, to an ecological regime shift model. The *2010 Pelagic Organism Decline Workplan and Synthesis of Results* explains the evolution of the IEP's scientific understanding of the POD through August 2010. The report is available online at: http://www.water.ca.gov/iep/docs/FinalPOD2010Workplan12610.pdf

Old Regime	Environmental Drivers	New Regime
Variable, High	Outflow	*Variable, Lower*
To the west, Variable	Salinity gradient	*To the east, Constricted*
Complex, Variable	Landscape	*Simplified, Rigid*
Low, Variable	Temperature	*High, Uniform*
High, Variable	Turbidity	*Low, Less variable*
High P, low N	Nutrients	*Low P, High N (NH_4^+)*
Few, Low	Contaminants	*Many, High*
Predation, Fishing	"Harvest"	*Predation and Entrainment*



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nutrients and pollutants, the toxicity of chemicals in Delta water and sediments, and complex interactions between tides, flows, salinity, turbidity, and channel geometry. Better levee risk management, subsidence reduction and reversal, and flood prediction and protection draw fundamentally from science and engineering. The reliance on strong science throughout the Delta Plan and the need for further science throughout the implementation of the Plan necessitates ongoing investments and formal methodologies to develop and apply this knowledge (adaptive management and best available science).

Using science and adaptive management increases the likelihood of success for a given project. Science and adaptive management apply standardized processes and structures for measuring, monitoring, assessing, and communicating results of management actions relative to the intended goals and the questions being asked. Science and adaptive management are not simply academic exercises; they provide an approach for using public funds more effectively, efficiently, and economically.

Adaptive Management

Adaptive management is defined in the Delta Reform Act as "a framework and flexible decision making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvements in management planning and implementation of a project to achieve specified objectives" (Water Code section 85052).

Adaptive management is an approach that allows taking action under uncertain conditions. The approach requires measurement and evaluation to determine whether a given action achieves intended goals, and if not, adjustments are made. Future uncertainties create greater urgency for us to implement adaptive management in the Delta so that, if necessary, management interventions can occur based on new information (Healey 2008).

Why is science-based adaptive management appropriate to practice in the Delta? Because adaptive management is a strategy for making decisions and taking actions rather than constantly delaying actions until more information is available. It allows you to manage, learn, and then manage according to what you have learned, rather than picking a management strategy and implementing it without regard for scientific feedback or monitoring. This is especially important in the context of the Delta because in some instances, competing and uncertain explanations will arise for which management cannot be delayed until causes are better understood (Healey 2008).

Adaptive management is an approach to resources management that increases the likelihood of success in obtaining goals in a manner that is both economical and effective because it provides flexibility and feedback to manage natural resources in the face of often considerable uncertainty regarding management effects.

The Delta Reform Act requires that ecosystem restoration and water management covered actions include a science-based, transparent, and formal adaptive management strategy (Water Code section 85308(f)). The Delta Plan includes a nine-step adaptive management framework that includes three phases: Plan, Do, and Evaluate and respond. The Council requires that the nine-step adaptive management framework be used for proposed covered actions involving ecosystem restoration and water management. Where appropriate, and as information becomes available, the Council will use adaptive management to revise and update the Delta Plan.

The policy describing how covered actions for ecosystem restoration and water management are expected to demonstrate compliance with the adaptive management framework is provided in Chapter 3.

A Nine-step Adaptive Management Framework

Several frameworks for adaptive management have been developed elsewhere and provide the basis for the Delta Plan's adaptive management approach (Christensen et al. 1996, Stanford and Poole 1996, CALFED Bay-Delta Program 2000, Habron 2003, Abal et al. 2005, Healey 2008, Kaplan and Norton 2008, Bay Delta Conservation Plan Independent Science Advisors on Adaptive Management 2009, Williams et al. 2009). Although differences among various frameworks exist, they generally contain three broad phases: Plan, Do, and Evaluate and respond. Throughout all three phases of the adaptive management process, decisions are made by managers, policy makers and/or technical experts; there is no single decision-making step in the adaptive management framework.

The Council will use the nine-step adaptive management framework in Figure 2-1 to evaluate the use of adaptive management for proposed covered actions for ecosystem restoration and water management. This framework and the description of each step are largely derived from Stanford and Poole (1996), CALFED Bay-Delta Program (2000), Abal et al. (2005), and the Bay Delta Conservation Plan Independent Science Advisors on Adaptive Management (2009).

Figure 2-1
A Nine-step Adaptive Management Framework for the Delta Plan
The shading represents the three broad phases of adaptive management (Plan, Do, and Evaluate and respond), and the boxes represent the nine steps within the adaptive management framework. The circular arrow represents the general sequence of steps. The additional arrows indicate possible next steps for adapting (for example, revising the selected action based on what has been learned.)

Ecosystem restoration and water management covered actions should include an adaptive management plan that considers all nine steps of this framework; however, they need not be rigidly included and implemented in the order described here. The intent is to build logical and transparent information exchange and decision points into management actions that increase management options and improve outcomes, not to add a new layer of inflexible processes and bureaucracy.

Plan

The *Plan* phase of the adaptive management framework is presented as four steps.

1. Define/Redefine the Problem

The first step of effective adaptive management is to clearly define the problems that will be addressed in the form of a problem statement. The problem statement should clearly link to program goals and to specific objectives, which should be developed by proponents in an open and transparent manner. All problem statements must be based on the best available science (described later in this chapter) and clearly documented information. Defining a problem commonly requires defining the boundaries of the problem (for example, its geographic and temporal scales).

2. Establish Goals and Objectives

Clear goals and objectives must be established by proponents of proposed covered actions for ecosystem restoration and water management and be based on the best available science. Goals are broad statements that propose general solutions. Objectives are more specific than goals, and are often quantitative, specific narrative statements of desired outcomes allowing evaluation of how well the objectives are being achieved.

3. Model Linkages between Objectives and Proposed Action(s)

Models formalize and apply current scientific understanding, develop expectations, assess the likelihood of success, and identify tradeoffs associated with different management actions. Models can be conceptual, statistical, physical, decision support, or simulation. Models link the objectives to the proposed actions and clarify why an intended action is expected to result in meeting its objectives. Models provide a road map for testing hypotheses through statements that describe the expected outcome of an action.

Both qualitative (conceptual) and quantitative models can effectively link objectives and proposed actions by illuminating if and how different actions meet specific objectives. Conceptual models are particularly useful for decision makers, scientists, and the public because they illustrate the most critical cause-and-effect pathways. Conceptual models provide an articulation of the hypotheses being tested and how various actions might achieve particular objectives. Conceptual models also help to develop performance measures, which are qualitative or quantitative information that tracks status and trends toward meeting objectives. Conceptual models should be used in adaptive management planning because they help explain how other types of models, research, and actions will be used to explore hypotheses and address specific existing and anticipated uncertainties.

4. Select and Evaluate Action(s): Research, Pilot, and Full-scale

The process for selecting and evaluating an action or suite of actions to meet objectives includes an evaluation of the best available science represented in the conceptual model. This evaluation should guide development of the action:

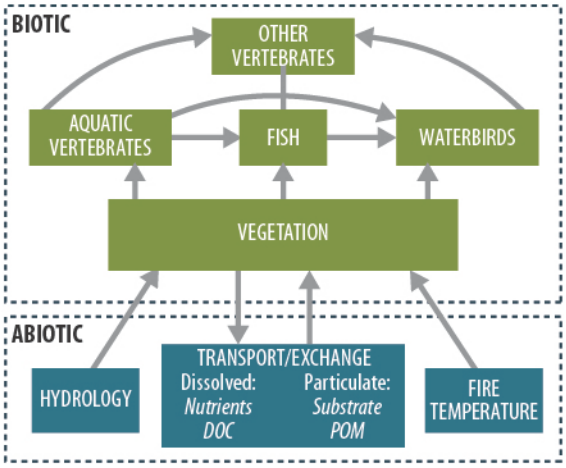
- Level of the action(s) to be taken (research, pilot-scale project, or full-scale project)
- Geographical and temporal scale of the action(s)
- Degree of confidence in its benefits
- Consequences of being wrong

Kissimmee River Restoration Project

In the 1960s, the Kissimmee River, located in south-central Florida, was substantially channelized for flood-control purposes (Toth et al. 1998). In the 1990s, planning began for a 15-year restoration project. The restoration design included 70 km of river channel and 104 km² of floodplain—the largest attempted river restoration project in the world (Dahm et al. 1995). The project uses an adaptive management process that provides a positive example of adaptive management in practice.

Adaptive research, monitoring, and evaluation programs were developed to provide a scientific foundation for fine-tuning each phase of the restoration effort (Toth et al. 1998). To "model linkages between objectives and proposed action(s)," conceptual models were developed to anticipate the restored Kissimmee River ecosystem, predict patterns of response for abiotic and biotic variables, and consider methods and performance measures for evaluating progress toward restoration in the river basin (Dahm et al. 1995).

February 9, 2001, photo of implemented Kissimmee River Restoration Project showing the backfilled canal, degraded soil area, remnant river channel, the connector channel, and wetland areas.



General conceptual model of ecosystem structure and interactions for the Kissimmee River and floodplain (Dahm et al. 1995)

The Kissimmee River Restoration Evaluation Program (KRREP) provides a practical example of the "design and implementation of a monitoring plan" step in adaptive management. The KRREP is a comprehensive monitoring program designed to evaluate ecosystem responses to the restoration project through comprehensive monitoring and assessment of data collected before and after major construction phases (South Florida Water Management District 2011). When the KRREP observes that changes in the river system after a construction phase do not achieve the expected result, adaptive management strategies are considered. For more information about the Kissimmee River Restoration Project, please visit:
http://my.sfwmd.gov/portal/page/portal/xweb%20protecting%20and%20restoring/kissimmee%20river.

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The scale of the action selected should be informed by the certainty of the relevant scientific information, consider the reversibility of the action, and account for the potential cost of delaying larger-scale actions. For example, when the best available science cannot predict the outcome of an action with a reasonable degree of certainty, and irreversible consequences exist for incorrectly predicting the outcomes of an action, further research or a pilot-scale action is likely more appropriate than a full-scale action, unless the cost of delaying a larger-scale action is very high (for example, a species of concern goes extinct or urban water supplies are cut off). In some instances, choosing to take "no action" could be the best selection (when no foreseen benefit would result from a research, pilot-scale, or full-scale action). Where possible, the action(s) selected should test cause-and-effect relationships in the conceptual model so that the model can be adapted using the information learned from implementing the action(s).

Do

The *Do* phase of adaptive management includes two steps that occur in parallel.

5. Design and Implement Action(s)

The design and implementation of action(s) includes clearly describing specific activities that will occur under the selected action(s) and how they will link to the monitoring plan. Design includes creating a plan for implementing the action(s) and monitoring responses from the action(s). The design of the action(s) should be informed by existing uncertainties, and should be directly linked to meeting the goals and objectives.

Action(s) should be designed with the entire adaptive management process in mind. This means that the monitoring and actions are designed with data-collection methods that allow for analysis using statistical comparisons or other methods of assessment, the duration of implementation covers a time period over which major change is expected to occur, and "what if" scenarios for when to adapt are thought through in advance. Simulation models could be a useful tool for assessing these design components. Simulation models are useful tools for assessing the benefit gained from performing an action more intensely given the potential time frame for measuring a response. The design step also includes identifying adequate funding to carry out the action(s) and the associated monitoring and assessment for an appropriate period.

6. Design and Implement Monitoring Plan

A well-designed monitoring plan includes a data-management plan. A data-management plan describes the process for organizing and clearly documenting observations, including how data are collected; the methods, quality assurance, and calculations used; the time and space scales of the variables; and accurate site locations and characteristics. Data management is critical for analyses, syntheses, and evaluations.

A well-designed monitoring plan goes beyond data collection and data management. A monitoring plan often includes targeted research to answer why certain results are observed and others are not. A monitoring plan also includes clear communication of the information gathered and current understanding drawn from this information. A complete monitoring plan includes the following types of monitoring:

- Compliance monitoring (required by permits)
- Performance monitoring (measuring achievement of targets)
- Mechanistic monitoring (testing the understanding of linkages in the conceptual model)
- System-level monitoring (holistic and long term)

These types of monitoring can measure and communicate various types of information, such as administrative/inputs (such as dollars awarded and spent or projects funded), compliance/outputs (such as tons of gravel added or acres exposed to tidal action), and effectiveness/outcomes (such as actual outcome expected from implementing an action at the local scale, suites of actions at the systemwide scales, and status and trends assessments). The monitoring plan design must include the development of an integrated

suite of monitoring metrics that can be integrated and summarized to inform decision makers and the public as described in step eight, *Communicate Current Understanding*.

Monitoring plan design requires making tradeoffs between resources spent on monitoring and resources spent on actions and analyses. To aid in this evaluation of tradeoffs, a rigorous pre-analysis using simulation models can show the information value of different variables that might be monitored. These values assessments can then be used to compare the benefits from monitoring certain variables against the benefit of using resources for other actions.

Implementation of actions and monitoring should be closely coordinated. Before an action is implemented, initial conditions should be clearly documented to the extent practicable so that a baseline is established. Baseline data includes characterization of natural variation observed in the examined system over space and time. For many ecological and hydrological variables, an extensive set of baseline data is available because of the efforts of the Interagency Ecological Program and repositories of information such as those available from the U.S. Geological Survey and the California Department of Water Resources. The implementation of action(s) and monitoring should be executed in a transparent manner and clearly communicated to the public. Status and trends metrics that compare conditions before and after action implementation are often good assessment and communication tools.

Evaluate and Respond

The *Evaluate and Respond* phase of adaptive management includes three key steps.

7. Analyze, Synthesize, and Evaluate

Analysis, synthesis, and evaluation of the action(s) and monitoring are critical for improving current understanding. Analysis and synthesis should incorporate information on how conditions have changed, expectedly and unexpectedly, as a result of implementing the action(s). The evaluation should examine whether performance measures indicate that one or more of the objectives have been met as a result of the implemented action(s), and if so, why. If an objective is not met, the potential reasons why it was not should be clearly identified and communicated. Analyses should be cumulative. As each year's data becomes available, analyses should assess whether the probability of the desired outcome has changed and, if so, how this affects decisions about the action. The results of the analysis, synthesis, and evaluation step could be published in technical peer-reviewed papers and reports for the purpose of external review, transparency, and accessibility where results warrant this level of communication. Scientists and technical experts will be critical for carrying out this step.

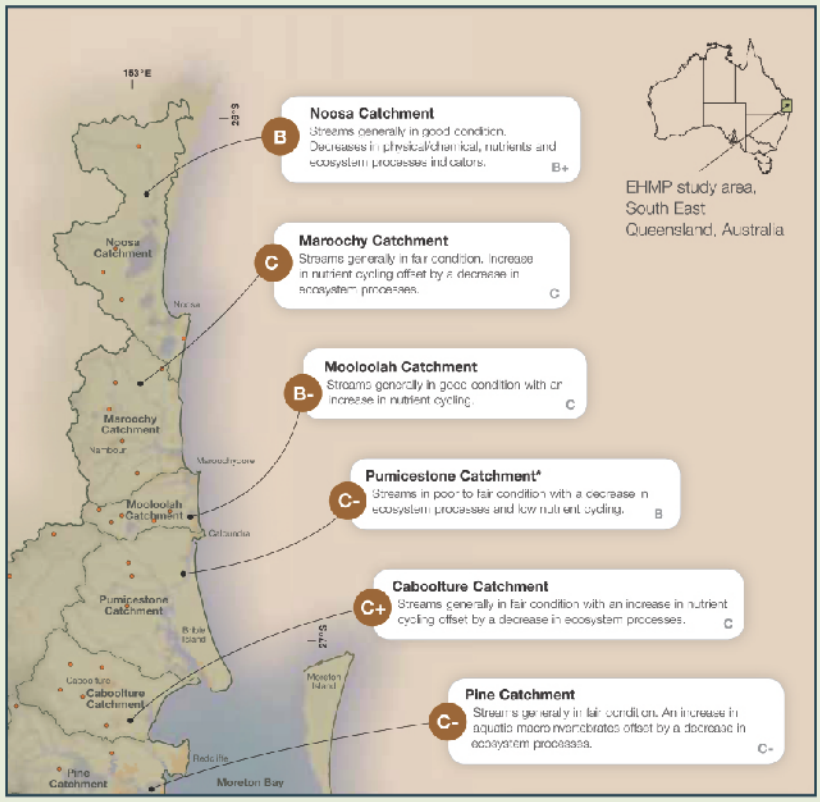
8. Communicate Current Understanding

Communication of current understanding gained through analysis, synthesis, and evaluation of implemented action(s) and monitoring is a key step for informing and equipping policy makers, managers, stakeholders, and the public to appropriately respond and adapt. This step spans the *Do* and the *Evaluate and Respond* phase of adaptive management because the communication of current understanding and related recommendations for change requires both policy and technical expertise. The information communicated should be technically sound, well synthesized, and translated into formats conducive to informing a nontechnical audience (for example, a report card format or a general science outlet such as a newsletter). The information should then be disseminated to those directly involved in the adaptive management process for the plan, program, or project and to those interested in the outcome of the action.

Technical staff and decision makers should be regularly involved in the exchange of information as data are analyzed and synthesized. Communication should be ongoing and occur at appropriate intervals at which an improved understanding could help refine other steps of the adaptive management framework.

Healthy Waterways

Healthy Waterways, in South East Queensland, Australia, is an organization with collaborative partnerships that work to improve the health of waterways, catchment, and ecosystems that support the livelihoods and lifestyles of the region's people. An adaptive management framework developed by Healthy Waterways' partners has served as the operating philosophy and cornerstone of program implementation for over a decade.



From Healthy Waterways 2010 Annual Report Card
(2010 grades are brown, 2009 grades are gray)

Healthy Waterways' practice of adaptive management has led to improved understanding about how to deal with resource management issues and the flexibility necessary for changing socioeconomic and socioecological relationships in South East Queensland (Abal et al. 2005). Healthy Waterways has excelled at two specific steps of adaptive management: "communicate current understanding" and "adapt".

Communication of current understanding is facilitated through a commitment to public education and outreach, annual public report cards, and the use of leading technology to analyze, interpret, and communicate waterways information through the health-e-waterways dynamic report cards (http://www.health-e-waterways.org/). These communication efforts have led to adapting actions based on current understanding; these adapted actions are subsequently evaluated in the next year's annual report card.

Details about Healthy Waterways and its adaptive management elements are available at www.healthywaterways.org.

The key to successful communication is a skilled and dedicated interdisciplinary person or team who understands the technical information learned, the functional needs of the decision makers, and how to best transmit this information.

9. Adapt

Proponents of covered actions for ecosystem restoration and water management need to be engaged and prepared to adapt to changes in current understanding. Informed and equipped with new results and

understanding, decision makers should reexamine the other steps of the adaptive management framework and revise these steps where current understanding suggests doing so. Possible next steps could include redefining the problem statement, amending goals and objectives, altering the conceptual model, or selecting an alternative action for design and implementation.

Knowing when to adapt is not always obvious. Adaptive management actions should have a planned time frame that includes when to adapt (based on understandings of the system and its uncertainties), and that time frame should be abandoned only if the results show that the action is doing more harm than good. In general, one year's results, however anomalous, are seldom enough to demonstrate that the action should be adapted. Furthermore, when the analysis, synthesis, and evaluation of information learned from implementing an action indicates that no benefit is resulting from the action, resources should no longer be spent on that action no matter how popular it might be.

Knowledge Base for Adaptive Management

The knowledge base is the foundational scientific understanding of a system, both environmental and social, that creates the context for planning stages of science-based adaptive management. A strong knowledge base informs policy makers and the public. It has wide benefit, as seen in the work of the Council's Delta Science Program (formerly the CALFED Science Program), whose mission is to provide the best possible scientific information for water and environmental decision making in the Delta. The following elements of the knowledge base also provide information necessary to effectively *Plan*, *Do*, and *Evaluate and Respond* within an adaptive management framework:

- Best available science
- Scientific research
- Monitoring
- A Delta Science Plan

These elements create the capacity for informed planning, meaningful actions and associated monitoring, and knowledgeable evaluation and response.

Best Available Science

Best available science is specific to the decision being made and the time frame available for making that decision. There is no expectation of delaying decisions to wait for improved scientific understanding. Action may be taken on the basis of incomplete science if the information used is the best available at the time.

Best available science is developed and presented in a transparent manner, including clear statements of assumptions, the use of conceptual models, description of methods used, and presentation of summary conclusions. Sources of data used are cited, and analytical tools used in analyses and syntheses are identified. Best available science changes over time, and decisions may need to be revisited as new scientific information becomes available. Targeted investment in science reduces scientific uncertainty and improves best available science.

Best available science must be consistent with the scientific process (Sullivan et al. 2006). Ultimately, best available science requires the best scientists using the best information and data to assist management and policy decisions. The processes and information used should be clearly documented and effectively communicated.

Steps for Achieving the Best Science

Science consistent with the scientific process includes the following elements:

- Well-stated objectives
- A clear conceptual or mathematical model
- A good experimental design with standardized methods for data collection
- Statistical rigor and sound logic for analysis and interpretation
- Clear documentation of methods, results, and conclusions

The best science is transparent; it clearly outlines assumptions and limitations. The best science is also reputable; it has undergone peer review conducted by active experts in the applicable field(s) of study. Scientific peer review addresses the validity of the methods used, the adequacy of the methods and study design in addressing study objectives, the adequacy of the interpretation of results, whether the conclusions are supported by the results, and whether the findings advance scientific knowledge (Sullivan et al. 2006).

There are several sources of scientific information and tradeoffs associated with each (Sullivan et al. 2006, Ryder et al. 2010). The primary sources of scientific information, in a generalized ranking of most to least scientific credibility for informing management decisions, include the following: independently peer-reviewed publications including scientific journal publications and books (most desirable); other scientific reports and publications; science expert opinion; and traditional knowledge. Each of these sources of scientific information may be the best available at a given time and contain varying levels of understanding and uncertainty. These limitations should be clearly documented for scientific information used as the basis for decisions.

Guidelines and Criteria

Several efforts have been conducted to develop criteria for defining and assessing best available science. In 2004, the National Research Council Committee on Defining the Best Scientific Information Available for Fisheries Management prepared a report (National Research Council Report) that concluded guidelines and criteria must be defined in order to apply best available science in natural resource management (National Research Council 2004). Major findings and recommendations included establishing procedural and implementation guidelines to govern the production and use of scientific information. The guidelines were based on six broad criteria: relevance, inclusiveness, objectivity, transparency and openness, timeliness, and peer review.

The Legislature of the State of Washington also developed criteria for assessing best available science that are used by counties and cities in developing policies and regulations pursuant to the Washington State Growth Management Act. These criteria include six characteristics for a valid scientific process: peer review, methods, logical conclusions and reasonable inferences, quantitative analyses, context, and references (Washington Administrative Code).

Best available science for proposed covered actions and for use in the Delta Plan should be consistent with the guidelines and criteria developed by the National Research Council and the State of Washington. Proposed covered actions should document that the science used follows the criteria adapted from the National Research Council report as they apply to the Delta, summarized in Table 2-1.

It is recognized that differences exist among the accepted standards of peer review for various fields of study and professional communities. When applying the above criteria for best available science, the Council will recognize that the level of peer review for supporting materials and technical information (such as scientific studies, model results, and documents) included in the scientific justification for a proposed covered action is variable and relative to the scale, scope, and nature of the proposed covered action. The Council understands that varying levels of peer review may be commonly accepted in various fields of study and professional communities, and will consider this when reviewing the scientific justification for proposed covered actions.

Scientific Research to Inform Delta Decision Making

Table 2-1
Criteria for Best Available Science

Criteria	Description
Relevance	Scientific information used should be germane to the Delta ecosystem and/or biological and physical components (and/or process) affected by the proposed covered actions. Analogous information from a different region but applicable to the Delta ecosystem and/or biological and physical components may be the most relevant when Delta-specific scientific information is nonexistent or insufficient. The quality and relevance of the data and information used shall be clearly addressed.
Inclusiveness	Scientific information used shall incorporate a thorough review of relevant information and analyses across relevant disciplines. Many analysis tools are available to the scientific community (e.g., search engines and citation indices).[a]
Objectivity	Data collection and analyses considered shall meet the standards of the scientific method and be void of nonscientific influences and considerations.[b]
Transparency and openness	The sources and methods used for analyzing the science (including scientific and engineering models) used shall be clearly identified. The opportunity for public comment on the use of science in proposed covered actions is recommended. Limitations of research used shall be clearly identified and explained. If a range of uncertainty is associated with the data and information used, a mechanism for communicating uncertainty shall be employed.
Timeliness	Timeliness has two main elements: (1) data collection shall occur in a manner sufficient for adequate analyses before a management decision is needed, and (2) scientific information used shall be applicable to current situations. Timeliness also means that results from scientific studies and monitoring may be brought forward before the study is complete to address management needs.[c] In these instances, it is necessary that the uncertainties, limitations, and risks associated with preliminary results are clearly documented.
Peer review	The quality of the science used will be measured by the extent and quality of the review process. Independent external scientific review of the science is most important because it ensures scientific objectivity and validity.[d] The following criteria represent a desirable peer review process:[e] Independent External Reviewers. A qualified independent external reviewer embodies the following qualities: (1) has no conflict of interest with the outcome of the decision being made, (2) can perform the review free of persuasion by others, (3) has demonstrable competence in the subject as evidenced by formal training or experience, (4) is willing to utilize his or her scientific expertise to reach objective conclusions that may be incongruent with his or her personal biases, and (5) is willing to identify the costs and benefits of ecological and social alternative decisions. When to Conduct Peer Review. Independent scientific peer review shall be applied informally or formally to proposed projects and initial draft plans, formally in writing after official draft plans or policies are released to the public, and formally to final released plans. Coordination of Peer Review. Independent peer review shall be coordinated by entities and/or individuals that (1) are not a member of the independent scientific review team, (2) have a particular and special expertise in the subject under review, and (3) have had no direct involvement in the particular actions under review.

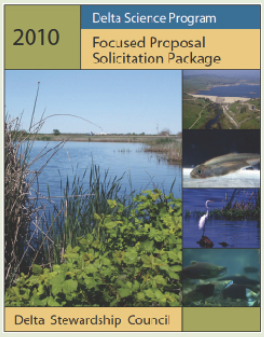
a. McGarvey 2007.
b. National Research Council 2004, Sullivan et al. 2006.
c. National Research Council 2004.
d. Meffe et al. 1998.
e Adapted from Meffe et al. 1998.

To build the knowledge base for informing adaptive management in the Delta over the next few decades, ongoing investment in research is essential for understanding how the system changes over time. This research should be organized in a Delta Science Plan. Delta-related research should use the following approach:

- Focus upon key uncertainties
- Support the best and brightest through competitive grant programs
- Invest in young scientists and researchers
- Use peer review in the selection of research projects
- Look to local and outside science and management experts to focus and define applied research topics
- Welcome and support alternative ways of learning about the system (for example, through involvement of local communities in scientific projects and discussions)

The Delta Science Program will be the central entity that supports new research to understand the changing Delta and build upon the knowledge base used to support adaptive management (See sidebar, "Science to Reduce Key Uncertainties in the Delta"). Directed research that more rapidly addresses specific scientific information needs of agencies operating in the Delta will continue to be supported by these agencies through the cooperative Interagency Ecological Program (IEP) for the San Francisco Estuary. The IEP is a cooperative effort of nine State and federal agencies to monitor and study ecological changes in the Delta. The IEP works closely with the Delta Science Program to coordinate, integrate, and oversee research activities in the Delta.

Science to Reduce Key Uncertainties in the Delta



The Delta Science Program awards research grants through Focused Proposal Solicitation Packages (PSP). The goal of the solicitations is to invest in new scientific knowledge to advance understanding of the complex environments/systems within the Council's jurisdiction to aide policy-makers and managers. Awards for the Delta Science Program's most recent research grant solicitation, the 2010 PSP, were approved by the Council in March 2011. The 2010 PSP focused topic areas were developed by agency and stakeholder managers to ensure that research grants addressed key current management and policy uncertainties. The four selected topics were Native Fish Biology and Ecology; Food Webs of Key Delta Species and their Relationship to Water Quality and Other Drivers; Coupled Hydrologic and Ecosystem Models; and Water and Ecosystem Management Decision Support System Development. These topics reflect the need to better understand the life histories of native fish species, the role of nutrients and contaminants in the Delta, the link between Delta hydrology and ecology, and the need for interactive computer models to assist in decision-making.

Monitoring

A comprehensive monitoring plan that emphasizes routine monitoring and targeted research are essential to the success of adaptive management and should be well described in the Delta Science Plan. Monitoring to detect change in the Delta will require that objectives of the monitoring be clearly linked to actions emanating from well-stated goals and objectives. Monitoring activities in the Delta should build upon the strengths and long-term data sets of the IEP and other regional monitoring programs. The IEP produces publicly accessible data sets that include fish status and trends, water quality, estuarine hydrodynamics, and food web monitoring. A comprehensive monitoring plan for the Delta should expand on the work of the IEP and plan for coordinated synthesis, integration, and communication beyond monitoring associated with covered actions.

Delta Science Plan

A comprehensive science plan for the Delta is needed to organize and integrate ongoing scientific research, monitoring, and learning about the Delta as it changes over time. A Delta Science Plan is essential to support the adaptive management of ecosystem restoration and water management decisions in the Delta. Multiple organizing frameworks for science in the Delta have been proposed, but a comprehensive science plan that specifies how scientific research, monitoring, analysis, and data management will be coordinated among entities has yet to be fully formulated.

The goal of a Delta Science Plan is to organize Delta science activities in an efficient, collaborative, and integrative manner. To meet this goal, the Delta Science Plan shall address the following issues:

- A collaborative institutional organizational structure for conducting science in the Delta
- An assessment of financial needs and funding sources to support science
- A plan for prioritizing research and developing simulation models
- A strategy for addressing uncertainty and conflicting scientific information
- A comprehensive plan for monitoring
- Data management, synthesis, scientific exchange and communication

Effectively addressing these issues in a comprehensive Delta Science Plan is crucial to the growth of the scientific knowledge base and enhanced scientific understanding of the ever-changing Delta into the future.

The Delta Science Program will play a central role in working with others (such as the IEP and Bay Delta Conservation Plan) to develop a Delta Science Plan by January 1, 2013. In this role, the Delta Science Program will maintain its objectives to support research, synthesize science, promote independent scientific peer review, coordinate science, and communicate scientific information to policymakers and decision makers (Water Code section 85280 (b)(4)). The Delta Independent Science Board will also play a critical role in providing oversight of the scientific research, monitoring, and assessment programs that support adaptive management of the Delta by periodically reviewing them at least once every 4 years (Water Code section 85280(a)(3)).

Effective Governance for Adaptive Management

To be effective, governance to support and implement adaptive management for a changing Delta must be flexible and have the capacity to change policies and practices in response to what is learned over time. Governance for adaptive management should provide a decision-making structure that fosters communication between scientists and decision makers, and has clear lines of authority where timely decisions are made and implemented. Decisions made within the adaptive management process for covered actions for ecosystem restoration and water management should be made by decision makers for

the entity with the responsibility for implementing the adaptive management. Adaptive management decisions relevant to revising and updating the Delta Plan will be made by the Council. Governance to support implementing adaptive management for covered actions for ecosystem restoration and water management and the Delta Plan must provide for the institutional capacity to interact, learn, and adapt.

The Council's regulatory policy requiring the use of the nine-step adaptive management framework and best available science presented in this chapter is provided in Chapter 3.

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Chapter 3
Governance: Implementation of the Delta Plan

The Sacramento-San Joaquin Delta Reform Act established the Delta Stewardship Council to achieve more effective governance as reflected in these findings in Water Code section 85300 (a) – (e).

85001. (c) By enacting this division, it is the intent of the Legislature to provide for the sustainable management of the Sacramento-San Joaquin Delta ecosystem, to provide for a more reliable water supply for the state, to protect and enhance the quality of water supply from the Delta, and to establish a governance structure that will direct efforts across state agencies to develop a legally enforceable Delta Plan.

85020. (h) Establish a new governance structure with the authority, responsibility, accountability, scientific support, and adequate and secure funding to achieve these objectives

85022. (a) It is the intent of the Legislature that state and local land use actions identified as "covered actions" pursuant to Section 85057.5 be consistent with the Delta Plan. This section's findings, policies, and goals apply to Delta land use planning and development.

85204. The council shall establish and oversee a committee of agencies responsible for implementing the Delta Plan. Each agency shall coordinate its actions pursuant to the Delta Plan with the council and the other relevant agencies.

85225.5. To assist state and local public agencies in preparing the required certification, the council shall develop procedures for early consultation with the council on the proposed covered action.

85225.10. (a) Any person who claims that a proposed covered action is inconsistent with the Delta Plan and, as a result of that inconsistency, the action will have a significant adverse impact on the achievement of one or both of the coequal goals or implementation of government-sponsored flood control programs to reduce risks to people and property in the Delta, may file an appeal with regard to a certification of consistency submitted to the council.

(b) The appeal shall clearly and specifically set forth the basis for the claim, including specific factual allegations, that the covered action is inconsistent with the Delta Plan. The council may request from the appellant additional information necessary to clarify, amplify, correct, or otherwise supplement the information submitted with the appeal, within a reasonable period.

(c) The council, or by delegation the executive officer, may dismiss the appeal for failure of the appellant to provide information requested by the council within the period provided, if the information requested is in the possession or under the control of the appellant

(c) The council shall review the Delta Plan at least once every five years and may revise it as the council deems appropriate. The council may request any state agency with responsibilities in the Delta to make recommendations with respect to revision of the Delta Plan.

(d) (1) The council shall develop the Delta Plan consistent with all of the following:

(A) The federal Coastal Zone Management Act of 1972 (16 U.S.C. Sec.1451 et seq.), or an equivalent compliance mechanism.

(B) Section 8 of the federal Reclamation Act of 1902.

(C) The federal Clean Water Act (33 U.S.C. Sec. 1251 et seq.).

(2) If the council adopts a Delta Plan pursuant to the federal Coastal Zone Management Act of 1972 (16 U.S.C. Sec. 1451 et seq.), the council shall submit the Delta Plan for approval to the United States Secretary of Commerce pursuant to that act, or to any other federal official assigned responsibility for the Delta pursuant to a federal statute enacted after January 1, 2010.

(e) The council shall report to the Legislature no later than March 31, 2012, as to its adoption of the Delta Plan.

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Chapter 3
Governance: Implementation of the Delta Plan

Central to the work of the Delta Stewardship Council (Council) and the achievement of the coequal goals is the implementation of this Delta Plan.

In most cases, the Delta Plan functions as a strategic document because it provides guidance and recommendations to cities, counties, and State, federal, and local agencies for how to restore the Delta ecosystem and provide a more reliable water supply for California. The Council will work with government agencies, the California Legislature, and stakeholders to promote and coordinate implementation of these recommendations.

However, the Delta Plan also contains several significant regulatory policies with which cities, counties and state and local agencies are expected to comply. The Delta Reform Act of 2009 established a certification process for compliance with the Delta Plan. This means state and local agencies that propose to carry out, approve or fund a qualifying action, called a "covered action" in the Delta Plan, must certify that this action is consistent with the Delta Plan and must file a certificate of consistency with the Delta Stewardship Council.

In contrast to how many other plans are implemented, the Council does *not* exercise direct review and approval authority over covered actions to determine their consistency with the regulatory policies in the Delta Plan. Instead, The Council serves as an appellate body. Any person alleging that a covered action is not consistent with the Delta Plan may appeal the certificate of consistency to the Council within 30 days of its being filed. Upon receiving an appeal, the Council has 60 days to hear the appeal and an additional 60 days to make its decision and issue specific written findings. If the covered action is found to be inconsistent, the project may not proceed until it is revised so that it is consistent with the Delta Plan.

This chapter provides detailed information on how the Delta Plan will be implemented. Key elements include:

- Requirement that covered actions must comply with Delta Plan policies
- Delta Stewardship Council roles
- Geographic considerations of the Delta Plan
- How the Delta Plan policies will work
- Amendments to the Delta Plan

Covered Actions Must Comply With Delta Plan Policies

Only certain activities qualify as covered actions, and the Delta Reform Act establishes criteria and exclusions, discussed in this chapter. The Delta Plan contains policies, which have regulatory affect, and recommendations, which are non-regulatory:

- Only those State or local agencies proposing a covered action ("proponents") need to certify consistency with the policies included in the Delta Plan.
- In the case of all other actions (those that do not meet the criteria of being a covered action or are otherwise explicitly excluded), the Delta Plan's policies, where applicable, are recommendations.

This chapter further clarifies what is and is not a covered action. As an example, routine levee maintenance by a reclamation district in the Delta would not be a covered action because it falls within a statutory exemption. Also, an addition to a house in the Delta would likely not be a covered action because it would not appear to meet the statutory criteria. Routine agricultural practices are unlikely to be considered a covered action unless they have a significant impact on the achievement of the coequal goals or flood risk.

This Delta Plan incorporates and builds upon existing State policies where possible, because its intent is to meet the Delta Reform Act's requirements without establishing an entirely new set of state policies. For example, Delta Plan policies related to reducing flood risk incorporate and build upon recent California legislation that requires upgrades to levees protecting urban areas. Similarly, policies related to water management build upon existing planning requirements and existing State water conservation policy.

In some cases, Delta Plan policies seek to prevent actions that may preclude the future implementation of projects necessary to meet the coequal goals, such as the acquisition of floodplain area for construction of a new flood bypass or restoration of certain lands uniquely suited to habitat. Similarly, the Delta Plan includes policies to protect floodplains and floodways until studies are completed by the Department of Water Resources (DWR).

Delta Stewardship Council Governance Roles

The Council has several defined roles under the Delta Reform Act.

Finding of Consistency under the Covered Actions Review Procedures

The Council has an appellate role to determine the consistency of covered actions. The appeals process is described in statute and further defined in the appeals procedures adopted by the Council and included in this Plan as an appendix. Per statute, the Council must use the standard of substantial evidence when reviewing appeals.

Incorporation of Another Plan into the Delta Plan, Updating the Delta Plan

The Council may incorporate other completed plans related to the Delta into the Delta Plan to the extent that the other plans promote the coequal goals. More detail on how this would work is included in this chapter. Criteria for required incorporation of the Bay Delta Conservation Plan are specified in Water Code section 85320(a), and additional information is included in the Council's appeals procedures.

Statute also directs the Council to review and update the Delta Plan on a regular schedule. Specifically, the Council shall review the Delta Plan at least once every 5 years and may revise it as often as the Council deems appropriate.

Information, Comments, and Advice

The statute directs the Delta Science Program to provide the best possible unbiased scientific information to inform water and environmental decision-making in the Delta. The Delta Science Program will provide oversight of the scientific research, monitoring, and assessment programs that support adaptive management of the Delta and shall report regularly to the Council on this topic, including making recommendations to the Council.

The Council has a role in commenting on any State agency environmental impact reports as appropriate to the mission of the Council. Additionally, the Council has a role in advising local and regional planning agencies regarding the consistency of their planning documents with the Delta Plan.

Figure 3-1
Delta Stewardship Council Roles
The Council has several defined roles under the Delta Reform Act.

Facilitation, Coordination, and Integration

The Council has an important role as a facilitator, coordinator, and integrator of activities among the local, State, and federal agencies and other entities that affect the Delta and statewide water supply reliability. In future updates to the Delta Plan, the Council may include recommendations for governance reform necessary to support the coequal goals.

In recognition that other government agencies have authorities and responsibilities that are critical to the achievement of the coequal goals, the Delta Reform Act requires the Council to establish and oversee a

committee of agencies responsible for implementing the Delta Plan. The statute directs each agency to coordinate its actions pursuant to the Delta Plan with the Council and other relevant agencies. The Council will commence regular, public coordination meetings of the appropriate and interested federal, State, and local agencies and stakeholders after adoption of the Delta Plan. In addition, Council staff has met with federal agencies and is developing the Delta Plan in consultation with these agencies in order to pursue future consistency and compliance with the Coastal Zone Management Act, as required by Water Code section 85300(d)(1)(A).

Geographic Considerations and the Delta Plan

The requirement of consistency with the Delta Plan applies only to covered actions that occur in whole or in part in the Delta. However, because California's water supply reliability and Delta ecosystem concerns are united in the Delta, the geographic area considered during development of the Delta Plan must include areas that divert water upstream of the Delta and areas that receive export water from the Delta. In this regard, the Council recognizes that the Delta Reform Act requires that the Delta Plan address certain statewide water issues vital to sustainable management of the Delta.

The area considered in development of the Delta Plan encompasses the Delta, the Suisun Marsh, the Delta watershed, and areas of the state that use water exported from the Delta watershed, as shown in Figure 1-1.

- The primary area considered includes the legal Delta (as defined by Water Code section 12220) and the Suisun Marsh (as defined by Public Resources Code section 29101 and protected by Division 19, commencing with Section 29000). For purposes of the Delta Plan, the Delta and the Suisun Marsh are collectively referred to as the "Delta" unless otherwise specified. According to law, the Council has authority over covered actions that take place in whole or in part in the Delta. Figure 1-2 shows the Delta and Suisun Marsh.

- Implementation of the Delta Plan also may affect other areas of California, including the Delta watershed, the Trinity River watershed, and areas outside the Delta in which exported water is used. Actions in the secondary planning area may significantly impact the Council's ability to achieve the coequal goals.

How Will the Policies of the Delta Plan Work in Practice?

This section includes a discussion of the general requirements for certifying consistency with the Delta Plan and additional examples of covered actions. Delta Plan policies are not intended and shall not be construed as authorizing the Council or any entity to exercise their power in a manner that will take or damage private property for public use without the payment of just compensation. These policies are not intended to affect the rights of any owner of property under the Constitution of the State of California or the United States. None of the Delta Plan policies increases the State's flood liability.

What Is the Definition of a Covered Action? Who Determines Whether a Proposed Plan, Program, or Project Is a Covered Action?

All actions that come within the covered action provisions of 85057.5(a) (1), (2) and (4) are covered by this Delta Plan unless the action comes within a statutory exclusion listed in 85057.5(b) or is expressly excluded in this Delta Plan. A covered action is defined in the Delta Reform Act as:

> *"…a plan, program, or project as defined pursuant to Section 21065 of the Public Resources Code that meets all of the following conditions:*
>
> 1. *Will occur, in whole or in part, within the boundaries of the Delta or Suisun Marsh;*
> 2. *Will be carried out, approved, or funded by the state or a local public agency;*
> 3. *Is covered by one or more provisions of the Delta Plan;*
> 4. *Will have a significant impact on the achievement of one or both of the coequal goals or the implementation of government-sponsored flood control programs to reduce risks to people, property, and state interests in the Delta." (Water Code section 85057.5(a))*

A State or local agency project proponent determines whether a proposed plan, program, or project is a covered action. A proponent's first step in determining whether an action is a covered action is to identify whether the proposed plan, program, or project meets the definition in Public Resources Code section 21065. That particular provision is the section of the California Environmental Quality Act (CEQA) that defines the term "project" for purposes of potential review under CEQA.[2] If the action does indeed meet the definition of a project under CEQA, the next step in determining a covered action is to review the four additional conditions in the definition of covered action, *all* of which must be met by a proposed plan, program, or project.

To qualify as a covered action, the action must occur, in whole or in part, within the boundaries of the Delta or Suisun Marsh.

The action must be carried out, approved, or funded by the State or a local public agency.

A proposed plan, program, or project must be covered by one or more provisions of the Delta Plan, meaning that a policy is applicable to the proposed action. The Delta Plan may exclude specified actions; therefore, those actions would not be covered by one or more provisions of the Delta Plan.

In addition, a proposed plan, program, or project must have a "significant impact" as defined under Water Code section 85057.5(a)(4). For this purpose, the Council has determined that "significant impact" means a change in existing conditions that is directly, indirectly, and/or cumulatively caused by a project and that will significantly affect the achievement of one or both of the coequal goals or the implementation of government-sponsored flood control programs to reduce risks to people, property, and State interests in the Delta.

Although a regulatory action by another State agency is not a "covered action," the underlying action regulated by that agency can be a covered action (provided it otherwise meets the definition). For example, the issuance of a California Endangered Species Act take permit by the Department of Fish and

[2] It is important to note, however, that CEQA's various statutory and categorical exemptions—which are considered only after the threshold determination of a CEQA "project" is made—are not similarly incorporated by cross-reference in the definition of covered action.

Game (DFG) is a regulatory action of a State agency, and therefore is not a covered action. However, the underlying action requiring the take permit could be a covered action and, if it is, it must be consistent with the Delta Plan's policies. Therefore, even when a covered action is regulated by another agency (or agencies), the action still must be consistent with the Delta Plan. In the situation where a covered action is governed by multiple agencies and laws, the action must comply with all the relevant legal requirements.

As specified in Paragraph 2 of the Council's Administrative Procedures Governing Appeals (Appendix B), if requested, Council staff will meet with an agency's staff during "early consultation" to review the consistency of a proposed action and to make recommendations. The agency's staff may also seek clarification of whether a proposed project is a covered action, provided that the ultimate determination on whether it is a covered action shall be made by the agency, subject to judicial review.

Statutory Exemptions

Certain actions are statutorily excluded from the definition of covered action. Water Code section 85057.5(b) includes the following examples:

- A regulatory action of a State agency (such as the adoption of a water quality control plan by the State Water Resources Control Board, or the issuance of a California Endangered Species Act permit by the DFG)
- Routine maintenance and operation of the State Water Project or the Central Valley Project
- Routine maintenance and operation of any facility located, in whole or in part, in the Delta, that is owned or operated by a local public agency (such as routine maintenance of levees by a reclamation district)

Administrative Exemptions

The Council has determined that the following types of projects are not covered actions because they will not have a significant impact under Water Code section 85057.5(a)(4):

- "Ministerial" projects under CEQA (because they only require the application of fixed standards or objective measurements set forth in an ordinance or other legal or regulatory provision)
- "Emergency" projects under CEQA, as defined in Public Resources Code section 21080(b)(2)-(4)
- Temporary water transfers of up to 1 year in duration

The Council will consider, as part of its ongoing adaptive management of the Delta Plan, whether these exemptions remain appropriate and/or whether the Plan should be amended to include other types of projects.

Figure 3-2 shows the steps in identifying whether a proposed plan, project, or program is a covered action.

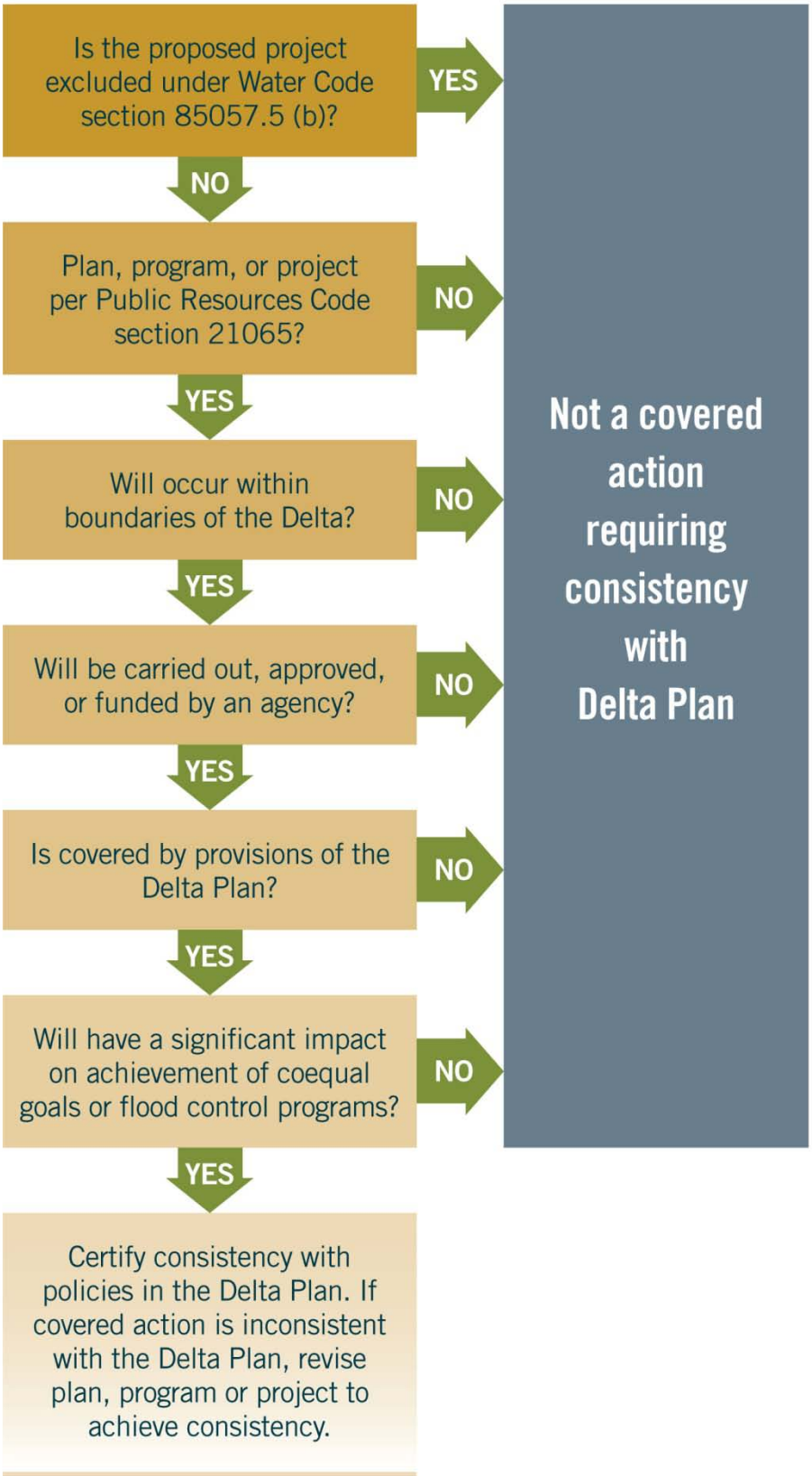

Figure 3-2
Decision Tree for State and Local Agencies on Possible Covered Actions

Certifications of Consistency

State or local agencies that propose to undertake covered actions are required to certify with the Council, prior to initiating implementation, that these proposed plans, programs, or projects are consistent with the Delta Plan (Water Code section 85225 et seq.). The Council will develop a checklist that agencies may use to facilitate the process. Additionally, as required in statute, an agency that acts as a proponent of a covered action must prepare a written certification of consistency with detailed findings as to whether the covered action is consistent with the Delta Plan (Water Code section 85225). These findings must be submitted to the Council as part of the certification of consistency. Any person may appeal the certification of consistency within 30 days; if a valid appeal is filed, the Council is responsible for subsequent evaluation and determination—as provided in statute and the Council's Administrative Procedures Governing Appeals—of whether the proposed covered action is consistent with the Delta Plan's policies. More than one policy in the Delta Plan may apply to a covered action.

As required by the Delta Reform Act and by the Council's procedures that govern appeals, local or State agencies must include in their written certifications of consistency detailed findings as to whether the covered action is consistent with the Delta Plan. Those detailed findings must address consistency with each policy in the Plan that is implicated by the covered action. The Council acknowledges that in some cases, based upon the nature of the covered action, full consistency with all relevant policies may not be feasible. In those cases, per policy G P1 (described below), project proponents must clearly identify areas where consistency is not feasible, establish that consistency with those areas is not feasible, and explain how the covered action nevertheless, on whole, is consistent with the coequal goals. In such cases, the Council may determine, on appeal, that the covered action is consistent with the Delta Plan.

As outlined in G P1, certifications of consistency must demonstrate that a covered action is consistent with the Delta Plan by being fully transparent, disclosing potential environmental impacts, and identifying how best available science will be used in decision-making and adaptive management. Information developed by the Council or provided to the Council will be publicly accessible on the Council's website.

Short-form certifications of consistency apply when an action is taken in conformance with another plan that has been incorporated into the Delta Plan. See more about short-form consistency and when and where it applies in the section that follows G P1.

Policy

G P1 Certifications of consistency with the Delta Plan must address the following:

- A covered action must be consistent with the coequal goals and the inherent objectives. In addition, a covered action must be consistent with each of the policies contained in this Plan implicated by the covered action. The Delta Stewardship Council acknowledges that in some cases, based upon the nature of the covered action, full consistency with all relevant policies may not be feasible. In those cases, covered action proponents must clearly identify areas where consistency is not feasible, explain the reasons, and describe how the covered action nevertheless, on whole, is consistent with the coequal goals and the inherent objectives. In those cases, the Delta Stewardship Council may determine, on appeal, that the covered action is consistent with the Delta Plan.

- All covered actions must be fully transparent by disclosing all potentially significant adverse environmental impacts and feasible mitigations of those adverse impacts.

- As relevant to the purpose and nature of the project, all covered actions must document use of best available science (as described in Chapter 2).

- Ecosystem restoration and water management covered actions must include adequate provisions, appropriate to the scope of the covered action, to assure continued implementation of adaptive management consistent with the Delta Plan. This requirement shall be satisfied through:
  - An adaptive management plan that describes the approach to be taken for each of the nine steps of the adaptive management framework of Chapter 2, and
  - Documentation of access to adequate resources and delineated authority by the entity responsible for the implementation of the proposed adaptive management process.
- All covered action proponents shall certify that the covered action shall comply at all times with existing applicable law.

Amending the Delta Plan

According to the Delta Reform Act, the Council must review the Delta Plan at least once every 5 years and can revise it as the Council deems appropriate.

This authority is consistent with the Council's obligation to base the Delta Plan on the best available scientific information and to adaptively manage the Plan as new information becomes available. Nothing in this section (or elsewhere in the Delta Plan) is intended to limit this authority.

Discretionary Incorporation of Another Plan or Program into the Delta Plan

The Council may incorporate another plan or program, in whole or in part, into the Delta Plan if it furthers the coequal goals or inherent objectives of the Delta Reform Act. When incorporated, the plan, program, or its incorporated elements become part of the Delta Plan, and therefore part of the basis for future consistency determinations. At the time the Council uses its discretion to incorporate another plan or program, the Council will determine the extent of the regulatory effect of the incorporated plan or program. Specifically, the Council will determine whether:

- Future covered actions within the scope of the incorporated plan or program only need to be consistent with the incorporated plan or program, or
- Future covered actions must be consistent with both the incorporated plan or program and some or all other applicable provisions of the Delta Plan. For example, the Council may incorporate an ecosystem restoration plan, but determine that the plan does not include an adaptive management component and therefore require that future covered actions within the scope of the ecosystem restoration plan be consistent with the incorporated plan as well as with the adaptive management policy of the Delta Plan (G P1, as included in this chapter).

For a plan or program that has not been incorporated into the Delta Plan, the agency will file a consistency certification with the Council. If that consistency certification is not appealed or if an appeal is not successful, a proponent of a specific project contemplated by that larger plan must still file a certificate of consistency with the Council. However, the Council encourages the specific project proponent to use and rely on relevant information contained in the larger plan's certification of consistency. Upon appeal, the Council retains the authority to find the specific project inconsistent with the Delta Plan even if the Council finds that the larger plan is consistent with the Delta Plan.

Discretionary Incorporation of Specific Projects into the Delta Plan

The Council may incorporate a specific project into the Delta Plan when the specific project would contribute to achieving the coequal goals or inherent objectives. An agency may propose to the Council that such specific project be incorporated into the Delta Plan, or may include specific projects in its proposal to incorporate a plan into the Delta Plan, as described above. To be incorporated, the specific project must be adequately described, including the project's location, scope, size, and anticipated environmental effects.

Unless the Council specifies additional requirements at the time the project is incorporated into the Delta Plan, when an agency takes a covered action concerning an included project, the agency must file a certificate of consistency indicating only that the specific project is the same project (location, scope, size, and anticipated environmental effects) that was incorporated into the Delta Plan.

Incorporation of the Bay Delta Conservation Plan into the Delta Plan

The Bay Delta Conservation Plan (BDCP) is a major project considering large-scale improvements in water conveyance and large-scale ecosystem restorations in the Delta. When completed, it must be incorporated into the Delta Plan if it meets certain statutory requirements. Completion of the BDCP process and the full suite of projects now under consideration in that process would have large impacts on the Delta and would affect the coequal goals. Water Code section 85320 describes a separate, explicit process for incorporation of the BDCP into the Delta Plan. If the BDCP is incorporated into the Delta Plan, it becomes part of the Delta Plan and therefore part of the basis for future consistency determinations.

After BDCP's incorporation, an agency proposing a covered action that is included in the BDCP or qualifies for credit under the BDCP must file a consistency certification indicating only that the covered action is consistent with the BDCP. The Council retains the authority upon appeal to find the covered action inconsistent with BDCP and therefore the Delta Plan.

Pre-incorporation Use of Bay Delta Conservation Plan Studies or Concepts

The Council has determined that any consideration or use of BDCP-related studies or concepts in the Delta Plan will not have a pre-decisional effect on any possible future appeal of a DFG determination related to BDCP. As required by statute, the Council will base its review of any appeal on the complete record before it, consistent with Water Code section 85320(e) and the Council's adopted appellate procedures.

Chapter 4
A More Reliable Water Supply for California

The Sacramento-San Joaquin Delta Reform Act declared State policy for California's Water Resources and the Delta (Public Resources Code section 29702):

> *(a) Achieve the two coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.*

Inherent in the coequal goals, the legislature declares the following objectives inherent in the coequal goals for management of the Delta (Water Code section 85020):

> *(a) Manage the Delta's water and environmental resources and the water resources of the State over the long term.*
>
> *(d) Promote statewide water conservation, water use efficiency, and sustainable water use.*
>
> *(f) Improve the water conveyance system and expand statewide water storage.*

Increased regional self-reliance and reduced reliance on the Delta for water supplies is established as State policy (Water Code section 85021):

> *The policy of the State of California is to reduce reliance on the Delta in meeting California's future water supply needs through a statewide strategy of investing in improved regional supplies, conservation, and water use efficiency. Each region that depends on water from the Delta watershed shall improve its regional self-reliance for water through investment in water use efficiency, water recycling, advanced water technologies, local and regional water supply projects, and improved regional coordination of local and regional water supply efforts.*

Water Code sections 85302, 85303, 85304, and 85211 provide direction on the implementation of measures to promote the coequal goals and inherent objectives.

> *85302. (d) The Delta Plan shall include measures to promote a more reliable water supply that address all of the following:*
>
> > *(1) Meeting the needs for reasonable and beneficial uses of water.*
> >
> > *(2) Sustaining the economic vitality of the State.*
> >
> > *(3) Improving water quality to protect human health and the environment.*
>
> *85303. The Delta Plan shall promote statewide water conservation, water use efficiency, and sustainable use of water.*
>
> *85304. The Delta Plan shall promote options for new and improved infrastructure relating to the water conveyance in the Delta, storage systems, and for the operation of both to achieve the coequal goals.*
>
> *85211. The Delta Plan shall include performance measurements that will enable the council to track progress in meeting the objectives of the Delta Plan. The performance measurements shall include, but need not be limited to, quantitative or otherwise measurable assessments of the status and trends...*
>
> > *(b) The reliability of California water supply imported from the Sacramento River or the San Joaquin River watershed.*

The longstanding constitutional principle of reasonable use and the public trust doctrine form the foundation of California's water management policy and are particularly applicable to the Delta watershed and to the others areas that use Delta water as the basis for resolving water conflicts. (Water Code Section 85023) The constitutional principle is defined in Section 2 of Article X of the California Constitution as:

> *The right to water or to the use or flow of water in or from any natural stream or water course in this State is and shall be limited to such water as shall be reasonably required for the beneficial use to be served,*

and such right does not and shall not extend to the waste or unreasonable use or unreasonable method of use or unreasonable method of diversion of water.

Water Code Sections 85031 and 85032 provides clarification that existing water rights, procedures or laws are not affected:

85031. (a) This division does not diminish, impair, or otherwise affect in any manner whatsoever any area of origin, watershed of origin, county of origin, or any other water rights protections, including, but not limited to, rights to water appropriated prior to December 19, 1914, provided under the law. This division does not limit or otherwise affect the application of Article 1.7 (commencing with Section 1215) of Chapter 1 of Part 2 of Division 2, Sections 10505, 10505.5, 11128, 11460, 11461, 11462, and 11463, and Sections 12200 to 12220, inclusive.

(b) For the purposes of this division, an area that utilizes water that has been diverted and conveyed from the Sacramento River hydrologic region, for use outside the Sacramento River hydrologic region or the Delta, shall not be deemed to be immediately adjacent thereto or capable of being conveniently supplied with water therefrom by virtue or on account of the diversion and conveyance of that water through facilities that may be constructed for that purpose after January 1, 2010.

(c) Nothing in this division supersedes, limits, or otherwise modifies the applicability of Chapter 10 (commencing with Section 1700) of Part 2 of Division 2, including petitions related to any new conveyance constructed or operated in accordance with Chapter 2 (commencing with Section 85320) of Part 4 of Division 35.

(d) Unless otherwise expressly provided, nothing in this division supersedes, reduces, or otherwise affects existing legal protections, both procedural and substantive, relating to the state board's regulation of diversion and use of water, including, but not limited to, water right priorities, the protection provided to municipal interests by Sections 106 and 106.5, and changes in water rights. Nothing in this division expands or otherwise alters the board's existing authority to regulate the diversion and use of water or the courts' existing concurrent jurisdiction over California water rights.

85032. This division does not affect any of the following:

(a) The Natural Community Conservation Planning Act (Chapter 10 (commencing with Section 2800) of Division 3 of the Fish and Game Code).

(b) The California Endangered Species Act (Chapter 1.5 (commencing with Section 2050) of Division 3 of the Fish and Game Code).

(c) The Fish and Game Code.

(d) The Porter-Cologne Water Quality Control Act (Division 7 (commencing with Section 13000).

(e) Chapter 8 (commencing with Section 12930) of Part 6 of Division 6.

(f) The California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code).

(g) Section 1702.

(h) The application of the public trust doctrine.

(i) Any water right.

(j) The liability of the state for flood protection in the Delta or its watershed.

Chapter 4
A More Reliable Water Supply for California

One of the Delta Reform Act's coequal goals for management of the Sacramento–San Joaquin Delta is "to provide a more reliable water supply for California" (Water Code section 85054).

In the Delta Reform Act, the Legislature finds that the "Delta watershed and California's water infrastructure are in crisis and existing Delta policies are not sustainable" (Water Code section 85001(a)). In its effort to provide a more reliable water supply for the state, the Delta Plan must address objectives the Legislature declared were inherent to the coequal goals: "manage the Delta's water and environmental resources and the water resources of the State over the long term… promote statewide water conservation, water use efficiency and sustainable water use… and improve the water conveyance system and expand statewide storage" (Water Code section 85020).

The Delta Reform Act does not offer a definition of water supply reliability, but it provides multiple references to strategies or objectives that the Delta Plan must address to improve water supply reliability for California, including:

- "Providing a more reliable water supply for the state involves implementation of water use efficiency and conservation projects, wastewater reclamation projects, desalination, and new and improved infrastructure, including water storage and Delta facilities." (Water Code section 85004(b))
- "Reduce reliance on the Delta in meeting California's future water supply needs through a statewide strategy of investing in improved regional supplies, conservation, and water use efficiency. Each region that depends on water from the Delta watershed shall improve its regional self-reliance for water through investment in water use efficiency, water recycling, advanced water technologies, local and regional water supply projects, and improved regional coordination of local and regional water supply efforts." (Water Code section 85021)
- "Promote statewide water conservation, water use efficiency, and sustainable use of water." (Water Code 85303)
- "Promote options for new and improved infrastructure relating to the water conveyance in the Delta, storage systems, and the operation of both to achieve the coequal goals." (Water Code section 85304)

The Delta Plan recognizes the inherent variability of California's water supplies resulting from the state's erratic precipitation patterns, and how this will likely become increasingly volatile in the future as a result of climate change. The Delta Plan also recognizes that major regions of California depend on receiving some portion of their water supply from flows that originate in the Delta watershed. Statewide

Water Supply Reliability

Providing a more reliable water supply for California is one of the coequal goals established by State law and is an essential element of the Delta Plan. Fundamentally, this means that California must match its demands for, and use of water to, the available supply.

California's water supply comes primarily from rain and snow (precipitation), the use of groundwater, extensive reuse of water, and some imported water from other regions (DWR 2009). However, our water supply is volatile; it does not arrive in a regular amount each and every year. Our state's water supplies vary from year to year for many reasons:

- Weather patterns change from year to year, and precipitation amounts vary dramatically from year to year.
- Periodic droughts occur throughout our history.
- Natural and human-made catastrophic events, such as earthquakes, floods, levee breaks, and pipeline failures compound our problems.
- Environmental requirements may limit the amount of water available for other purposes.
- Legal requirements to maintain high water quality standards for drinking water may limit the amount of water than can be exported from regions of the state with a significant supply of fresh water.
- Legal battles between regions of the state, battles between various economic interests, and complicated determinations of water use priorities and impacts have occurred throughout our history as a state.
- Climate change that alters temperature and precipitation and causes sea level rise also impacts how and where water may be used for human purposes and for the environment.

The longstanding policy of California is that urban water suppliers should be prepared to cope with the inherent uncertainty of their water supplies. Since 1983, the Urban Water Management Planning Act has required large urban suppliers to develop long-term water management plans (Water Code section 10610 et. seq.). These plans must identify any water source that "may not be available at a consistent level of use" under normal, dry, and multiple dry year scenarios, and explain how, to the extent practicable, they "will supplement or replace the uncertain supply with either other sources of water or through implementation of water conservation and water efficiency measures" (Water Code section 10631(c)(2)).

The Delta Reform Act and the Delta Plan take similar approaches to improving the reliability of the state's water supply. Both reaffirm that all regions of the state must diversify their water supplies. Both reaffirm that all regions of the state must reduce their reliance on Delta water for future needs. Both require that all regions of the state must adopt conservation and water use efficiency measures to demonstrate reasonable use of water, consistent with California's Constitution, Article 10, Section 2, that water must be used reasonably and that waste of water is not permitted.

Accordingly, decreasing the statewide per capita demand for water, through conservation and water reuse efficiencies, is a necessary step, as are reasonable actions to improve the water system efficiency and seek new water supplies. Those steps go together; they do not stand alone.

For regions of the state that depend on the Delta watershed for some portion of their water supply, the Delta Plan specifically calls upon them to improve their self-reliance by implementing measures that diversify and expand their water supplies from other sources as well as increase conservation and water use efficiency.

The Delta Plan also recognizes that the amount of water available from the Delta, delivered through the State Water Project and the Central Valley Project, must be made more predictable. The Bay Delta Conservation Plan process is the primary focus of the State's effort to develop a long-term solution for the Delta, and it will address the major conveyance and operational improvements as well as ecosystem enhancements that are needed to make this happen. In the interim, the Delta Plan promotes smaller, incremental improvements for storage and conveyance that may be implemented in the Delta watershed over the next 5 to 10 years to improve the reliability of these supplies.

The task of providing a more reliable water supply for California is a responsibility shared by everyone in the state. The Delta Plan calls upon all water suppliers—urban and agricultural—throughout California to prepare a "Water Supply Reliability" element in their respective water plans to demonstrate that each region of the state is taking appropriate steps to improve the management of its existing water supplies and, to the extent possible, increase and diversify its water supplies. Improving water supply reliability for the state means that California is on a track to increase it's water conservation and water efficiency, develop more water from more sources, and reduce its reliance on the Delta to meet the state's future water needs.

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improvements in water conservation, water efficiency, and development of new local and regional supplies over the past decade have significantly increased California's ability to meet most of its agricultural and urban water needs. Yet, at the same time, the reliability of water deliveries from the State Water Project (SWP) and the Central Valley Project (CVP) has diminished because of drought and the sharp decline of native fisheries that has resulted in court-ordered and regulatory water project operating restrictions to protect the Delta ecosystem.

The Delta Plan adopts the overarching goal of improving the reliability of the state's water supply through the expansion and more efficient management of California's water resources at the state, regional, and local levels so that the State and local water suppliers can more predictably match demands for, and use of water to, the available water.

The Delta Plan envisions a future where:

- California has more reliable water supplies through enhanced conservation and water efficiency as well as through the development of additional local and regional water supplies, and achieving improved regional water balance, water quality protection, and improved storage and conveyance facilities.
- Regions that rely on receiving some portion of their water from the Delta watershed as part of their overall supply have reduced their reliance on these deliveries and improved their self-reliance through increased conservation and diversification of their local and regional sources of supply.
- The reliability of SWP and CVP deliveries from the Delta watershed has improved through enhanced storage and conveyance that is consistent with protection of the Delta ecosystem.

This chapter provides an overview of California's water picture and the relationship between the Delta and California's water supply. Six key water supply strategies must be implemented to achieve the coequal goal of providing a more reliable water supply for California:

- Reduced reliance on the Delta through improved regional self-reliance
- Updated Delta flow requirements
- Completion of the Bay Delta Conservation Plan
- Expanded water storage and improved existing conveyance
- Sustainable groundwater management
- Improved reporting and transparency

The California Water Picture

Variability and uncertainty are the dominant characteristics of California's water resources. Precipitation is the source of 97 percent of California's water supply. It varies greatly from year to year, as well as by season and where it falls geographically in the state. With climate change, the state's precipitation is expected to become even more unpredictable.

In an average water year, precipitation provides California with about 200 million acre-feet (MAF) of water falling as either rain or snow (DWR 2009).[3] However, the total volume of water the state receives can vary dramatically between dry and wet years. California may receive less than 100 MAF of water during a dry year and more than 300 MAF in a wet year (Western Regional Climate Center 2011a).

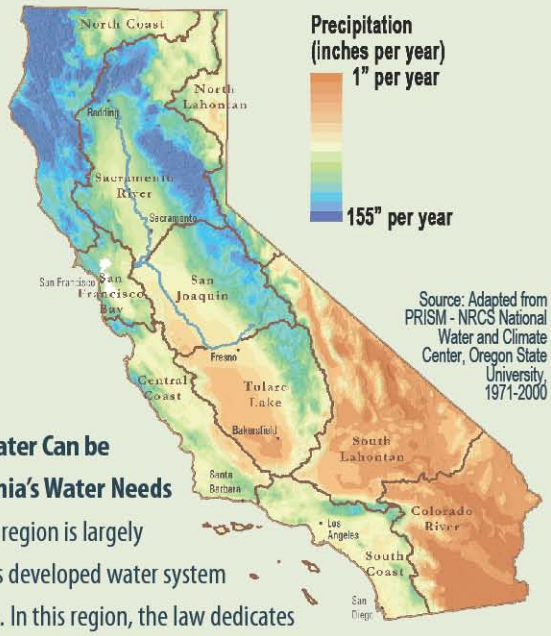
Because so much of California's precipitation comes from relatively few storms, the pattern of extreme annual fluctuations in the State's water supply is intensified. California experiences the most erratic

[3] Includes up to 10 MAF of water flowing into California from Oregon, Mexico, and the Colorado River.

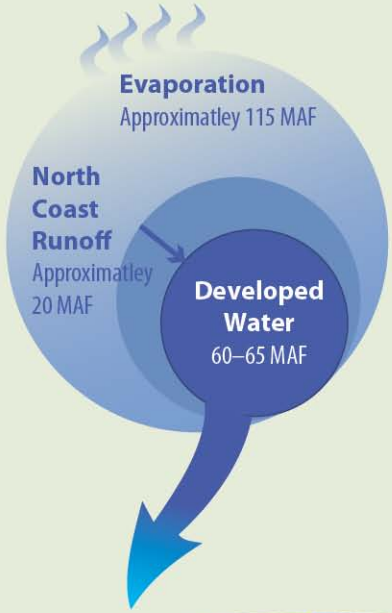
Where California's Water Goes

Where California's Water Comes From

Most of California's water comes from rain and snow that falls in northern half of the state. On average, precipitation and inflow supplies California with about 200 MAF per year. More than half of this supply evaporates or is taken up by trees and vegetation (through transpiration), leaving about 80 to 85 MAF of water available for in-stream and human uses in an average year.

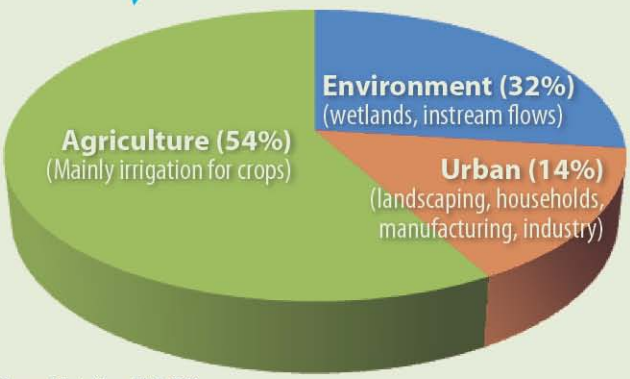


Source: Adapted from PRISM - NRCS National Water and Climate Center, Oregon State University, 1971-2000



Only Some of this Water Can be Used to Meet California's Water Needs

California's North Coast region is largely isolated from the state's developed water system of reservoirs and canals. In this region, the law dedicates an average of about 20 MAF annually to instream flows. This means the State's developed supply (the amount of water that has been brought under human control and is available for human and environmental use) averages about 60 to 65 MAF per year.



Source: Adapted from DWR, 2009

Where California's Water Goes

The State's developed water supply is divided between agricultural, urban, and environmental uses. In 2000, an average year, 14 percent was used for urban purposes, 54 percent was used by agriculture, and nearly 32 percent was used for instream flows and managed wetlands, although much of this water was also reused.

[SIDEBAR UNDER DEVELOPMENT]

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pattern of precipitation of all the states in the nation, with the bulk of its annual water supply falling within just 5 to15 days (Dettinger et al. 2011).[4] This means that in years when fewer storms pass over California, the state faces the problem of too little water; conversely, a few extra storms may result in flooding.

Out of all precipitation that California receives, over half evaporates[5], which leaves about 40 to 50 percent of the water available for use in urban areas, agriculture, and the environment, collectively. In an average water year, the available supply is between 80 to 85 MAF. Again, the fluctuations between wet and dry years can be extreme, with wet years providing over 95 MAF and critically dry years producing less than 65 MAF of available supply (LAO 2008).

Of the 80 to 85 MAF of available supply in an average year, around 18 to 20 MAF is dedicated to meet federally protected Wild and Scenic River flows and other instream flow requirements in the largely hydrologically separate North Coast region. This water is not available for human uses elsewhere in the state (Hanak et al. 2011).[6] This means that the state's developed supply—the amount of water that has been brought under human control and is available for human and environmental use—is about 60 to 65 MAF per year in an average year. In the year 2000, when California received approximately 97 percent of its average annual precipitation, available water totaled about 63 MAF.

Human use of this developed supply in 2000 was about 43 MAF, with about 9 MAF going to urban (municipal and industrial) uses and 34 MAF being used for agricultural irrigation (DWR 2009).[7] The remaining supply of roughly 20 MAF is often counted as environmental water, although much of this water is also reused for urban and agricultural purposes.

The unpredictability and geographic variation in precipitation that California receives make it challenging to managing the available runoff to meet urban and agricultural water needs. The majority of California's precipitation occurs between November and April, yet most of the state's demand for water is in the hot, dry summer months. In addition, most of the precipitation falls in the mountains in the northern half of the state, far from major population and agricultural centers. In some years, the far north of the state can receive 100 inches or more of precipitation, while the southernmost regions receive only a few inches (Western Regional Climate Center 2011b).

The historical record also shows that California has frequently experienced long multi-year droughts, as well as extremely wet years that coincide with substantial flooding (Hanak et al. 2011). Since 1906, one-third of the water years in California have been considered by DWR to have been "dry or critically dry"; the percentage has increased to 37 percent since 1960, which is consistent with the predicted impacts of climate change on California (California Data Exchange Center 2011).

To cope with this hydrologic variability and also manage floods during wet years, a vast interconnected system of surface reservoirs, aqueducts, and water diversion facilities has been constructed over the last hundred years by State, federal, and local agencies. This system helps California to store and convey water supplies from areas that have water available to areas that have water needs. In most regions of the state, these imported water supplies supplement local and regional water sources.

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[4] For example, Southern California cities experienced their lowest recorded annual precipitation in history within the past decade. In addition, the city of Los Angeles experienced both its driest and wettest years on record (California Natural Resources Agency 2008)

[5] Includes evaporation, evapotranspiration of native vegetation, groundwater subsurface outflows, and other losses (DWR 2009).

[6] The only exceptions in the North Coast are the diversions from the Trinity River to the Sacramento River for Central Valley Project supplies The decision made in the mid-1970's not to permit major diversions of water from the North Coast reduced the amount of water expected to be made available to the State Water and the Central Valley Projects for export.

[7] Accounting for how much water California actually uses is complicated because water can be reused several times before it reaches the ocean or otherwise cannot be recovered. When water is applied to agricultural and urban uses, there is often water that is not consumed and is returned to the environment, e.g., agricultural return flows and treatment of residential wastewater that is discharged downstream.

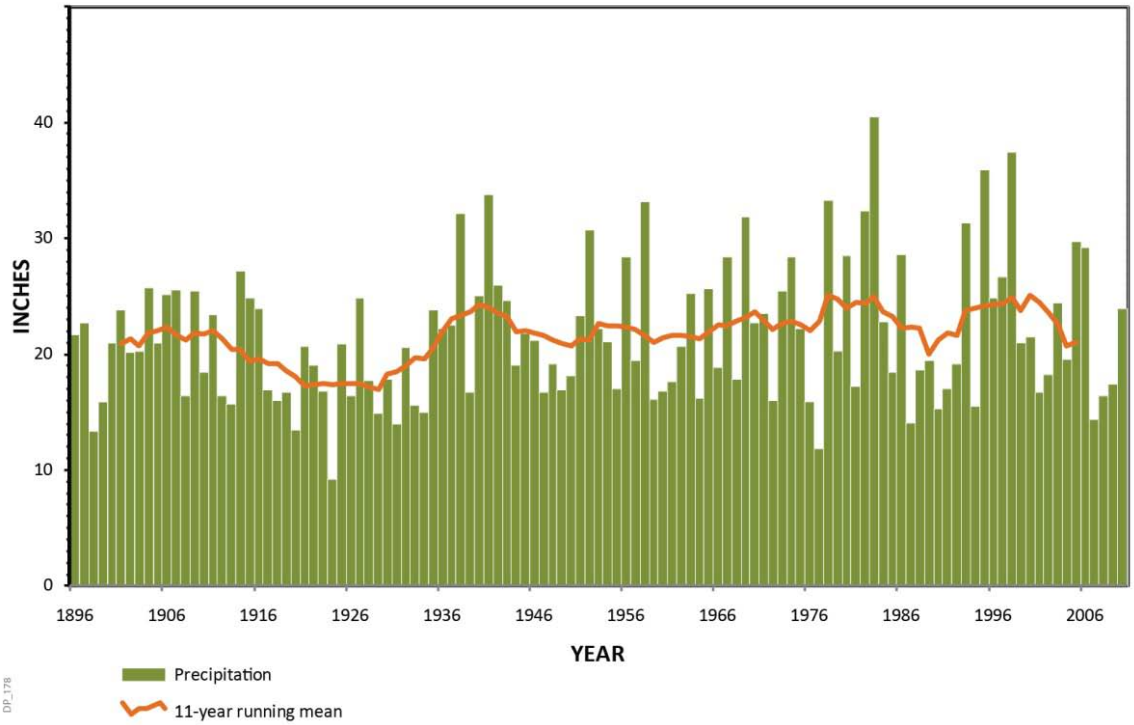


Figure 4-1
California's Variable Precipitation
On average, California receives about 200 million acre-feet per year, but in wet years precipitation can exceed 300 million acre-feet and in dry years it can be less than 100 million acre-feet. The unpredictability of the state's rainfall, and its history of multi-year droughts, makes the management of available water to reliably meet in-stream and human uses extremely challenging. Source: DWR 2009; Western Regional Climate Center 2011a

The amount of water infrastructure that has been built in the state is impressive. California has over 1,400 major reservoirs with a combined storage capacity of 43 MAF, about half the average annual statewide runoff (Hanak et al. 2011; DWR 2011a). Thousands of miles of canals and large pumps have been constructed to move water around the state. The first major regional storage and conveyance projects were developed to store and convey supplemental water from the Delta watershed in the Sierra Nevada and from the Owens Valley to the rapidly growing regions in the San Francisco Bay Area and Southern California, respectively.[8] The state's largest and most recent projects are the State Water Project (SWP) and the Central Valley Project (CVP), which were mostly constructed between 1930 and 1970. These projects were designed to export water from the Delta watershed and provide supplemental water for agricultural and urban uses, primarily in the Central Valley and Southern California.

However, surface storage and conveyance of water supplies are only part of California's complex water system. The average amount of water delivered from these facilities—the SWP and CVP exports, and the Hetch Hetchy, Mokelumne, and Los Angeles aqueducts—accounts for about 16 percent of the state's water supplies.[9] The remaining 84 percent of the state's water supply comes largely from local surface water deliveries, groundwater supplies, and imported water from the Colorado River (DWR 2009).

[8] These included the San Francisco Public Utilities Commission's Hetch Hetchy Project, Los Angeles' Owens Valley and Mono Basin Aqueduct, and the East Bay Municipal Utility District's Mokelumne Aqueduct. Additional projects that brought Colorado River water into California were the Imperial Irrigation District's All American Canal and the Metropolitan Water District of Southern California's Colorado River Aqueduct.

[9] In an average year (based on 2000), the State Water Project and Central Valley Project account for 14.2 percent of the state's developed water supplies. The remaining 1.7 percent comes through the Hetch Hetchy, Mokelumne, and Los Angeles Aqueducts.

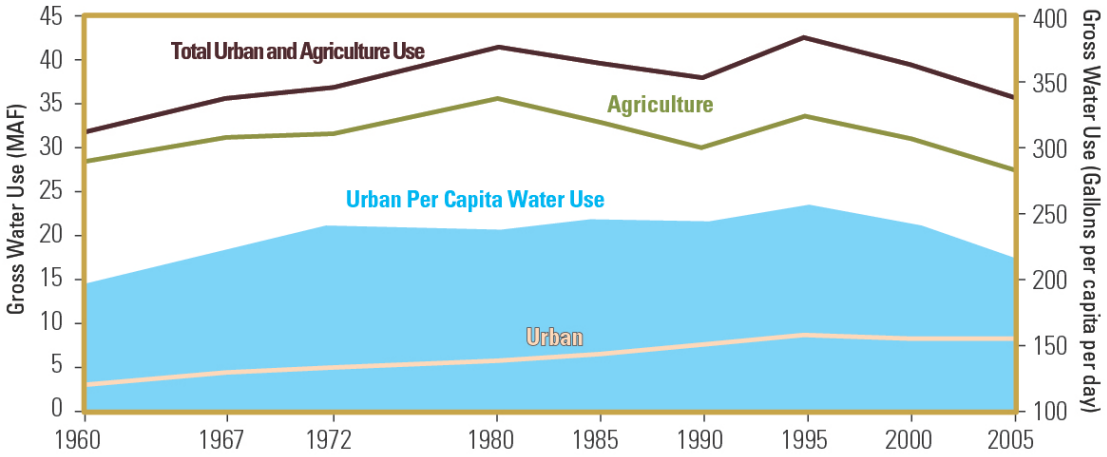
Figure 4-2
Moving and Storing California's Water [UNDER DEVELOPMENT]
State, federal, and local water projects store and convey water across California to meet the needs of farms and cities.
Source: DWR 2009

Historically, local water resources constituted the backbone of California's water supply reliability. Local surface storage and deliveries, together with reuse, account for about 40 percent of the state's developed water supplies. Groundwater is also a significant resource, supplying about 35 percent of the state's water needs, and 40 percent or more during droughts. Imported water from the Colorado River provides 10 percent of the state's developed water supply, serving communities in Southern California. A small amount is attributed to recycled water and other local reuse projects (DWR 2009).

As the State looks to the future, many new planning and project initiatives are now underway to expand these local and regional water supplies. Recycled water, brackish groundwater and ocean desalination, capture of stormwater runoff and treatment, and treatment and reuse of poor-quality water now constitute the state's most rapidly growing new sources of water (DWR 2009). These projects often make water available from local and regional resources that may have been ignored, underutilized, or unavailable until recent decades. For example, urban stormwater runoff has long been viewed as a flooding and water quality problem, not as a water resource. Many communities are now capturing this water for groundwater recharge and outdoor irrigation. Often, these local and regional water supplies have the additional advantage of being available even during extreme drought conditions, making them some of the most reliable sources of water available.

Since 1980, California's total water use has been declining. The majority of this reduction has occurred in the agricultural sector, where increased irrigation and efficiency and some land retirements have shifted water use patterns (Hanak et al. 2011). Urban water use has also become more efficient and per capita water use has declined significantly in the past 10 years. The result is that statewide urban water use has remained flat for more than a decade despite the addition of more than 5 million people to California's population during this period.

Trends in California Water Use



Over the last two decades, California's total water use has been declining. A majority of the reduction has occurred in the agricultural sector, where increased irrigation efficiency and some land retirements have shifted water use patterns. Urban water use is also becoming more efficient, and per capita water use has declined significantly. As a result, statewide urban water use has remained relatively flat over the last decade, despite substantial population growth. Some major cities, like the city of Los Angeles, are using the same amount today as they did over 30 years ago, even with the addition of over 5 million people to their population. California's experience mirrors national trends which show declining water use patterns, particularly in the urban sector.

Source: Hanak et al. 2011; adapted from DWR 2009

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Increased water efficiency and conservation is not just happening in California; it is a nationwide trend, with many water suppliers now reporting declining residential water sales (Rockaway 2011). These efficiency gains have resulted from improved water-conserving products (low-flow toilets, showers, dish washers, and washing machines), building code requirements for use of water-efficient designs and appliances, installation of more water-efficient landscaping, and implementation of conservation programs that have widely retrofitted homes and businesses with more-efficient appliances.

New laws enacted in California within the last 5 years require significant additional improvements in both urban and agricultural water conservation and water efficiency. In particular, the state is on track to achieve a 20 percent reduction in statewide per capita water use by 2020. Other laws include a requirement to comply with the State's Demand Management Measures (including the adoption of a conservation-based rate structure), adoption of water-conserving landscape ordinances, and implementation of cost-effective agricultural water-efficient practices.

Taken together, the addition of substantial new water supplies from local and regional sources and the increase in efficient water use is significantly improving the reliability of the California's water supplies. Continued implementation of these strategies is a vital component to making the state's water supplies more resilient under conditions of drought, emergency shortages, and climate change.

The Delta and California's Water Supply

The Sacramento–San Joaquin Delta is at the center of water in California. Overall, about half of the state's runoff flows through the Delta.

The natural Delta system was formed by water inflows from upstream tributaries in the Delta watershed and outflow to Suisun Bay and San Francisco Bay. The Sacramento River watershed and tributaries east of the Delta supplied roughly 85 percent of these flows, and the San Joaquin River provided about 15 percent (LAO 2008).

Over time, this natural pattern of water flows has changed as the result of upper watershed diversions and the construction of facilities to divert and export water through the Delta to areas where supplemental water supplies are needed, including densely populated areas like San Francisco and Southern California and agricultural regions like the San Joaquin Valley and Tulare Lake. The SWP and CVP, the largest surface water storage and delivery systems in the state, use the Delta as the hub of their conveyance systems to deliver water to large pumps located in the southern Delta. These exports, when combined with upstream diversions and uses, have transformed the Delta, reducing its annual water outflows to the ocean on average by 50 percent (CALFED Ecosystem Restoration Program 2008).

Overall, in-Delta water use has remained relatively constant over the past 100 years (DWR 2007). In-Delta use including water to the Contra Costa Canal, and Mokelumne and Hetch Hetchy Aqueducts accounts for roughly 2.1 MAF per year (DWR 2005). Water exported through the SWP and CVP started in the 1950s and can range from approximately 3 MAF in some dry years to more than 6 MAF.[10]

More water is exported by the SWP and CVP in average or dry years than in wet years.[11] This is because the current infrastructure for water conveyance and surface storage limits the ability of the State and federal systems to capture more water during high flows that otherwise would have been available for diversion. Wet year exports through these projects averaged about 4.6 MAF, significantly less than average or dry year diversions (DWR 2009).

[10] Based upon average diversions between 2003 and 2006.

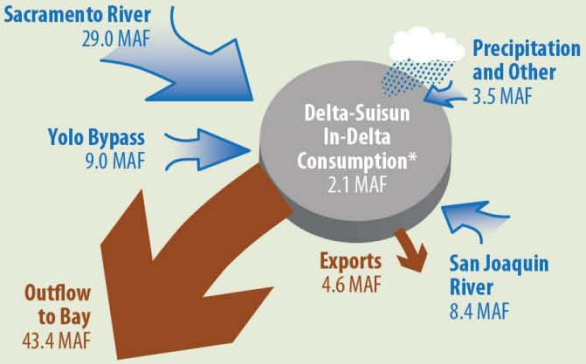
[11] 2011 is the first wet year in which exports have exceeded 6 MAF. This is attributed to the increase in available storage capacity after several new storage projects were completed south of the Delta over the last 10 years.

California's Water and the Delta

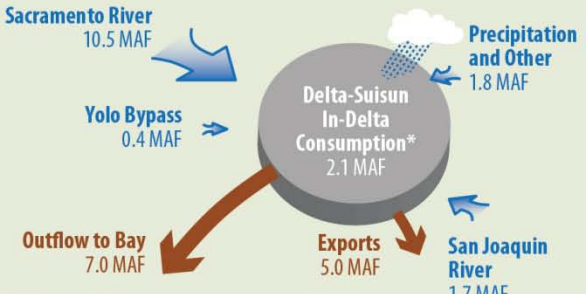
Most of the water that flows into the Delta comes from the Sacramento River watershed and San Joaquin River. The remaining flows come from smaller rivers to the east and local precipitation. Collectively these flows support the Delta ecosystem and contribute to urban and agricultural needs in the Delta and Bay Area, Central Valley, and Southern California. Over the past century, upstream diversions and water exports have transformed the Delta, reducing average outflows to the ocean by an average of 50 percent.

Source: LAO, 2008

Delta Exports Vary from Year to Year



WET YEAR — Lots of water is available to meet a wide range of needs including outflow to the ocean, but less is required for exports due to availability of other supplies and insufficient storage in areas that use water exported from the Delta.**



Source: DWR, 2005

DRY YEAR — Low water flows overall, diminished Delta outflow, but most need for exports for agricultural and urban uses and greatest competition for the Delta's water resources, both for the Delta ecosystem and to provide adequate water for in-Delta users.**

* Includes water to the Contra Costa Canal, and Mokelumne and Hetch Hetchy Aqueducts

** Representative data from 1998 and 2001, prior to implementation of existing Delta export restrictions to protect Delta fisheries.

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Many constraints in the Delta impact the reliability of SWP and CVP water deliveries from this system. The recent sharp declines in native fish populations have resulted in court-ordered and regulatory restrictions on State and federal pumping of export water, and in combination with the recent drought, have reduced exported water deliveries to SWP and CVP contractors. SWP and CVP deliveries are expected to average 60 percent of maximum contract amounts in future years, down from 63 percent estimated in 2007 (DWR 2010b).

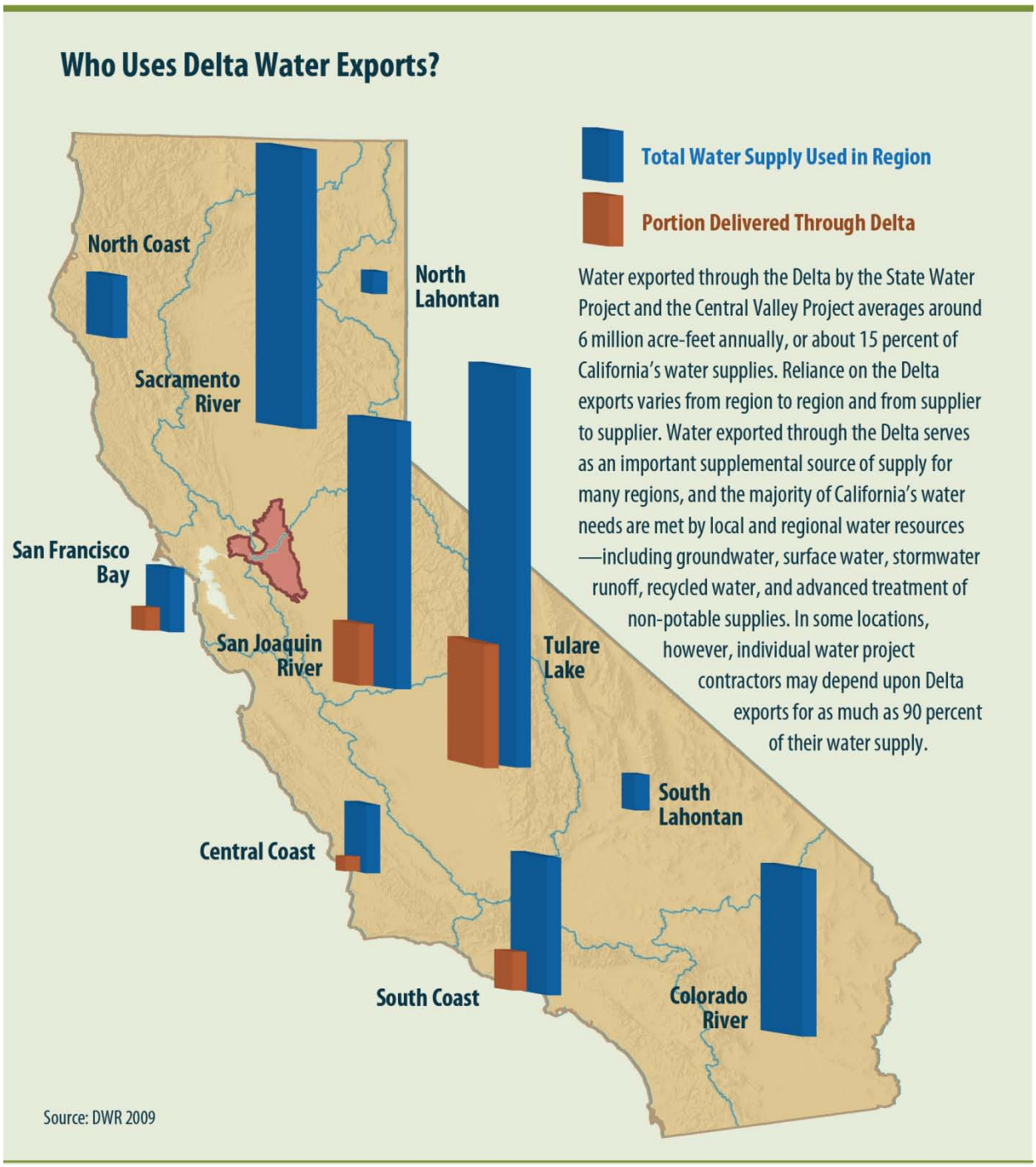
Further, conflicts over the Delta and its water supplies are increasing—including concerns about the continued health of the Delta's ecosystem, increasing variability of the state's annual precipitation, catastrophic levee failures caused by earthquakes and subsidence, increased flood risks, impaired water quality, aging storage and conveyance infrastructure, and the long-term impacts of climate change. The result is that the Delta cannot reliably meet the water supply demands place upon it.

This problem is compounded by SWP and CVP contracts that promise more water than can be consistently delivered. The SWP and CVP contract amounts were originally based on assumptions about additional facilities that were to be constructed at a later date. For various reasons, some of these facilities were never built and, as a result, the State and federal systems cannot reliably deliver full contract amounts (see Chapter 1). In fact, the CVP has fulfilled 100 percent of its contract allocations only three times in its history, and the SWP has delivered 100 percent of its contract amounts only five times (Cooley et al. 2009) In addition, unlike the State Water Project, in the Federal system shortages are not evenly distributed; they are allocated based on seniority of water rights. As a result, in dry years some contractors will receive 100 percent of their water allocations while others receive as little as 10 percent. Overall, SWP and CVP deliveries have averaged about 60 percent of the total original contracted amounts of nearly 10 MAF of water (Cooley et al. 2009).

Because of the Delta's central location, the water needs of most Californians are connected in some way to the Delta. Residents and businesses in or near the Delta and San Francisco Bay area are most dependent on water supplied from the Delta and its watershed. While exports from the Delta watershed account for about 14 percent of the state's total water supply, some portion of this water flows annually to 25 million of the state's residents and 3 million irrigated acres of farmland (DWR 2009; DWR 2007).

Reliance on water provided through Delta exports varies throughout California from region to region, supplier to supplier, and user to user; this consideration is important for evaluating how water supply reliability can be best improved. For example, the service area for Metropolitan Water District of Southern California covers five counties and includes over 18 million residents, and yet it relies on the Delta for roughly 25 percent of its water supplies. In other locations such as Zone 7 Water Agency, water contractors may depend upon Delta exports for as much as 90 percent of their water supply.

Expansion of local and regional water supplies and improved water conservation and efficiency can significantly reduce pressure on the Delta ecosystem. By planning and implementing programs and projects that further increase the diversity and yield of local and regional water supplies, the state will improve the reliability of its water supplies and help regions to reduce their reliance on the Delta. At the same time, additional improvements in surface water storage and conveyance will increase the reliability of deliveries from the SWP and CVP systems.


Who Uses Delta Water Exports?
Total Water Supply Used in Region
Portion Delivered Through Delta
Water exported through the Delta by the State Water Project and the Central Valley Project averages around 6 million acre-feet annually, or about 15 percent of California's water supplies. Reliance on the Delta exports varies from region to region and from supplier to supplier. Water exported through the Delta serves as an important supplemental source of supply for many regions, and the majority of California's water needs are met by local and regional water resources —including groundwater, surface water, stormwater runoff, recycled water, and advanced treatment of non-potable supplies. In some locations, however, individual water project contractors may depend upon Delta exports for as much as 90 percent of their water supply.
North Coast
North Lahontan
Sacramento River
San Francisco Bay
San Joaquin River
Tulare Lake
South Lahontan
Central Coast
South Coast
Colorado River
Source: DWR 2009
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Policies and Recommendations

Reduce Reliance on the Delta through Improved Regional Water Self-reliance

The State has long recognized the importance of improving regional water supply self-reliance through conservation, water use efficiency, and the increased development of local and regional water supplies. These programs and projects increase the reliability of the state's water supplies by reducing overall demand and developing a diverse array of water sources for California that, when combined, are more resilient under conditions of drought, emergency shortage, and climate change.

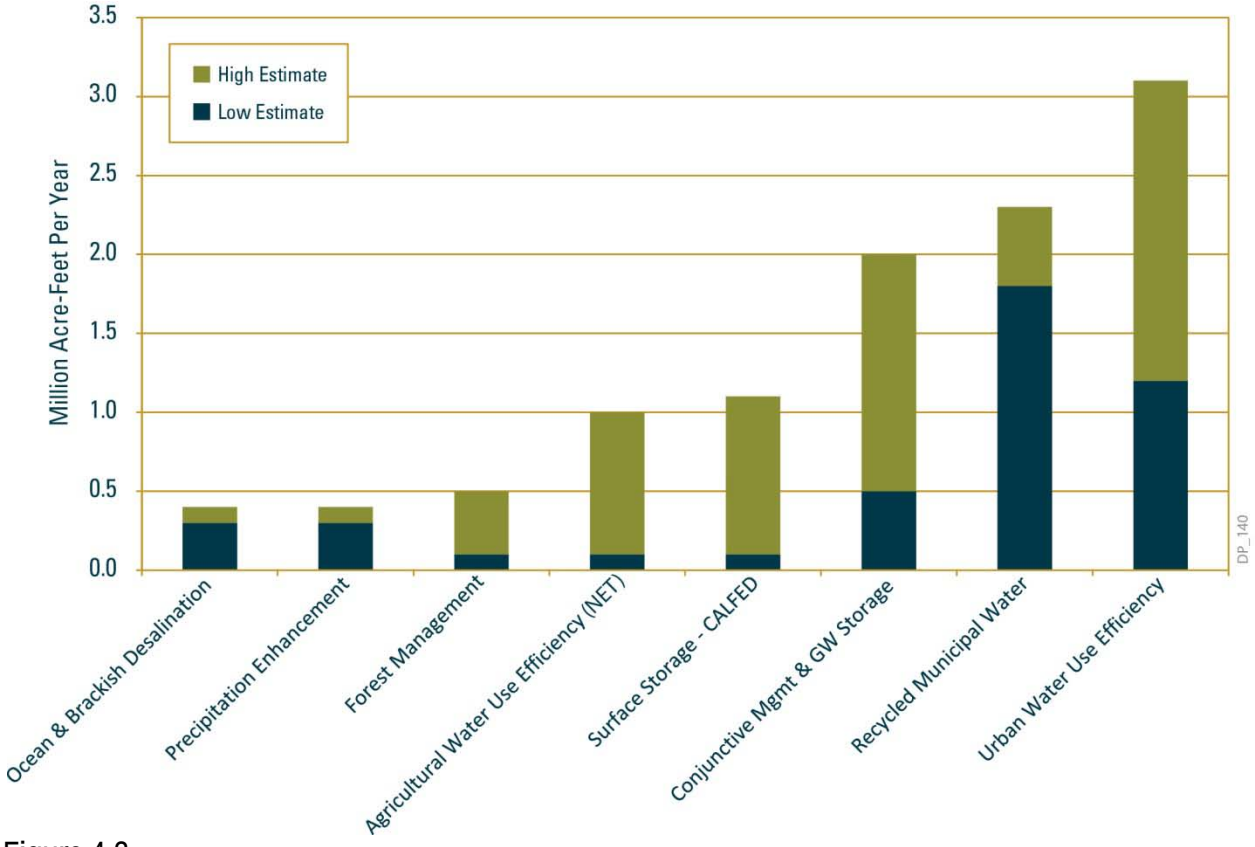

Figure 4-3
Strategies to Increase Water Supply and Reduce Demand
California has a wealth of additional water resources that can be developed. In 2009, the Department of Water Resources estimated that the state could further reduce water demand and increase water supplies in the range of 5 to 10 million acre-feet over the next 30 years through the use of existing technologies. Improved efficiency and the development of these supplies will reduce reliance on the Delta and greatly improve water supply reliability for California.
Source: DWR 2009

The state has a wealth of water resources that can be developed. The California Water Plan 2009 Update estimates that the state could reduce future water demand and increase water supplies in the range of 5 to 10 MAF over the next 30 to 40 years.[12] If California developed only half of this water (about 5 MAF)

[12] DWR provides a cautionary note that the water supply benefits summarized in the California Water Plan are not intended to be additive, recognizing that some resource management strategies may complement or compete with one another for funding, system capacity, or other components necessary for implementation. However, the range of 5 to 10 MAF is consistent with recent studies that assess potential water savings or increased water supplies.

through water efficiency and new water supplies, it would be sufficient to support the addition of almost 30 million residents to the state.[13] Nearly all of these potential supplies would come from improved conservation and water use efficiency in the urban and agricultural sectors, local groundwater and surface storage, conjunctive management, recycled water, and drinking water treatment, groundwater remediation, and desalination. For some of these resources, California has adopted formal goals, including:

- **Urban Water Conservation**. The State's goal is to achieve a reduction in statewide per capita water use of 20 percent, from a 2005 baseline of 192 gallons per capita daily (GPCD) to 154 GPCD.[14] This represents a potential annual water savings of 1.74 MAF per year that will be accomplished within the next 9 years. This is consistent with DWR's 2009 estimate that 2.1 MAF can be conserved in roughly the same period through increased use of water-efficient appliances, reduced water use for landscaping, and tiered price structures.

- **Recycled Water**. The State's goal is to increase the use of recycled water over 2002 levels by at least 1 MAF per year by 2020 and by at least 2 MAF per year by 2030.[15] DWR's 2009 estimate indicates that as much as 2.25 MAF could be recovered, about half of the amount of wastewater that is treated and released to flow to the ocean.

- **Stormwater Runoff**. The State's goal is to increase capture and reuse of stormwater by at least 500,000 acre-feet per year by 2020, and at least 1 MAF per year by 2030.[16] The 2008 Scoping Plan for California's Global Warming Solutions Act of 2006 (AB 32) finds that up to 333,000 acre-feet of stormwater could be captured on an annual average for reuse in Southern California alone.[17]

In total, DWR has identified 27 "resource management strategies" that water suppliers should consider when expanding their water management programs (DWR 2009). Although every resource management strategy may not be feasible in each service area, combinations of these strategies will enable water suppliers to maximize the cost-effective diversification and integration of their supplies. For example, groundwater treatment to address water quality problems can provide a new source of reliable drinking water supplies. Stormwater runoff can be captured and reused for conjunctive management of groundwater basins. Tiered water pricing provides a strong incentive to encourage increased water efficiency for urban and agriculture that will also result in more flexible operations of existing water infrastructure.

The State has promoted local and regional water supply planning by requiring water suppliers to develop plans, such as Urban Water Management Plans and Agricultural Water Management Plans, that forecast sources of supply and the actions needed (including water conservation and water efficiency measures) to ensure that future water needs are met over the next 25 years. Through the enactment of SBX7 7, agricultural water supplies and urban water suppliers are required to identify and implement all cost-effective efficiency measures.[18]

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[13] A 2008 report from the Los Angeles Economic Development Corporation found that "using water more efficiently reduces demand, which has the same effect as adding water to the system." For Southern California, the report concludes that "urban water conservation could have an impact equivalent to adding more than 1 MAF of water to the regional supply (about 25% of current annual use)." (LAEDC 2008)

[14] SBX7 7, Water Code section 10608.24 et. seq

[15] SWRCB 2009-0011, Adoption of a Policy for Water Quality Control for Recycled Water.

[16] Ibid

[17] Climate Change Scoping Plan Appendices, Volume 1. December 2008.

[18] These requirements also include implementation of urban Demand Management Measures and self-certification compliance with the California Urban Water Conservation Council. These Demand Management Measures include adoption of water conservation based rate structures. Of note, in 2008 the Legislature clarified how one form of tiered water pricing (allocation-based pricing) can

Existing law also requires that water suppliers include a Water Supply Reliability and Water Shortage Contingency element in their Urban Water Management Plans, recognizing that suppliers need to prepare for extended droughts or the potential catastrophic interruption of water deliveries through earthquakes or other events.[19] Water suppliers must evaluate whether their water sources may be available at a consistent level of use and describe their plans for supplementing or replacing these sources, to the extent practicable, with alternatives or water demand management measures (Water Code section 10631(c)(2)). Water suppliers must also describe the tools and options that will be used to maximize resources and minimize the need to import water from other regions (Water Code section 10620(f)). With the passage of the Delta Reform Act and the implementation of this Delta Plan, water suppliers must also demonstrate their reduced reliance on water from the Delta or the Delta watershed.

Since 2000, the State has also promoted voluntary Integrated Regional Water Management planning, recognizing that collaboration among the agencies in a watershed provides opportunities for better water management decisions and coordinated infrastructure investments.[20] A 2006 report on the benefits of investment in Integrated Regional Water Management identified over 1.2 MAF of water benefits in combined water supply and demand reductions that have been achieved through $1 billion of investments from State bond funds in local and regional projects (DWR 2009).

CASE STUDIES AND INFORMATION TO BE PROVIDED ON REGIONAL SELF-RELIANCE.

Many agricultural and urban water suppliers throughout the state are taking action to improve water conservation and efficiency and to expand their local and regional water supplies. However, many others are not. Despite laws requiring preparation and implementation of Urban Water Management Plans and Agricultural Water Management Plans, many agencies still regard these plans as voluntary because the only consequence of not completing them is that the water supplier becomes ineligible to receive State grant and loan funding for water projects. In the 2005 round of Urban Water Management Plan submittals, this incentive increased the number of plans submitted over previous years; however, only 75 percent of agencies that should submit plans actually did as of December 31, 2006 (DWR 2006).

The value that Californians place on water is reflected in a constitutional provision ensuring its reasonable and beneficial use. Article X, Section 2, of the California Constitution prohibits the waste and unreasonable use of the state's water resources. There is broad authority under Water Code section 275 for the State Water Resources Control Board (SWRCB) or DWR to take appropriate proceedings or actions to prevent water waste or violation of the reasonable use standard. This is the strongest tool available to the State of California to protect its interest in improved management of the State's water supplies. SBX7 7 recognized that the urban water suppliers' failure to comply with this provision could result in unreasonable use proceedings, based on the failure of urban water agencies to reduce per capita water demand consistent with the State's 20 percent by 2020 requirements, starting in 2021.

Problem Statement

Many water suppliers have significantly improved water conservation and efficiency, developed new local and regional water supplies, and reduced their reliance on the Delta in meeting future water supply needs, but others have not. The lack of full participation by water suppliers throughout the state in

be implemented consistent with Proposition 218 requirements (California Constitution, Articles XIII.C and XIII.D) and include costs for water conservation, securing dry-year water supplies, and additional water to meet customer needs that exceed base use allocations.

[19] DWR estimates that a moderate to large earthquake capable of causing multiple levee failures could happen in the next 25 years. There is a 40 percent chance of 27 or more islands simultaneously failing during a major earthquake, with most extensive levee failure likely to occur in the west and central Delta. Levee repairs could take more 2.5 years to complete. Delta exports could be disrupted for about a year with a loss of up to 8 MAF (DWR 2010b).

[20] Refer to Hastings West Northwest, Journal of Environmental Law and Policy, Volume 14 No. 2, Summer 2008, P 1463, California Water Management Subject to Change, by John T. Andrew, Jessica Roberts Pearson, John K. Woodling.

planning and implementing plans and projects that will improve California's water supply reliability and reduce reliance on the Delta is a significant impediment to achieving the coequal goals.

Policies

WR P1 A covered action to export water from, transfer water through, or use water in the Delta is inconsistent with the Delta Plan if the covered action negatively impacts one or more of the coequal goals and one or more of the water suppliers[21] that receive water from the Delta significantly causes the need for the covered action by failing to comply with one or more of the following:

- ♦ Compliance with State law
  - Urban water suppliers[22]
    - – Adopt and implement an Urban Water Management Plan and all required elements and measures, meeting the standards and timelines established in Water Code section 10610 et seq.
    - – Adopt and implement a plan to achieve 20 percent reduction in statewide urban per capita water use by December 31, 2020, meeting the standards and timelines established in Water Code section 10608 et seq.
- ♦ Agricultural water suppliers[23]
  - Adopt and implement Agricultural Efficient Water Management Practices including measurement of the volume of water delivered to customers, adoption of a pricing structure based in part on the quantity delivered, and implementation of specific conservation measures that are locally cost effective and technically feasible, meeting the standards and timelines established in Water Code section 10608 et. seq.
  - Adopt and implement an Agricultural Water Management Plan and all required elements, meeting the standards and timelines established in Water Code section 10800 et seq.
- ♦ Water Supply Reliability Element
  - To promote accountability throughout the state in achieving the coequal goals, water suppliers shall, no later than December 31, 2015, expand an existing or add a new Water Reliability Element in their Urban Water Management Plan and/or Agricultural Water Management Plan. Water suppliers may also meet this requirement by including

[21] Water suppliers, as used in this Delta Plan, refer to both "Urban water supplier" and "Agricultural water supplier" as defined in footnotes 20 and 21.

[22] "Urban water supplier" as used in this Delta Plan refers to both "urban retail water suppliers" and "urban wholesale water suppliers" under the Water Code. An "urban retail water supplier" means a water supplier, either publicly or privately owned, that directly provides potable municipal water to more than 3,000 end users or that supplies more than 3,000 acre-feet of potable water annual at retail for municipal purposes (Water Code section 10608.12(p)). An "urban wholesale water supplier " means a water supplier, either publicly or privately owned, that provides more than 3,000 acre-feet of potable water annually at wholesale for municipal purposes (Water Code section 10608.12(r)).

[23] "Agricultural water supplier" as used in this Delta Plan refers to both "agricultural retail water suppliers" and "agricultural wholesale water suppliers" under the Water Code. An "agricultural water supplier" means a water supplier, either publicly or privately owned, providing water to 10,000 or more irrigated acres, excluding recycled water. An "agricultural water supplier" includes a supplier or contractor for water, regardless of the basis of right that distributes or sells water for ultimate resale to customers. "Agricultural water supplier" does not include DWR (Water Code section 10608.12(a)). Any agricultural water supplier than provides water to less than 25,000 irrigated acres is not required to comply with SBX7 7 requirements unless sufficient funding is provided to the supplier to implement these provisions (Water Code section 10853).

a Water Reliability Element in an approved Integrated Regional Water Management Plan or other water plan that provides equivalent information.

- The Water Reliability Element shall detail how water suppliers are sustaining and improving regional self-reliance and reducing reliance on the Delta through investments in local and regional programs and projects, and shall document actual or projected reduction in reliance on Delta exports. At a minimum, the Water Reliability Element shall include:

  - **A plan for possible interruption of Delta water supply due to catastrophic events:** Identify how reliable water service will be provided or shortages managed for minimum periods of 6 months, 18 months, and 36 months in the event that diversions or exports from the Delta are interrupted during an average water year, dry water year, and following three dry water years.

  - **Implementation of planned investments in water conservation, water efficiency, and water supply development:** Identify specific programs and projects that will be implemented over a 20-year planning period and how they are consistent with the coequal goals and will contribute to improved regional self-reliance and reduced reliance on the Delta, including, but not limited to, the following strategies[24]:

    - Water conservation
    - Water use efficiency
    - Local groundwater and surface storage
    - Conjunctive use programs
    - Water transfers
    - Water recycling
    - Treatment and use of currently non-potable groundwater
    - Stormwater capture and recharge
    - Saline water and brackish water desalination

- **Evaluation of regional water balance:** Provide an assessment of the long-term sustainability of the water supplies available to meet projected demands within the supplier's hydrologic region, as defined by California Water Plan 2009 Update, over the 20-year planning period.[25] If the region's demand exceeds available supplies, identify the steps being taken through one or more of the Integrated Regional Water Management Plans to bring the region into long-term balance. If the region's demands exceed available supplies and it does not have an Integrated Regional Water Management Plan or the Plan does not address the steps being taken to bring the region into balance, then describe how the supplier's programs and projects are helping to bring the region into long-term balance.

- **Conservation-oriented water rate structure:** Evaluate the degree to which the supplier's current rate structure sustainably encourages and supports water conservation.

[24] The Department of Water Resources has identified 27 "resource management strategies" that water suppliers should consider as investments in water conservation, water efficiency, and water supply development. (DWR 2009)

[25] The purpose of a water balance is to provide an accounting of all water that enters and leaves a specific hydrologic region, how it is used, and how it is exchanged between regions. A water balance can be used to compare how water supplies and uses in a region can vary among wet, average, and dry hydrologic conditions and how each region's water balance compares with other regions and with the State's water balance. This is important to all water planning activities and provides a basis for evaluating unsustainable water management practices and making appropriate improvements (DWR 2009).

- Conservation-oriented Rate Structure
  - Water suppliers shall, by December 31, 2020, develop and implement a conservation-oriented rate structure, which may include consideration of a water-budget-based rate structure that sustainably encourages and supports more efficient water use without causing a shortfall in system revenues.[26]

Recommendations

WR R1 The Department of Water Resources, in consultation with the Delta Stewardship Council, the State Water Resources Control Board, and others, should develop and approve, by December 31, 2012, guidelines for the preparation of a Water Reliability Element that satisfies the criteria contained in WR P1.

WR R2 The Department of Water Resources, in consultation with the Delta Stewardship Council, the State Water Resources Control Board, and others, should develop and include in the future California Water Plan updates the information needed to track the water supply reliability performance measures identified in the Delta Plan and assess improvements in regional self-reliance, reduced reliance on the Delta, and statewide water supply reliability.

WR R3 The Department of Water Resources, the State Water Resources Control Board, the Department of Public Health, and other agencies, in consultation with the Delta Stewardship Council, should revise State grant and loan ranking criteria by December 31, 2012, to provide a priority for water suppliers that include a Water Reliability Element in their adopted Urban Water Management Plans, Agricultural Water Management Plans, and/or Integrated Regional Water Management Plans that satisfies the requirements of WR P1. The Delta Stewardship Council will also work with these agencies to identify additional funding and other incentives to catalyze implementation of local and regional water conservation, water use efficiency, conjunctive management, and other projects that will improve regional self-reliance and reduce reliance on the Delta.

WR R4 All state agencies should take a leadership role in designing new and retrofitted state owned and leased facilities, including buildings and Caltrans facilities, to increase water efficiency, use recycled water, incorporate stormwater runoff capture and low impact development strategies, and reduce reliance on the Delta. The Delta Stewardship Council will work with these agencies to identify regulations and other policies that will support the improved water efficiencies and new water supply strategies, such as completion of uniform recycling criteria for potable reuse for groundwater recharge, consistent with SB 918 (Water Code section 13521 et seq.).

WR R5 The State Water Resources Control Board and/or the Department of Water Resources should require that proponents requesting a new point of diversion, place of use, or purpose of use that results in new or increased use of water from the Delta watershed should demonstrate that the project proponents have evaluated and implemented all other feasible water supply alternatives.

Update Delta Flow Requirements

California law grants the SWRCB considerable authority in the areas of water rights, water quality protection, and the setting of water flow criteria. The SWRCB also has the authority to enforce the Public

[26] A sustainable conservation-oriented rate structure has the following characteristics: encourages more efficient water use without causing a shortfall in system revenue; provides for the identification of waste, rewards efficient use, and penalizes excessive use; produces revenues from penalty rates that are used to fund conservation programs; is supported by a water bill that clearly communicates the cost of wasted water to the responsible person; and is supported by a person or staff who can respond to customers' calls for help in reducing usage (CUWCC 1997).

Trust Doctrine and the provisions of the California Constitution in Article X, Section 2, which pertain to the reasonable and beneficial use of water.

As competition for California's water supply has intensified, the SWRCB has been at the center of political disputes over how its decisions on water flow requirements should be made. Often, the decisions needed to protect the State's interests in ecosystem protection and water supply reliability have been blocked by conflicts among competing interests. Consequently, the state has found itself in an increasingly unsustainable situation with native fish populations crashing and the reliability of water exports from the Delta watershed diminishing.

In order to achieve the coequal goals, it is essential that the SWRCB complete the work to develop, implement, and enforce new updated flow requirements for the Delta and the major tributary streams in the Delta watershed. Delta export reliability hinges on first establishing water quality requirements to protect native Delta fish and the determining Delta flows and water quality standards. The State cannot effectively plan, finance, and build new conveyance and storage facilities to improve the reliability of water exports from the Delta watershed when future Bay-Delta Water Quality Control Plan objectives and flow requirements are not known.

In setting enforceable flow requirements, the SWRCB is required to balance the public trust uses in the Delta with public trust values upstream of the Delta and with the larger public interests of the State of California. Therefore, in determining whether it is feasible to protect Delta public trust uses through implementation of flow objectives, the SWRCB must consider what is feasible and what level of protection is consistent with the broader public interest and the California Constitutional Reasonable Use Doctrine.

The SWRCB is currently in the midst of a phased process to review and amend—or to adopt new—flow requirements for the Delta and its high-priority tributaries.[27] The SWRCB has set a work plan and schedule for developing flow standards for the Delta and its watershed. The first step was taken in 2008, when the SWRCB committed to a process to review and potentially modify the current Water Quality Control Plan for the Bay-Delta and its implementation through water rights and other actions (SWRCB 2008a). The SWRCB began that process in 2009 by conducting a periodic review of the Bay-Delta Water Quality Control Plan to identify water quality issues that should be addressed through upcoming water quality control planning processes. The SWRCB is reviewing the San Joaquin River flow and southern Delta water quality objectives and the implementation program for those objectives, and plans to complete its review by June 2012.

The SWRCB is taking, or has recently taken, several other actions related to updating flow objectives for the Delta and its high-priority tributaries. In 2010, the SWRCB completed its report titled *Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem* (SWRCB 2010a). This report provides an assessment of the flows needed to protect the Delta and its ecological resources, but does not address other public trust considerations. While informing the broader flow-standard-setting process, the report also underscores the importance to California of resolving as soon as possible what those future flow regimes need to be. In addition, the SWRCB is coordinating with DWR in its preparation of environmental documentation for the Bay Delta Conservation Plan (BDCP) and may consider these environmental documents and other information developed for the BDCP in its proceedings to review flow requirements in the Delta.

[27] The current flow requirements established by the SWRCB in D1641 remain in effect until the SWRCB formally adopts and implements revised flow objectives.

Problem Statement

The State cannot effectively plan, finance, and build new conveyance and storage facilities to improve the reliability of water exports from the Delta watershed when future Bay-Delta Water Quality Control Plan objectives and flow requirements are not known.

Policies

ER P1 Development, implementation, and enforcement of new and updated flow requirements for the Delta and high-priority tributaries are key to the achievement of the coequal goals. The State Water Resources Control Board should update the Bay-Delta Water Quality Control Plan objectives and establish flows as follows:

a) By June 2, 2014, adopt and implement updated flow objectives for the Delta that are necessary to achieve the coequal goals.[28]

b) By June 2, 2018, develop flow criteria for high-priority tributaries in the Delta watershed that are necessary to achieve the coequal goals.[29]

Prior to the establishment of revised flow objectives and criteria identified above, the existing Bay-Delta Water Quality Control Plan objectives shall be used to determine consistency with the Delta Plan.

By June 30, 2013, the Delta Stewardship Council will request an update from the State Water Resources Control Board on items ER P1 (a) and (b). If the Board indicates the items (a) or (b) cannot be met by the dates provided, the Delta Stewardship Council will consider and may amend the Delta Plan to achieve progress on the coequal goals in place of the updated flow requirements. For example, the Delta Stewardship Council could:

1. Determine that a covered action that would increase the capacity of any water system to store, divert, move, or export water from or through the Delta would not be consistent with the Delta Plan until the revised flow objectives are implemented.

2. Recommend that the State Water Resources Control Board cease issuing water rights permits in the Delta and the Delta watershed (or, if the absence of flow criteria is specific to one or more of the major tributaries, then the recommendation could be focused on the impacted areas).

Complete the Bay Delta Conservation Plan

One of the Delta Plan's objectives is to promote options for new and improved infrastructure relating to water conveyance in the Delta, storage systems, and for operating both to achieve the coequal goals (Water Code section 85304). The existing configuration of Delta water conveyance and associated conveyance facilities do not provide adequate long-term reliability to meet current and projected water needs for SWP and CVP water deliveries exported from the Delta watershed (DWR 2009). Conveyance of water through the Delta during dry years is especially challenging, when conflicts over the limited water supplies are the most intense and the operational capacity to pump export water is limited.

[28] Flow requirements could be implemented through several mechanisms including water rights hearing, FERC relicensing and negotiation and settlement. Implementation through hearings is expected to take longer than the deadline shown here.

[29] SWRCB staff will work with the Delta Stewardship Council to determine priority streams. As an illustrative example, priority streams could include the Merced River, Tuolumne River, Stanislaus River, Lower San Joaquin River, Deer Creek (tributary to Sacramento River), Lower Butte Creek, Mill Creek (tributary to Sacramento River), Cosumnes River, and American River (SWRCB 2011a, SWRCB 2011b).

Conveyance improvements can enhance the operational flexibility of the Delta system to divert and move water at times and from locations that are less harmful to fisheries, or to reliably transport environmental water supplies to specific locations at times when it can benefit fish and water quality (California Natural Resources Agency 2010).

The Bay Delta Conservation Plan (BDCP) is an applicant-driven, multiple-stakeholder Habitat Conservation Plan/Natural Communities Conservation Plan development process for the Delta that began in 2006. The California Natural Resources Agency has been leading the process in collaboration with other State, federal, and local agencies, environmental organizations, and other interested parties.

The BDCP is a major project considering large-scale improvements in water conveyance and large-scale ecosystem restoration in the Delta. It has the dual purpose of achieving greater water supply reliability through an improved Delta export water conveyance system, and contributing to recovery of threatened and endangered species in the Delta. The BDCP will include a scientifically based adaptive management program to ensure incorporation of new scientific information into decisions on water management and conservation measures.

The BDCP is expected to provide for regulatory and economic assurances to the stakeholders covered by the associated approved conservation plans. These assurances are expected to span a 50-year period, and provide a degree of certainty to permittees regarding their overall financial and resource investments in water conveyance infrastructure and ecosystem restoration (California Natural Resources Agency 2010).

The BDCP is a complex and challenging ongoing effort. The BDCP process is not expected to be completed until after the first Delta Plan is adopted by the Delta Stewardship Council. As described in Chapter 3, the BDCP will be incorporated into the Delta Plan if it meets the requirements of Water Code section 85320. If incorporated, the BDCP will become part of the Delta Plan and therefore part of the basis for future consistency determinations. For more information about the inclusion of the BDCP in the Delta Plan, refer to Chapter 3, Governance: Implementation of the Delta Plan; Chapter 5, Restore the Delta Ecosystem; and Appendix A.

Problem Statement

The goal of the BDCP is to promote the recovery of endangered, threatened, and sensitive species and their habitats in the Delta in a way that also improves reliability of water deliveries exported from the Delta watershed. The State cannot move forward to make large-scale improvements to Delta water conveyance and ecosystem restoration without an agreed-upon plan and regulatory framework, such as that being developed through the BDCP process.

Recommendation

ER R8 The relevant federal, State, and local agencies should complete the Bay Delta Conservation Plan, consistent with the provisions of the Delta Reform Act, and receive required incidental take permits by December 31, 2014. If the Bay Delta Conservation Plan process is not completed by this date, the Delta Stewardship Council will consider how to proceed with an alternative process to develop and complete the ecosystem and conveyance planning process.

Expand Water Storage and Improve Existing Conveyance

Improvements to surface and groundwater storage and existing Delta conveyance facilities are critical measures for enhancing the reliability of the state's water supplies. The current configuration of water storage and Delta conveyance facilities is not adequate or sufficiently flexible to meet the coequal goals. New facilities for conveyance and storage – and an improved linkage between the two – are needed to better manage California's water resources (Delta Vision Blue Ribbon Task Force 2008).

The statewide water storage capacity is currently inadequate, especially south of the Delta, to facilitate export of water at times of surplus when the only impediment is lack of available storage capacity (DWR 2009). For example, in spring 2011, the south Delta pumps were turned off because real-time urban and agricultural water users' needs could be met through local water supplies and previously delivered export supplies, and storage opportunities south of the Delta were insufficient to take delivery of available water.

Many water supply reliability benefits can be realized by increasing surface and/or groundwater storage and improved conveyance in the Delta (DWR 2010):

- The ability to better manage the timing of water availability to match water needs, especially seasonally and during periods of drought
- Improved management of environmental water flows, timing, and temperature in the river systems
- Improved water quality through more flexible operations
- Increased ability to quickly respond to emergency disruptions in the state's water supplies
- Improved flood control
- Improved floodplain floodwater storage/detention and release systems to increase water storage management flexibility in reservoirs
- Increased operational flexibility enhance opportunities for conjunctive use of surface and groundwater supplies and for water transfers

The need for improved storage is underscored by the predicted impacts of climate change on California's water supply. Already, the average spring snowpack in the Sierra Nevada has decreased by about 10 percent over the past century–a loss of 1.5 MAF of storage—as California's temperature has risen 1°Fahrenheit (California Natural Resources Agency 2008). DWR forecasts that the Sierra Nevada snowpack will decrease 25 to 45 percent from its historical average by 2050 (DWR 2009). Warmer storms are expected, which will result in less snowfall at lower elevations and increase the potential for severe floods. The SWP, which owns and operates the dams in the state's lowest-elevation watersheds, is particularly vulnerable to the long-term loss of water storage now provided by the Sierra Nevada snowpack (Knowles and Cayan 2002).

In the past decade, DWR has spent tens of millions of dollars on integrated studies to evaluate how large surface storage and conveyance may be improved. The State is currently completing surface storage investigations initiated under CALFED, and anticipates identifying the best options for major new storage facilities by the end of 2012. The BDCP is also evaluating conveyance improvements. Once the State decides which facilities to build, the problem will still not solved; the construction of these large-scale projects will likely take at least a decade or more.

In the meantime, smaller facility improvements, particularly for storage, are being implemented. Since 1995, over 1.2 MAF of additional surface storage has been constructed at the regional level, including the Diamond Valley, Seven Oaks, and Olivenhain reservoirs in Southern California and Los Vaqueros reservoir in Contra Costa County.[30] Important improvements are also being made through expanded regional groundwater storage north and south of the Delta. Notably, an assessment of groundwater storage opportunities in 2000 identified over 21 MAF of potential groundwater storage in Southern California and

[30] Contra Costa Water District is moving forward with the design and construction of a 160,000 acre-foot expansion; construction began in early 2011. The feasibility of a 275,000 acre-foot expansion is still under consideration by state and Federal agencies.

the southern portion of the San Joaquin groundwater basin (AGWA 2000). Many projects identified in this study are proceeding.

Significant opportunities are available to improve the operation of existing storage and conveyance facilities, build small-scale storage projects, or enhance opportunities for groundwater conjunctive management and water transfers in the next 5 to 10 years. DWR is leading a System Reoperation Task Force with Reclamation, the U.S. Army Corps of Engineers, and other State, federal, and local agencies on studies to assess opportunities for reoperating existing reservoir and conveyance facilities, particularly in the context of climate change. In addition, many cost-effective local and regional projects have been identified through recent applications for State funding, but were not selected through these competitive processes.

For example, the South San Joaquin Irrigation District was recently awarded federal funding to construct 12 miles of pressurized pipelines, link two surface water storage basins, and capture agricultural runoff for reapplication. The project will provide better-quality surface water while reducing use of the aquifer, which also serves Ripon residents. Water use will be cut by 50 percent, and farm production is expected to increase by 30 percent.[31]

Urban runoff also holds substantial potential for augmenting local groundwater management programs. For example, the Fresno-Clovis metropolitan area has built an extensive network of stormwater retention basins that recharges groundwater by capturing more than 70 percent of the local runoff (about 17,000 acre-feet) and excess Sierra Nevada snowmelt (an average of 27,000 acre-feet). Los Angeles County recharges an average 210,000 acre-feet of storm runoff, reducing the city's reliance on water from the Delta watershed. Recent studies estimate that additional stormwater capture opportunities in Los Angeles County could create a new supply of about 132,000 acre-feet (DWR 2009; Los Angeles and San Gabriel Watershed Council 2007).

The State must be prepared for the possibility that the complex and controversial nature of major projects could require many more years before California can build and operate large-scale storage and conveyance improvements, like those being identified through the BDCP and the Surface Water Storage Investigation studies. Therefore, the State should expedite these studies and begin making decisions.

As an interim step toward increasing California's water supply reliability, the State should identify, prioritize, and implement smaller and more incremental operational, conveyance, and storage improvements (such as expanding existing facilities or constructing new ones) that can be accomplished quickly, preferably within the next 5 to 10 years. These options should include groundwater storage and conjunctive management programs (in combination with conservation, local water supplies such as stormwater runoff capture and recycled water, and water transfer programs) and coordination with State, federal, and regional dam operators to develop revised reservoir management practices to increase water storage without compromising flood control.

Problem Statement

Current SWP and CVP surface and groundwater storage and conveyance facilities are inadequate to facilitate water exports in a manner consistent with Delta ecosystem protection at times when water could be diverted. It will be take many years before major new storage and conveyance facilities improvements become operational.

Policies

No policies with regulatory effect are included in this section.

[31] Stockton Record, May 19, 2011.

Recommendations

WR R6 The Department of Water Resources should complete the Surface Water Storage Investigations of proposed off-stream surface storage projects by December 31, 2012, including an evaluation of potential additional benefits of integrating operations of new storage with proposed Delta conveyance improvements, and recommend the critical projects that need to be implemented to expand the State's surface storage.

WR R7 The Department of Water Resources, in coordination with the California Water Commission , Bureau of Reclamation, State Water Resources Control Board, California Department of Public Health, the Delta Stewardship Council, and other agencies and stakeholders, should conduct a survey to identify projects that could be implemented within the next 5 to 10 years to expand existing surface and groundwater storage facilities, create new storage, improve operation of existing Delta conveyance facilities, and enhance opportunities for conjunctive use programs and water transfers. The California Water Commission should hold hearings and provide recommendations on priority projects. These recommendations should be used to support water supplier requests for state grants and loans and other sources of funding for these projects.

Sustainable Groundwater Management

Groundwater is a major source of California's water supplies. It provides for roughly 20 to 40 percent of the state's combined urban and agricultural water use, depending on water year type, with about 75 percent used for agricultural irrigation and the remainder for urban uses (DWR 2009). In some regions, groundwater can provide 60 percent or more of the supply during dry years (DWR 2003a). Over 40 percent of Californians rely on groundwater for part of their water supply, and many small to moderate-sized towns and cities are entirely dependent on groundwater for their drinking water systems (DWR 2003a).

DWR estimates that groundwater use is increasing, and that it will grow at a faster rate in future decades as climate change reduces the reliability of surface water deliveries (DWR 2009). The state's most significant groundwater use occurs in regions of California that also rely on water from the Delta watershed, including the San Joaquin Valley, Tulare Lake, Sacramento Valley, Central Coast, and South Coast. The Tulare Lake region alone accounts for over one-third of the state's total groundwater pumping (DWR 2009).

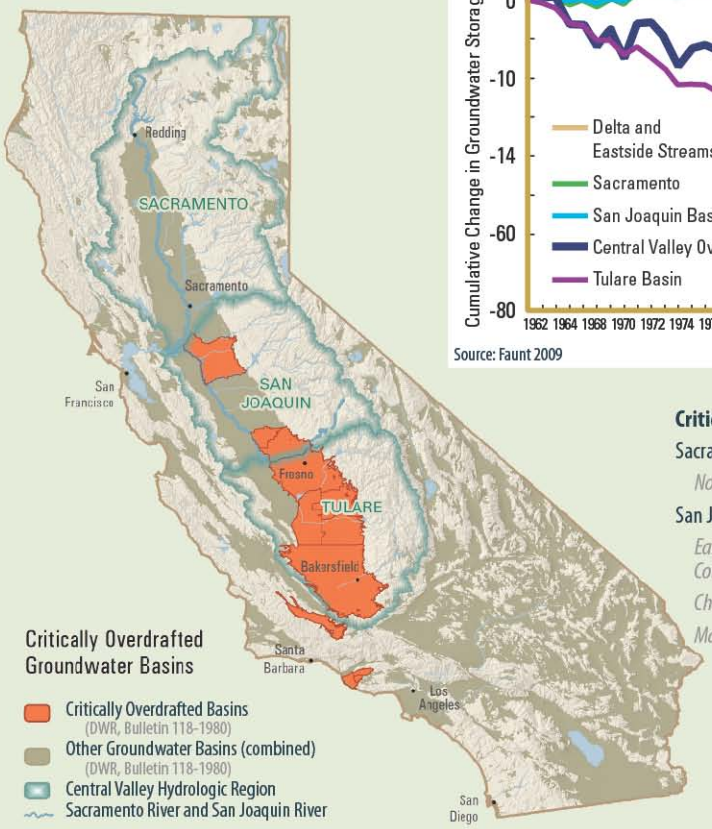
Despite the critical importance of this water supply to California, groundwater use is largely unregulated in the state. With few exceptions, overlying landowners are allowed to pump and make reasonable use of groundwater without obtaining permission or approval from the State, and can continue to take groundwater regardless of the underlying aquifer's condition.[32] Except for Texas, California is the only state where groundwater resources are managed at the local rather than state level.

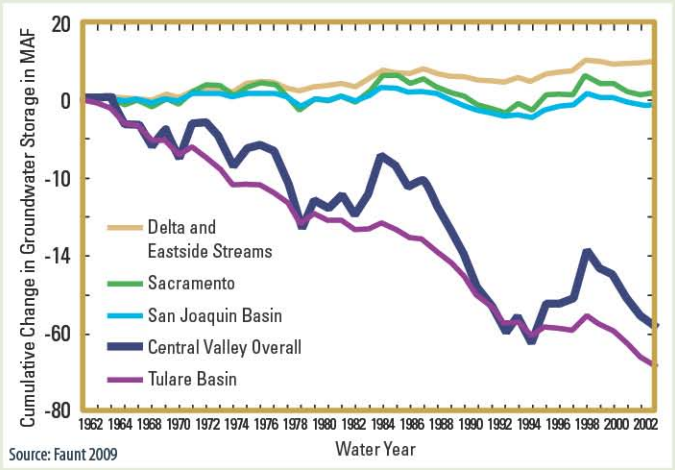
The lack of State oversight means that only limited information is available about how California's groundwater basins are being managed. Some areas of the state appear to have made significant progress in developing sustainable groundwater management programs through voluntary groundwater management plans, local ordinances, and court adjudications (Nelson 2011). However, other areas have not, and those pumping groundwater in these basins appear to be withdrawing far greater volumes of water from the underground aquifers than can be sustained. DWR estimates statewide average overdraft

[32] There are some exceptions. The State Water Resources Control Board has a formal process for granting water rights if the groundwater is classified as return flow of "subterranean stream." The Porter-Cologne Act authorizes the SWRCB to manage discharges to groundwater that may impact water quality. California Water Code sections 2100-2010 authorize the SWRCB to manage groundwater pumping under specific conditions. Groundwater use is subject to the state's Reasonable Use Doctrine, as defined in Section 2 of Article X of the California Constitution. Additionally, adjudicated basins – where groundwater withdrawals and management are legally reviewed and accepted by all users – are subject to monitoring by a court-appointed Water Master. There are presently 21 adjudicated basins in California, most of which are located in Southern California (Cooley, et.al.,2009).

of about 2 to 3 MAF per year (DWR 2009).Without appropriate long-term management, the state's groundwater resources will be significantly impacted, and in some cases the aquifer's capacity to store groundwater can be irretrievably lost (DWR 2003a).

Groundwater Overdraft Challenges





Critically Overdrafted Basins

Sacramento Hydrologic Region
None

San Joaquin Hydrologic Region
Eastern San Joaquin County Basin
Chowchilla Basin
Madera Basin

Tulare Hydrologic Region
Kings Basin
Keweah Basin
Tulare Lake Basin
Tule Basin
Kern County Basin

Other Hydrologic Regions
Cuyama Valley Basin
Oxnard Basin
Las Posas Basin
Valley Basin

Groundwater is California's single largest source of water, providing about 35 percent of the state's supply. Over 40 percent of Californian residents rely on groundwater for some portion of their supply, while many small to moderate sized communities are entirely dependent on groundwater for their drinking water systems.

Groundwater overdraft is a critical problem facing specific regions of California. Overdraft is a condition in which the amount of water withdrawn from a basin by pumping exceeds the amount of water that recharges a basin over the long term, resulting in permanent loss of storage capacity, water quality degradation, and environmental impacts. It is estimated that the San Joaquin Valley has lost about 60 MAF of groundwater storage in the past 50 years, and subsidence impacts over half of this region.

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Already, in several areas of the state, severe groundwater overdraft resulting from over-pumping has created serious economic and environmental consequences. A 2009 report by the U.S. Geological Survey found that about 60 MAF of groundwater storage has been lost in the San Joaquin Valley since 1961 (Faunt 2009). While water levels in some of the northern and western parts of the Valley have shown some recovery, the Tulare Basin continues to experience dramatic declines in groundwater levels and depletion of groundwater storage (Faunt 2009). Groundwater extraction in some areas of the Central Valley have caused water levels to drop by more than 200 feet, and groundwater subsidence impacts over half of the San Joaquin Valley (Nelson 2011). The collective costs of chronic overdraft are significant in terms of damage to streets, bridges, canals, and the aquifer itself resulting from subsidence, reduced groundwater availability during droughts, impairment of groundwater quality, higher pumping costs to other water users in the region, and environmental damage to streams and wildlife.

The State has tried to encourage additional voluntary development of locally controlled groundwater monitoring programs and related management plans through AB 3030 (1992), AB 303 (2000), AB 599 (2001), and SB 1938 (2002), the Integrated Regional Water Management Program (through funding provided by Propositions 13, 50, and 84), and by limiting availability of State funding (bond funds or State revolving fund loans) for water infrastructure only to agencies that have adequate groundwater plans in place. The State also provides technical assistance to help local agencies more efficiently and sustainably manage groundwater resources, and has identified fourteen required and recommended components for groundwater management plans.[33] In addition, SBX7 6 created a statewide program for local reporting of groundwater elevation data.[34] Known as the California Statewide Groundwater Elevation Monitoring Program (CASGEM), this State program will collect reported groundwater elevations and start making the data available online by January 1, 2012.

However, until the enactment of SBX7 6, local groundwater plans were not required to be submitted to DWR. As of 2003, the number of adopted plans and the current status of groundwater management throughout California was unknown (DWR 2003a), and remains so today. Basic groundwater management information (rates of recharge and extraction, estimates of safe yield, monitoring of changes in storage in the aquifers and water quality conditions, and identification of replenishment sources and connections with surface water supplies) has not been quantified for many areas of the state (DWR 2003a). In fact, so little is known about the current status of California's groundwater basins that in 2003 DWR was unable to revise the designation of critically over-drafted basins in its update on California's Groundwater Resources (Bulletin 118). In the absence of current information, DWR simply republished the list of eleven basins identified in 1980—more than 30 years earlier.[35]

[33] Prior to 2002, there were no required groundwater plan elements. In 2002, the Legislature enacted SB 1938 to require that groundwater management plans adopted by local agencies include certain components to be eligible for public funds administered by DWR for construction of groundwater projects (Water Code section 10750 et. seq). These include public notification and engagement in the planning process, identification of Basin management objectives, components relating to monitoring and management of groundwater levels and quality, adoption of monitoring protocols and inclusion of a map. Recommended components include a description of the physical setting and characteristics of the aquifer system, a description of how the goals and actions identified in the plan help to achieve the Basin management objectives, more detailed description of the monitoring program and integrated regional water management planning efforts, and a report on plan implementation.

[34] SBX7 6 adds to and amends parts of Division 6 of the Water Code, specifically Part 2.11 Groundwater Monitoring. The law requires that local agencies monitor and report the elevation of their groundwater basins to help better manage the resource during average water years and drought conditions. DWR will implement groundwater monitoring programs in regions where local agencies fail to implement a program or fail to provide reports. DWR is required by the law to establish a priority schedule for monitoring groundwater basins, and to report to the Legislature on the findings from these investigations by January 2012 and every 5 years thereafter starting in 2015 (Water Code section 10920 et. seq). As an incentive to enforce compliance with this monitoring requirement, the legislation bars counties from receiving state water grants and locals when local agencies do not conduct the required monitoring.

[35] The eleven basins identified by DWR as being in a critical condition of overdraft are Pajaro Basin, Ventura Central Basin, Chowchilla Basin, Kings Basin, Tulare Lake Basin, Kern County Basin, Cuyama Valley Basin, Eastern San Joaquin Basin, Madera Basin, Kaweah Basin, and Tule Basin.

The goal for management of California's groundwater resources should be to sustainably maintain and maximize long-term reliability of these water supplies, with a focus on preventing significant degradation of groundwater quality extraction (DWR 2003a, ACWA 2011). Better information on changes in groundwater levels, rates of groundwater extraction, and the location of basins with severe and chronic overdraft is needed as a baseline for the State's water resource management efforts. This information will support local development of sustainable groundwater management programs in critical regions of the state, especially when combined with improved watershed management, conjunctive management, water efficiency, and increased use of recycled water, stormwater runoff, water quality treatment, and other water management programs. It will also contribute to modeling used by DWR to evaluate scenarios for improving the reliability of Delta export deliveries.

Problem Statement

California's groundwater constitutes a significant percentage of the state's water supplies, especially in areas of the state that also rely upon deliveries of water from the Delta watershed. Groundwater is a vitally important source of supply for California during periods of critical water shortages caused by droughts or climate change, or by potential catastrophic failure of water delivery facilities. The continued existence of groundwater basins in a chronic condition of critical overdraft along with poor groundwater management practices, including unsustainable pumping and lack of groundwater management plans, impedes water supply reliability and threatens to cause serious economic and environmental harm to the California.

Policies

No policies with regulatory effect are included in this section.

Recommendations

WR R8 The Department of Water Resources, in collaboration with the Bureau of Reclamation, U.S. Geological Survey, the State Water Resources Control Board and other state, Federal, and local agencies, should update Bulletin 118 using field data, California Statewide Groundwater Monitoring Elevation Monitoring (CASGEM), groundwater agency reports, satellite imagery, and other best available science by December 31, 2014. This Bulletin update should include a systematic evaluation of the major groundwater basins to determine sustainable yield and overdraft status, an evaluation of California's groundwater resources in 20 years if current groundwater management trends remain unchanged, the anticipated impacts of climate change on groundwater resources, and the recommendations for actions by state, Federal and local actions to improve groundwater management. In addition, the Bulletin update should identify groundwater basins in a critical condition of overdraft. This information should be available for inclusion in the Urban Water Management Plans and Agricultural Management Plans required to be submitted to the State by December 31, 2015.

WR R9 Water suppliers that receive water diverted or exported from the Delta watershed and that receive a significant percentage of their long-term average water supplies from groundwater should develop and implement sustainable groundwater management plans that are consistent with both the required and recommended components of local groundwater management plans identified by the Department of Water Resources (Bulletin 118, Update 2003) by December 31, 2014.

WR R10 Local and regional agencies in groundwater basins that have been identified by the Department of Water Resources as being in a critical condition of overdraft should develop and implement a sustainable groundwater management plan, consistent with both the required and recommended components of local groundwater management plans identified by the Department of Water Resources (Bulletin 118, Update 2003), by December 31, 2014. If local or

regional agencies fail to develop and implement these groundwater management plans, the State Water Resources Control Board should take action to determine if the continued overuse of a groundwater basin constitutes a violation of the State's Constitution Article X, Section 2 prohibition on unreasonable use of water and whether a groundwater adjudication is needed to prevent the destruction of or irreparable injury to the quality of the groundwater, consistent with Water Code Section sections 2100-2101.[36]

Improved Reporting and Transparency

One of the greatest challenges to California water management is the lack of consistent, comprehensive, and accurate estimates of actual water use in the state, both by the type of use (agricultural, urban, and environmental) and by region. Consequently, water use reported to the State is a combination of measured uses and estimated use that are not actually measured, with limited verification of actual water use.

No standardized set of monitoring and reporting requirements for water use exists in California. Water data is primarily collected from the local, regional, and State sources by five different state agencies (DWR, SWRCB, Department of Public Health, California Public Utilities Commission, and the California Energy Commission), the federal Bureau of Reclamation, and two voluntary associations (California Urban Water Conservation Council and Agricultural Water Management Council). Each collects data based on their individual mission or project needs which means each track, record, and report on water use in different ways (Hanak et al. 2010; SWRCB 2009).

Not all water uses are required to be monitored and measured. Many water rights were issued decades ago when water measurement was not required. Consequently, the SWRCB, until very recently, allowed water right holders to estimate water use and, in the past, has allowed them to simply report that they delivered and use water without specifying the quantities. As a result, total diversion amounts are currently unknown and may be unsustainably over-allocated (SWRCB 2008b). Similarly, many groundwater withdrawals are not monitored or reported, limiting DWR's ability to update its assessment of the state's groundwater overdraft conditions made over 30 years ago (DWR 2003a).

Yet even when data reporting is required, not all water users provide the information. A 2009 report prepared by the SWRCB for the California Legislature on the development of a coordinated measurement database indicated that, historically, about 67 percent of water permit and license holders actually report their use information, and fewer than 35 percent of other water right claimants who are required to report actually do so (SWRC, 2009b).

In many cases, the State has relied upon voluntary reporting of water use, but it is often incomplete, inconsistent, and lacks quality control. As part of its work to update the California Water Plan every 5 years or so, DWR collects water use information through annual Public Water System Surveys of water suppliers. Using the approximately 1,000 surveys and follow-up effort, DWR can boost the response rate to about 70 percent (SWRCB 2009b). Currently, the collection of survey data is not coordinated with the summary information required through the Urban Water Management Plans, nor is the data provided through these plans verified for accuracy. Another source of data on water use is the water conservation reports collected by of the California Urban Water Conservation Council. However, in 2008, these voluntary submittals were provided by only 225 of the largest urban water supplies, about half of the agencies that could report.

Another important source of data about California's water uses are the State and federal water contracts. Reclamation has established best management practices for water efficiency, consistent with the CVPIA,

[36] The SWRCB anticipates the development of a Strategic Workplan for Groundwater by 2012 that will lay out the Board's plans to protect groundwater, including (1) application of the SWRCB's water quality and water rights authorities to address the problems that have the greatest potential to impact beneficial uses of groundwater; (2) focus resources on the most important problems; and (3) encourage efforts to protect and management groundwater at the local or regional level.

and requires federal contractors to perform a "Water Needs Assessment," submit an annual report that includes a full water balance (production from all sources, system losses, and changes in storage and water), implement an effective water conservation and efficiency program based on the contractor's approved water conservation plan (Reclamation 2011). DWR does not require similar provisions in SWP contracts.

Further, Reclamation requires all contract negotiations to be conducted in public to improve transparency. DWR adopted revised procedures in 2003[37] that, similar to the Reclamation provisions, require negotiations to be conducted in public, with advance notice of the time and place of negotiations and provision of the draft document for public review. However, these DWR requirements appear to apply only to permanent water transfers agreements and SWP project-wide contracts (DWR 2003b, DWR 2003c). See Appendix C, which includes DWR policies for contract negotiations and water transfers.

Legislation within the past 3 years has resulted in significant improvements to the State's monitoring and reporting requirements. Provisions for groundwater monitoring (Water Code Section 10920 et seq.), in-Delta water diversion reporting (Water Code section 5100 et seq.), in-Delta enforcement investigations (Water Code section 85230), compliance with the State's goal of achieving a 20 percent reduction in statewide urban per capita water use by 2020 (Water Code section 10608 et seq.), and improved reporting on agricultural water use efficiency measures (Water Code section 10608 et seq. and 10800 et seq.) are now being implemented. Assembly Bill 1040 (Laird 2007) required DWR, SWRCB, and the Department of Public Health to study the development of a coordinated database for the urban and agricultural water measurement information that is provided to each agency.

In late 2010, the SWRCB adopted emergency regulations requiring online reporting of water use by all water rights holders, including appropriative, riparian, pre-1914, and groundwater users, with the first cycle of reports due in June 2011. In addition, the SWRCB has initiated a program to investigate and terminate illegal diversions within the Delta.

The development of a uniform, streamlined, and electronically based water use data-collection process would benefit the State. Better and more complete data on agricultural and urban water use would facilitate improved water management. State agencies would have more timely access to water use data, and the quality and accuracy of the data would improve. A streamlined system should also reduce the reporting burden on local and regional agencies.

Problem Statement

California does not maintain adequate uniform data about current local, regional, and state water uses and the status of its water supplies. The lack of consistent, comprehensive, and accurate information impedes California's ability to sustainably manage the state's water resources and improve water supply reliability.

Policies

WR P2 All new contracts, contract modifications, contract renewals and agreements to export water from, transfer water through, or use water in the Delta except transfers for up to one year in length, are not consistent with Delta Plan unless they have been developed in a transparent manner consistent with Department of Water Resources' revised policies adopted in 2003 for contract renewals and permanent transfers included in Appendix C or comparable policies issued by the Bureau of Reclamation.

[37] DWR 03-10, Principles Regarding Public Participation Process in State Water Project Contract Negotiations. These guidelines were prepared in connection with the Settlement Agreement, dated May 5, 2003, reached in *Planning and Conservation league et al. v. Department of Water Resources, 83 Cal. App. 4th 892 (2000).*

Recommendations

WR R11 The Department of Water Resources, in coordination with the State Water Resources Control Board, the Department of Public Health, California Public Utilities Commission, California Energy Commission, Bureau of Reclamation, California Urban Water Conservation Council, Delta Stewardship Council, and other stakeholders should create by January 1, 2014, and maintain an integrated statewide system for water use monitoring. This new system should consolidate information into a single statewide data base that is in an electronic format and made available to the public online. It should be designed to simplify reporting, reduce the number of required reports, and be coordinated with the reporting requirements for the Urban Water Management Plans/Agricultural Water Management Plans and Integrated Regional Water Management Plans. Water suppliers that export water from, transfer water through, or use water in the Delta watershed should be full participants in the data base when it becomes available. The Department of Water Resources should every 5 years summarize and incorporate the key information collected through the statewide integrated data base in the California Water Plan Update.

WR R12 The Department of Water Resources should include a provision in all State Water Project contracts, contract amendments, contract renewals, and water transfer agreements that require the implementation of WR P1.

Performance Measures

Performance measures derive from the goals and objectives in the Delta Reform Act. One of the coequal goals for management of the Sacramento-San Joaquin Delta is "to provide a more reliable water supply for California" (Water Code section 85054). The Delta Plan must also address the inherent objectives to "manage the Delta's water and environmental resources and the water resources of the State over the long term… promote statewide water conservation, water use efficiency and sustainable water use… and improve the water conveyance system and expand statewide storage" (Water Code section 85020).

Performance measures for improving water supply reliability for California are placed into three general classes:

- Administrative performance measures address the actions or projects being implemented (or planning to be implemented) in the Delta Plan
- Driver performance measures evaluate the factors that may be influencing outcomes and include on-the-ground implementation of management actions.
- Outcome performance measures evaluate long-term responses to management actions or achievement of program goals.

The distinction between performance measure types is not rigid. In some cases, an outcome performance measure for one purpose may become a driver performance measure for another purpose.

Performance measures are needed to address the status and trend of the State's progress in achieving each of the strategies or objectives listed on the first page of this chapter.

The 2009 California Water Plan will serve as the baseline for the following performance measures, except where an alternative baseline is specified in the performance measure. It is expected that State's progress toward achieving a more reliable water supply will be reported in 5-year increments through future updates of the California Water Plan.

Development of informative and sensitive performance measures is a challenging task that will continue after the adoption of the Delta Plan. Performance measures need to be designed to capture important trends and to address whether specific actions are producing expected results. Efforts to develop performance measures in complex and large-scale systems like the Delta are commonly multiple-year endeavors. The recommended performance measures are provisional and subject to refinement as time and resources allow.

Administrative Performance Measures

- Percentage of urban and agricultural water suppliers that have adopted and are implementing water supply planning, conservation, and efficiency measures required by State law, meeting the standards and deadlines established by code.[38] Goal: 100 percent by 2015.
- Percentage of urban and agricultural water suppliers that incorporated a Water Supply Reliability Element in their management plans by December 31, 2015. Goal: 100 percent by 2015.
- Percentage of urban and agricultural water supplies that have adopted conservation-based water rate structures by December 31, 2020. Goal: 100 percent by 2020.
- Adoption and implementation by SWRCB of Bay-Delta Water Quality Control Plan flow objectives by June 2, 2014, and development of flow criteria for the major tributary streams in the Delta watershed by June 2, 2018.
- Completion by DWR of the BDCP by December 31, 2014.
- Completion by DWR of the Surface Water Storage Investigation with recommendations for critical projects that need to be implemented to expand the State's surface storage by December 31, 2012.
- Completion by DWR of a survey with recommendations for projects that may be implemented within the next 5 to 10 years to expand existing surface and groundwater storage facilities, create new storage, improve Delta conveyance facilities, and improve opportunities for water transfers by December 31, 2012.
- Completion by DWR of the update of Bulletin 118 (using field data, CASGEM, and best available science) and identification of the state's groundwater basins that are in a critical condition of overdraft by December 31, 2014.
- Percentage of water suppliers that have developed groundwater management plans that are consistent with the required and recommended components of groundwater management plans listed in DWR Bulletin 118-03. Goal: 100 percent by 2020.
- Percentage of groundwater basins identified by DWR as being in a critical condition of overdraft that have groundwater management plans consistent with the required and recommended components of groundwater management plans listed in DWR Bulletin 118-03. Goal: 100 percent by 2020.
- Activation by DWR of a statewide integrated water information database by January 2014.
- Percentage of SWP contracts and transfer agreements that require implementation of WR P1. Goal: 100 percent by 2020.

[38] Required measures include Urban Water Management Plan, SBX7 7 20 percent reduction in statewide GPCD by 2020, Water Conservation Best Management Practices, Agricultural Efficient Water Management Practices, and Agricultural Water Management Plans.

Driver Performance Measures

- Progress toward meeting the California's conservation goal of achieving a 10 percent reduction in statewide urban per capita water usage by 2015 and a 20 percent reduction in statewide urban per capita water usage by 2020.
- Progress toward achieving California's goal for the increased use of recycled water over 2002 levels by at least 1 MAF per year by 2020 and by at least 2 MAF per year by 2030.
- Progress toward achieving California's goal for the increased use of stormwater runoff of at least 500,000 acre-feet per year by 2020 and by a least 1 MAF per year by 2030).
- Progress toward completing substantial development and construction of new surface and groundwater storage and conveyance facilities by 2020, with the goal of completing all planned facilities by 2030.
- Progress in implementation of water conservation, water efficiency, and water supply improvement projects identified in local and regional Water Supply Reliability Elements and through the DWR survey by 2020 (measured by reported reductions in demand, increases in supplies, and by actual and projected reductions in reliance on water received from the Delta).
- Progress in securing and summarizing actual data on the status of the state's water supplies, demands, water balances, and reduced reliance on the Delta in future California Water Plan Updates starting in 2014.
- Progress in reviewing existing water conservation, water efficiency, and water supply performance goals and setting expanded future goals for local, regional, and statewide water conservation, water use efficiency, and water supply development.

Outcome Performance Measures

- Progress toward increasing statewide urban and agricultural water efficiency, measured by the amount of water used in these sectors relative to preceding years (reported in 5-year increments starting from 2000).
- Progress toward increasing local and regional water supplies, measured by the amount of additional supplies made available (reported in 5-year increments from 2000).
- Progress in each hydrologic region in reducing actual or projected reliance on Delta water supplies (reported in 5-year increments from 2000)
- Progress toward increasing the reliability of water supply exported from the Sacramento River or the San Joaquin watershed, measured by the amount of water made available relative to preceding years (reported in 5-year increments from 2000). Progress will also include consideration of changes in State and federal regulatory standards, increased flexibility of system operations, and improved water management and coordination with other water systems.
- Progress toward attaining regional water balance for hydrologic regions identified by the California Water Plan, measured by a comparison of the region's water demand with the region's available supply for wet, average, and dry year scenarios (reported in 5-year increments from 2000).
- Progress toward achieving improvements to the management of California's groundwater basins (measured by trends in groundwater levels, groundwater quality, and conjunctive management/usage of basins) and implementation of measures to reverse critical conditions of

overdraft in the most severely impacted groundwater basins (reported in 5-year increments from 2000).

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Chapter 5
Restore the Delta Ecosystem

The Delta Protection Act of 1992 defined the coequal goals and declared the coequal goals as state policy for the Delta (Public Resources Code section 29702, amended 2009). Section 29702 (a) through (c) are relevant to ecosystem restoration:

> *29702 The Legislature further finds and declares that the basic goals of the state for the Delta are the following:*
>
> > *(a) Achieve the two coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.*
> >
> > *(b) Protect, maintain, and, where possible, enhance and restore the overall quality of the Delta environment, including, but not limited to, agriculture, wildlife habitat, and recreational activities.*
> >
> > *(c) Ensure orderly, balanced conservation and development of Delta land resources.*

Eight objectives in Water Code section 85020 are inherent in the coequal goals. Section 85020 (a), (c), and (e) are relevant to this chapter:

> *85020. The policy of the State of California is to achieve the following objectives that the Legislature declares are inherent in the coequal goals for management of the Delta:*
>
> > *(a) Manage the Delta's water and environmental resources and the water resources of the state over the long term.*
> >
> > *(c) Restore the Delta ecosystem, including its fisheries and wildlife, as the heart of a healthy estuary and wetland ecosystem.*
> >
> > *(e) Improve water quality to protect human health and the environment consistent with achieving water quality objectives in the Delta.*

The coequal goals and inherent objectives seek broad protection of the Delta. Achievement of these broad goals and objectives requires implementation of specific strategies. Water Code sections 85022 and 85302 provide direction on the implementation of specific measures to promote the coequal goals and inherent objectives related to the Delta ecosystem restoration.

> *85022(d)(5) Develop new or improved aquatic and terrestrial habitat and protect existing habitats to advance the goal of restoring and enhancing the Delta ecosystem.*
>
> > *(6) Improve water quality to protect human health and the environment consistent with achieving water quality objectives in the Delta.*
>
> *85302(c) The Delta Plan shall include measures that promote all of the following characteristics of a healthy Delta ecosystem.*
>
> > *(1) Viable populations of native resident and migratory species.*
> >
> > *(2) Functional corridors for migratory species.*
> >
> > *(3) Diverse and biologically appropriate habitats and ecosystem processes.*
> >
> > *(4) Reduced threats and stresses on the Delta ecosystem.*

(5) Conditions conducive to meeting or exceeding the goals in existing species recovery plans and state and federal goals with respect to doubling salmon populations.

85302(d) The Delta Plan shall include measures to promote a more reliable water supply that address all of the following:

(1) Meeting the needs for reasonable and beneficial uses of water.

(3) Improving water quality to protect human health and the environment.

85302(e) The following subgoals and strategies for restoring a healthy ecosystem shall be included in the Delta Plan.

(1) Restore large areas of interconnected habitats within the Delta and its watershed by 2100

(2) Establish migratory corridors for fish, birds, and other animals along selected Delta river channels.

(3) Promote self-sustaining, diverse populations of native and valued species by reducing the risk of take and harm from invasive species.

(4) Restore Delta flows and channels to support a healthy estuary and other ecosystems.

(5) Improve water quality to meet drinking water, agriculture, and ecosystem long-term goals.

(6) Restore habitat necessary to avoid a net loss of migratory bird habitat and, where feasible, increase migratory bird habitat to promote viable populations of migratory birds.

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Chapter 5
Restore the Delta Ecosystem

The Delta Reform Act defines "restoration" as "...the application of ecological principles to restore a degraded or fragmented ecosystem and return it to a condition in which its biological and structural components achieve a close approximation of its natural potential, taking into consideration the physical changes that have occurred in the past and the future impact of climate change and sea level rise" (Water Code section 85066).

The Delta Reform Act also recognizes the Delta as "... the most valuable estuary and wetland ecosystem on the west coast of North and South America" (Water Code section 85022) and provides multiple references to specific ecosystem attributes and functions to be protected, restored, or enhanced in meeting the coequal goals.

An overarching goal for ecosystem restoration in the Delta Reform Act is to restore fish and wildlife to include more viable and resilient populations of native resident and migratory species.

The Delta Plan envisions a healthy Delta ecosystem that approximates its natural ecological potential and supports viable populations of native species. It includes the following attributes:

- Rivers in the Delta and its watershed that have expansive riparian edges that are seasonally connected to large floodplains.
- Tidal channels and bays in the Delta and Suisun regions (at the downstream end of the Delta landscape continuum) that connect with freshwater creeks and upland grasslands and woodlands.
- Extensive migratory corridors for fishes, birds, and terrestrial wildlife that connect habitats and provide escape routes.
- A more naturally variable hydrograph that makes aquatic, floodplain, and tidal marsh habitats more dynamic and resistant to colonization by nonnative species.
- A system in which impacts from multiple stressors do not exceed the capacity of the system to absorb and adapt to them. Current stressors include altered flows and reduced habitat quality and quantity, degraded water quality, nonnative invasive species, entrainment, predation, diminished food resources, migration barriers, and hatchery impacts.

Restoration of the current "domesticated" Delta back to the historical "wild" ecosystem is not possible, but three categories of understanding can help achieve restoration goals as they fit within the existing system:

- The first is to understand the historical Delta ecosystem to determine which important ecosystem features or functions may have been changed, degraded, or lost (Palmer et al. 2005). This is important because native species are adapted to the historical features and functions of the Delta (Moyle et al. 2010).

- The second is to apply principles of landscape ecology and ecosystem-based management so that restored ecosystems are adequately scaled, are resilient to disturbances, and restore native species' competitive advantages over nonnative species.
- The third is to identify and understand the many interacting stressors threatening the health of the Delta ecosystem so that they can be adequately addressed (Delta Independent Science Board 2011).

This chapter focuses on the importance of restoring two key Delta ecosystem attributes that have been greatly changed and degraded—the natural flow regime and adequate habitat for native species—and on reducing impacts of ecosystem stressors. Flows and stressors are also considered in other Delta Plan chapters (especially Chapters 4 and 6).

The Historical Delta Ecosystem

Historically, the Delta was a 700,000-acre mosaic of variable landscape types influenced by tides and river flows (Figure 5-1). Historical Delta landscapes showed considerable seasonal and interannual variability in flow characteristics and inundation patterns. The historical Delta can be divided into three primary landscapes: flood basins in the north Delta, tidal islands in the central Delta, and distributary rivers (multiple branches flowing away from main channels) in the south Delta (Grossinger et al. 2010; Whipple et al. 2010, 2011).

The historical flood basins in the north Delta occurred at the interface between fluvial (riverine) and tidally influenced portions of the Delta where the Sacramento River entered the Delta. A defining characteristic of this region was a broad zone of nontidal, freshwater, emergent plant-dominated (tule) wetlands that transitioned into tidal freshwater wetlands.[39] Other common features included shallow perennial ponds and lakes, riparian forests along natural levees, and seasonal wetlands. The historical central Delta included about 200,000 acres of tidal islands with freshwater emergent plants that were inundated regularly by spring tides. Banks of the tidal islands were commonly covered in tules, and willows, grasses, sedges, shrubs, and ferns grew in the interior of the islands. The historical south Delta contained a complex network of channels with low berms acting as natural levees, large woody debris, willows, and other shrubs with upland areas supporting open oak woodlands. Historical data from the Delta paint a picture of rich habitat complexity at multiple spatial and temporal scales (Grossinger et al. 2010; Whipple et al. 2010, 2011).

Domestication of the historical Delta and Suisun Marsh landscape and ecosystems over the past 160 years has involved constructing approximately 1,115 miles of levees, draining the lands behind the levees for crop production, and diverting water to southern parts of the state (Hanak et al. 2011). This has produced a rich agricultural and urban economy in the Delta and far beyond its borders, but it has come at a cost to the original estuarine ecosystem and its native species.

Most tributary rivers flowing to the Delta have been dammed. Access to areas critical to fish lifecycles is now greatly reduced, including spawning habitats for the state's iconic salmon. The once pronounced seasonal and interannual flow variability has given way to more stable and artificially regulated conditions, and the formerly highly complex landscape of the past has been replaced by a much more uniform landscape resembling a simplified grid of straightened river channels, fixed in space and time, used for north-south and east-west water conveyance and shipping.

[39] An emergent plant roots in shallow water but has most of its vegetative growth above water, for example, cattails and tules.

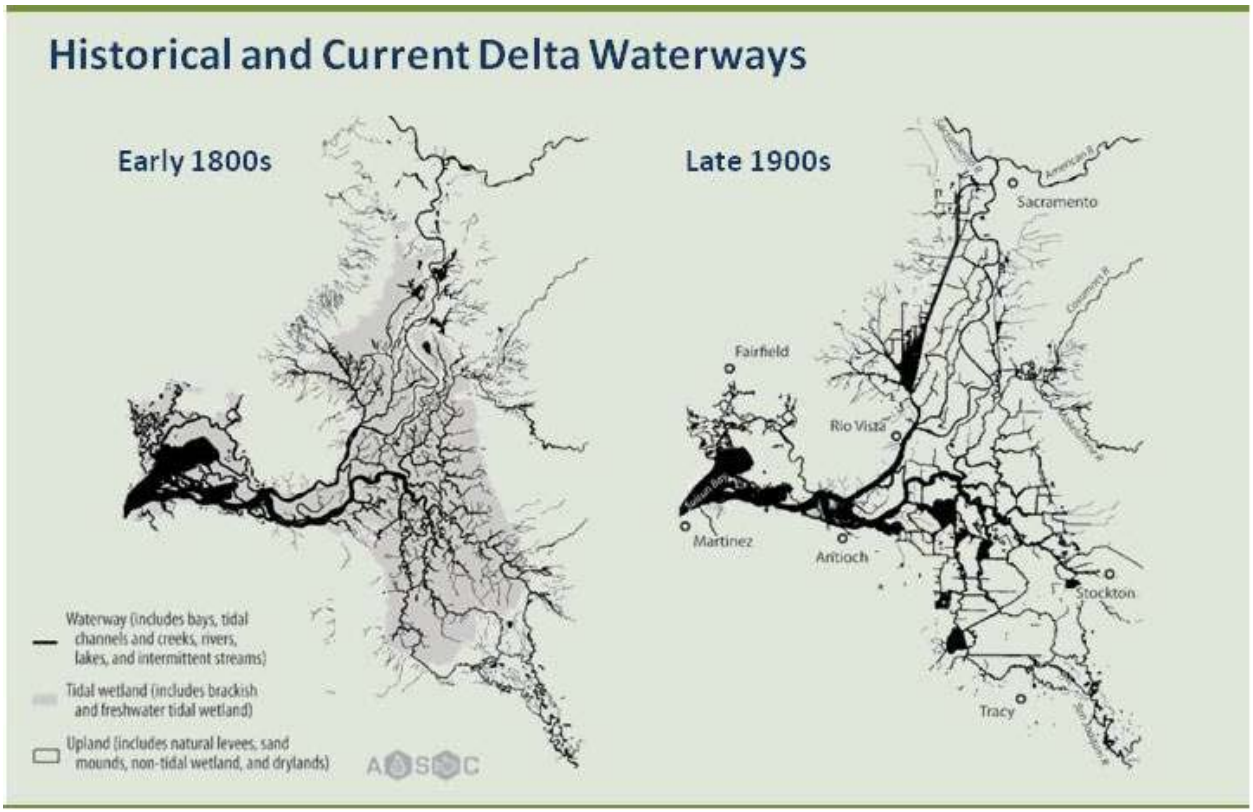


Figure 5-1
Historical and Current Delta Waterways
Comparison of historical (early 1800s) and modern Delta waterways. The map at left shows the complexity of early 1800s Delta hydrography (black) within tidal wetland (gray). The modern hydrography at right shows major differences including channel widening, meander cuts, cross levees, and loss of within-island channel networks and tidal wetland.
Source: Dr. Alison Whipple, San Francisco Estuary Institute-Aquatic Science Center, 2011
Historical sources: Historical Ecology of the Sacramento-San Joaquin Delta Study (draft data), Aquatic Science Center; Bay Area EcoAtlas, San Francisco Estuary Institute, 1999. Note: Detailed mapping of Suisun tidal marsh channels is not available at this time. Modern sources: Bay Area Aquatic Resources Inventory Dataset [geographic information system file type], San Francisco Estuary Institute, 2007-2011; U.S. Bureau of Reclamation, MPGIS Service Center; Delta Vegetation and Land Use, Aerial Information Systems, Inc. for the California Department of Fish and Game, Vegetation and Mapping Program.

It is important to recognize that ecosystem restoration in the Delta landscape will not restore the historical "wild" Delta, but knowledge of the historical Delta informs restoration actions by identifying what landscape elements best fit various localities where restoration projects are practical and feasible. Understanding the scales, patterns, and connections of historical landscape components gives us an appreciation for what has been changed, degraded, or lost, and provides a useful guiding image for restoration actions (Grossinger and Whipple 2010). At the same time, it is understood that return to the historical Delta's conditions is not probable or even desirable, because ecosystems are always responding to natural and human-related drivers of change (Folke et al. 2010). This is recognized in the definition of restoration in the Delta Reform Act with the goal of "...close approximation of its natural potential..." (Water Code section 85066).

Landscape Ecology

The objective of Delta ecosystem restoration is to find and implement strategies that use the least intervention possible to make the limited available land eventually mimic historical landscape functions

to a degree that enables native species to use them to meet their needs. Landscape ecology provides a set of tools for maximizing limited restoration opportunities for native species. This perspective considers the ways that species perceive and use the landscape for finding food and refuge and for adapting to change (Simenstad et al. 2000, Lindenmayer et al. 2008). Landscape ecology also considers the role of humans in affecting landscape patterns and processes (Turner 1989). The landscape perspective considers relationships between interacting landscape elements like elevation, slope, aspect, habitat type, habitat patch size, and corridor connections that species can navigate (Wiens 2002). The landscape perspective also provides a basis from which to promote processes of landscape self repair, or "self design," especially important in the face of sea level rise, so that historical landscape patterns can reorganize over time (Teal et al. 2009). Self design ultimately increases the sustainability and resilience of restored habitats over the long term.

The landscape perspective is important to resource managers because spatial context matters. Restored landscapes have neighboring land uses that include agriculture and urban areas. Each land use affects the other because they are connected by air, land, and water; yet humans often desire conflicting services from each. In addition, ecosystem function (described further on) depends on the interplay and interconnection of pattern and process over broad areas and, therefore, necessarily includes the role of humans in these relationships. Finally, resource managers have a stewardship responsibility to understand and manage the impacts of human activities that alter landscape characteristics and the relationship between ecosystem patterns and processes.

Ecosystem Restoration

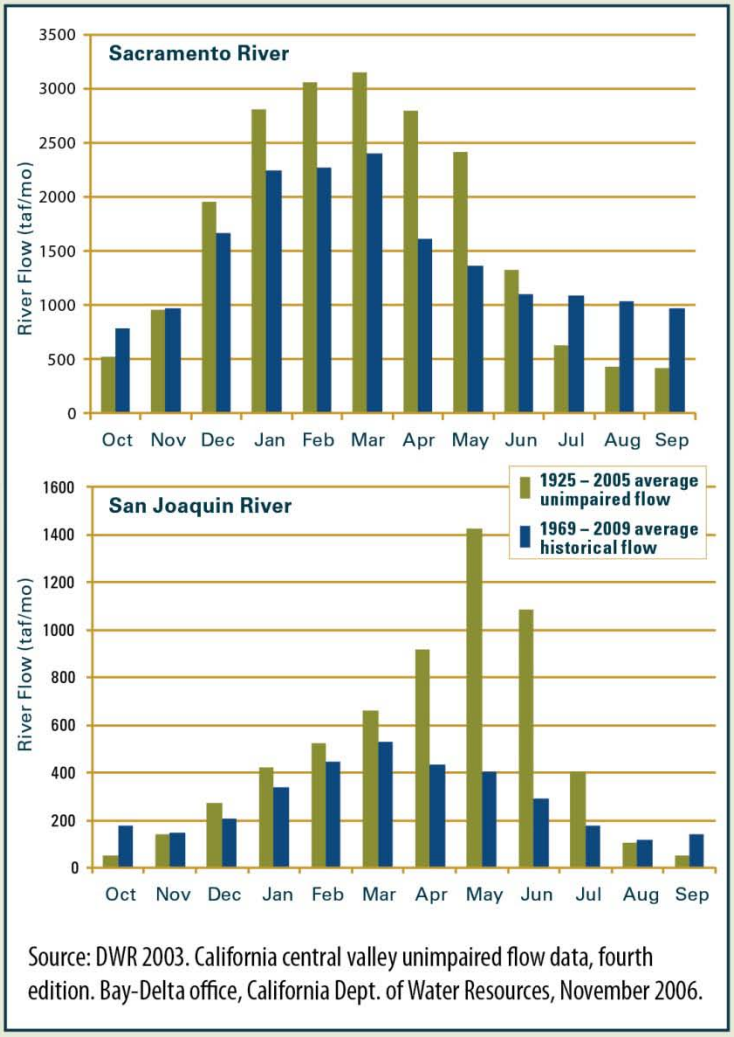
According to the Delta Reform Act, the Delta Plan shall include strategies to "restore the Delta ecosystem, including its fisheries and wildlife, as the heart of a healthy estuary and wetland ecosystem" (Water Code section 85020).

What, then, is an ecosystem, what makes it healthy, and how can its health be restored? An ecosystem is most simply defined as "a community of organisms together with its environment, functioning as a unit" (American Heritage 2009). Every ecosystem has a unique structure and function. Structure refers to the composition and arrangement of living and non-living elements that comprise the system (such as soils, elevation, waterways, species, populations, and habitats). This also includes culturally derived elements such as domestic animals, buildings, roads, and humans themselves. Ecosystem elements are connected through processes (production, food web interactions, nutrient cycling, and energy flow) that lead to particular ecological outcomes such as the presence of a unique native species grouping and the provision of goods and services valuable to humans (clean water, clean air, food, recreational opportunities, and spiritual benefits) (Wallace 2007).

All ecosystems change over time in response to numerous natural and anthropogenic drivers of change (Healey et al. 2008, Delta Independent Science Board 2011). Change is inevitable, but healthy, dynamic ecosystems change to retain their basic structure and functions—they are resilient. By contrast, degraded ecosystems lose resilience and when disturbed may shift to a new configuration that no longer supports the full suite of original species or provides the goods and services desired by humans (Folke et al. 2004).

Successful restoration of ecosystem health rehabilitates and strengthens key ecosystem elements and processes and increases ecological resilience to disturbance so that as many as possible of the original species, goods, and services are again available for human use and enjoyment. In the Delta, this necessarily includes creating a more natural flow regime, restoring habitats, and reducing threats and stresses.

Changes in Historical Flows Challenge Delta Ecology



Source: DWR 2003. California central valley unimpaired flow data, fourth edition. Bay-Delta office, California Dept. of Water Resources, November 2006.

Habitat for native species has been shaped in the past by cycles of unimpaired flows.* Since the 1960s, our water system, with upstream reservoirs and other human-created management, has changed these patterns in two ways:

1) Seasonal flows are much less variable, encouraging non-native fish and vegetation which can crowd out native species that depend on a more varied environment.
2) Peak flows now come earlier and at lower magnitudes, a shift that affects water temperatures, salinity and access to habitat, stressing native species.

*Unimpaired flow is runoff that would have occurred had water flow remained unaltered instead of stored in reservoirs, imported, exported, or diverted. For example, storing water in reservoirs reduces unimpaired flows during wet periods. Releasing water from reservoirs can increase flows to meet farm and urban demands in drier times when there is little rain.

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Policies and Recommendations

Creating a More Natural Flow Regime

Strong scientific consensus supports the concept that water flows more closely reflecting historical flow conditions are best for native communities of aquatic organisms (Poff et al.1997; Bunn and Arthington 2002). Flow is a major environmental driver that ultimately shapes ecological processes, habitat, and biotic composition in riverine and estuarine ecosystems such as the Delta. More natural flows are a key component of ecosystem restoration because they work hand in hand with habitat restoration to generate diverse and interconnected food webs, refuge options, spawning habitat, and regional food supplies (Carlisle et al. 2011).

In 2010, the State Water Resources Control Board (SWRCB) completed its report titled *Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem* (SWRCB 2010). This report provides an assessment of the flows needed to protect the Delta and its ecological resources, but does not address other public trust considerations. Some key points are:

- Nonflow changes like nutrient composition, channelization, habitat, invasive species, predation, entrainment, and water quality need to be addressed along with flows.
- Flow and physical habitat interact in many ways, but they are not interchangeable.
- Percent of unimpaired flow into the Delta is one pathway for setting flow criteria.
- More natural flows are important to migratory cues (when) and clues (where) for many fish species.
- Positive changes in flow or flow patterns benefit both humans and fish and wildlife.
- A coordinated land use policy in the Delta is needed.

Flow patterns in the Delta are determined primarily by tides, river flow, and water exports. Locations near the export pumps, like parts of Old River and Middle River in the southern Delta, experience “reverse” flows when the flows caused by the State and federal water project pumps exceed the normal downstream flows in these channels. In other words, at times these river channels actually run backward, which appears to have direct and indirect effects on the aquatic ecosystem. Reverse flow in the southern Delta is associated with increased entrainment of some fish species (Grimaldo et al. 2009) and disruption of migration patterns. Reverse flows caused by water exports also affect Delta habitat through effects on regional residence time, water temperature, and transport of sediment, nutrients, organic matter, and salinity that could, in turn, affect migrating fish behavior (SWRCB 2010).

Creating a more natural flow regime in the Delta is an important step toward meeting the coequal goal of a healthier Delta ecosystem.

Problem Statement

Native aquatic species in the Delta are adapted to flow regimes characteristic of California’s natural climate and hydrology. This includes higher flows in the winter and spring and lower flows in the summer and early fall. Altered Delta flow regimes are detrimental to native aquatic species and encourage nonnative aquatic species.

Flow is More than Just Volume

Flow is not simply the volume of water, but also includes the timing of flow, the frequency of specific flow conditions, the duration of various flows, and the rate of change in flows. Bunn and Arthington (2002) present four key principles underlying the links between hydrology and aquatic biodiversity and the impacts of altered flow regimes: (1) flow determines physical habitat, (2) aquatic species have evolved life history strategies based on natural flow regimes, (3) upstream-downstream and lateral connectivity are essential to organism viability, and (4) invasion and success of non-native species is facilitated by flow alterations. Altered flow regimes have been shown to be a major source of degradation to aquatic ecosystems worldwide (Petts 2009)

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Policies

ER P1 Development, implementation and enforcement of new and updated flow requirements for the Delta and high priority tributaries is key to the achievement of the coequal goals. The State Water Resources Control Board should update the Bay-Delta Water Quality Control Plan objectives and establish flows as follows:

a) By June 2, 2014, adopt and implement updated flow objectives for the Delta that are necessary to achieve the coequal goals.[40]

b) By June 2, 2018, develop flow criteria for high-priority tributaries in the Delta watershed that are necessary to achieve the coequal goals.[41]

Prior to the establishment of revised flow objectives criteria identified above, the existing Bay-Delta Water Quality Control Plan objectives shall be used to determine consistency with the Delta Plan.

By June 30, 2013, the Delta Stewardship Council will request an update from the State Water Resources Control Board on items ER P1 (a) and (b). If the Board indicates the items (a) or (b) cannot be met by the dates provided, the Delta Stewardship Council will consider and may amend the Delta Plan to achieve progress on the coequal goals in place of the updated flow objectives. For example, the Delta Stewardship Council could:

[40] Flow requirements could be implemented through several mechanisms including water rights hearing, FERC relicensing, and negotiation and settlement. Implementation through hearings is expected to take longer than the deadline shown here.

[41] SWRCB staff will work with the Delta Stewardship Council to determine priority streams. As an illustrative example, priority streams could include the Merced River, Tuolumne River, Stanislaus River, Lower San Joaquin River, Deer Creek (tributary to Sacramento River), Lower Butte Creek, Mill Creek (tributary to Sacramento River), Cosumnes River, and American River (SWRCB 2011a, SWRCB 2011b).

- Determine that a covered action that would increase the capacity of any water system to store, divert, move, or export water from or through the Delta would not be consistent with the Delta Plan until the revised flow objectives are implemented.

- Recommend that the State Water Resources Control Board cease issuing water rights permits in the Delta and the Delta watershed (or, if the absence of flow criteria is specific to one or more of the major tributaries, then the recommendation could be focused on the impacted areas).

Improving Habitat

Habitat is a fundamental ecological concept that refers to the place where an organism lives. This "place" is defined by conditions and resources that a given organism or species requires to survive and reproduce (Hall et al. 1997). Because no two species have exactly the same requirements, habitats are species-specific components of ecosystems. The term habitat is also often used when referring to land cover types (such as open water and riparian vegetation). It is important to note, however, that habitat and land cover type are not the same thing (Lindenmayer et al. 2008); an organism's habitat is much more than land cover type. For example, the total area of the Delta covered by open water has not changed substantially over the last few decades, but several open water (pelagic) fish species have undergone steep declines (Sommer et al. 2007), suggesting that at least some of the open water areas in the Delta have become inhospitable to these fishes. The actual functional habitat available to these open water species has shrunk, even though the area covered by open water has remained fairly stable. Similarly, changing land cover patterns (for example, increasing open water areas) does not automatically lead to increases in specific target species if detrimental conditions (such as poor water quality, predation risk, or entrainment) make these areas unsuitable as new habitat.

Habitat loss and fragmentation caused by human land use is an important driver of worldwide species losses (Foley et al. 2005). In estuaries and coastal areas, exploitation (for example, overfishing) and habitat destruction have been identified as the leading causes of species declines and extinctions (Lotze et al. 2006). Habitat restoration can lead to species recovery, especially when carried out in combination with the reduction of other stressor impacts such as exploitation, predation, or pollution (Lotze et al. 2006).

From a landscape perspective, habitats are species-specific "patches" in spatially varied landscapes. The occurrence and abundance of organisms is closely associated with the total amount of usable habitat in a landscape as well as with habitat patch sizes, shapes, and arrangements (Hannon and Schmiegelow 2002). Habitats that are too small, fragmented, or isolated may not support specific organisms over the long term—they are, in effect, no longer functional habitats for these organisms. Because habitats are species-specific, their necessary size, shape, and arrangement in a landscape differ among species. However, more, larger, and better-connected patches of a specific habitat generally are more likely to provide the conditions for the persistence or recovery of species associated with that habitat (Lindenmayer et al. 2008).

Much of the original habitat for native species in the Delta has been destroyed over the last 160 years (Healey et al. 2008, Moyle et al. 2010, Baxter et al. 2010). The current Delta continues to be a productive ecosystem, but the prevailing habitat types and conditions support a much different mix of species than the historical Delta did, and many of the currently thriving species are nonnative species. They include species considered desirable (largemouth bass, a sport fish that is economically, not ecologically, desirable) and undesirable (the Brazilian water weed *Egeria densa*) or even harmful (the harmful cyanobacteria *Microcystis aeruginosa*) by humans. Many nonnative species in the Delta evolved in ecosystems with much less variable habitat conditions (Moyle et al. 2010). On the other hand, current habitat conditions are insufficient to sustain a number of aquatic and terrestrial native species such as the fishes involved in the sudden "pelagic organism decline" (POD) in the first decade of the twenty-first

century (Sommer et al. 2007, Baxter et al. 2010), as well as winter- and spring-run Chinook salmon, giant garter snake, and Suisun thistle, among others (Healey et al. 2008, Moyle et al. 2010). Successful recovery of native species requires effective habitat restoration aimed at increasing the extent, quality (including connectivity), and diversity of native species habitats. Habitat restoration aimed at protecting and restoring native species and the ecosystem services they provide (such as native salmon for food; recreation; and cultural, intellectual, and spiritual inspiration) is thus another critical step in meeting the coequal goal of a healthier Delta ecosystem.

Better Habitat Equals Greater Growth

Figure illustrates faster growth in floodplain habitat compared to river habitat. Salmon on the left were reared within Cosumnes River channel habitat, while the salmon on the right were reared within Cosumnes River floodplain habitat. All salmon shown are the same age.

Source: Jeffres et al. 2008

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The Multi-agency Ecosystem Restoration Program (ERP) and Delta Conservation Strategy

In 2000, the CALFED Bay-Delta Program, a joint state and federal effort, began implementation of a major multi-element program aimed at improving the Delta ecosystem and increasing the reliability of its water supply. The program was based, in part, on a preferred water conveyance alternative, which was continued conveyance of water through the Delta (as opposed to a Peripheral Canal or alternative conveyance). CALFED program implementation was broken into two stages, Stage 1 (2000–2007) and Stage 2 (2008–2030), to allow reevaluation of its preferred alternative. A program performance evaluation conducted at the end of Stage 1 found that CALFED's through-Delta water supply conveyance alternative had not achieved sufficient progress in sustaining viable populations of endangered and threatened aquatic species or in ecosystem restoration, levee stability, or water supply reliability. In

response, the CALFED Program's Ecosystem Restoration Program (ERP) Implementing Agencies developed the *Conservation Strategy for Restoration of the Sacramento-San Joaquin Delta Ecological Management Zone and the Sacramento and San Joaquin Valley Regions* (DFG 2011).[42] The Delta Plan refers to Section 1 of this report as the ERP Delta Conservation Strategy.

The ERP Delta Conservation Strategy is important because it describes the ERP Implementing Agencies' current ecosystem restoration goals, objectives, and priorities for the Delta Ecological Management Zone (Delta EMZ). It also follows the principle of a single blueprint for ecosystem restoration and species recovery in the Delta in accordance with the principles of ecosystem-based management. The ERP Implementing Agencies have encouraged all agencies, groups, or individuals interested in resource conservation and management in the Delta to use this document as a shared vision to coordinate and integrate actions. It is for this reason that it serves as a key reference document for the Delta Plan to guide ecosystem restoration and other actions.

The ERP Conservation Strategy includes an elevation map for the Delta and Suisun Marsh and accompanying text to show the appropriate habitat types to be restored based on current elevations, included as Appendix D of the Delta Plan. Figure 5-2, referenced by Delta Plan policies ER P2 and ER P3 (presented below), was developed in consultation with DFG and is based on the figure and text in Appendix D. The Delta Plan requires habitat restoration actions to use this information to plan and implement habitat restoration projects (ER P2) and requires actions other than habitat restoration to avoid or mitigate adverse impacts to the opportunity for habitat restoration (ER P3). For example, tidal marsh habitat restoration projects would not be appropriate for areas outside of the areas labeled "intertidal" on Figure 5-2. Excavation of areas within the sea level rise accommodation zone to allow tidal flow to create tidal marsh today would not be allowed. For subsided islands, appropriate habitat restoration includes deep open water areas for pelagic species, seasonal wetlands, and wildlife-friendly agriculture. Actions that promote carbon sequestration and subsidence reversal are especially encouraged.

Actions other than habitat restoration should allow for future habitat restoration or provide appropriate mitigation, in consultation with DFG, for the loss of habitat restoration opportunities. For example, most agricultural practices would allow for future habitat restoration.

Levees and Riverine Habitat

State and federal policies to address water supply or flood risk in the Delta should also consider the impact of these policies on remaining habitat. For example, the overall effect of woody vegetation on levees is a topic of considerable current controversy. Current policy recommendations by the U.S. Army Corps of Engineers propose to strip woody vegetation off levees under their jurisdiction. A technical manual issued by the Federal Emergency Management Agency (FEMA) for earthen dams has been relied upon heavily to support the vegetation removal policy for earthen levees (FEMA 2005). However, if implemented as proposed, the order would denude many Delta levees, severely reducing already sparse shaded riverine aquatic habitat.

Scientific support for and against this policy is mixed. Concerns with maintaining woody vegetation on levees include difficulties with inspection and flood-fighting, potential for root holes, and tree toppling with scour erosion. Evidence also exists that allowing woody shrubs and small trees on levees enhances levee structural integrity while providing environmental benefits. A study on a channel levee along the Sacramento River concluded that roots reinforced the levee soil and increased shear resistance in a measurable manner (Shields and Gray 1992), providing increased stability against slope failures.

The benefits and risks of levee vegetation should be weighed carefully, and methods for maximizing benefits and minimizing risks to both habitat and levee structural integrity should be identified.

[42] Updated document is currently under review by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service.

The Role of Safe Harbor in Effective Delta Ecosystem Restoration

To support both Delta agriculture and species recovery, farmers in the Delta are encouraged to implement management practices to maximize habitat values, and the Delta Protection Commission (DPC) supports using incentives such as purchase of conservation easements from willing sellers (DPC 2010b, Natural Resources Policy P-2). Safe Harbor agreements, which are voluntary agreements between wildlife agencies and landowners whose actions contribute to the recovery of listed species, assure these landowners that the presence of an endangered species on their property will not result in restrictions on activities undertaken on their land. Facilitating and creating standard rules for these agreements with Delta landowners may encourage more landowners to participate in conservation programs.

Problem Statement

Landscape attributes, particularly waterway geometry, elevation, and other environmental conditions, have changed dramatically in the Delta and the Suisun Marsh over the last 160 years. The resultant reduction in the extent, quality, and diversity of habitats supporting native species has led to declines in populations of native resident and migratory species. In addition, there are growing concerns that increasing urbanization adjacent to the Delta and within the Secondary Zone may adversely affect resources in the Primary and Secondary Zones. The Delta Reform Act requires orderly, balanced conservation and development of land resources throughout the Delta. Some landowners are wary of restoring wildlife habitats on their property because of restrictions that could be imposed by the Endangered Species Act.

Policies

ER P2 Habitat restoration actions shall be consistent with the habitat type locations shown on the elevation map in Figure 5-2, and accompanying text shown in Appendix D, based on the *Conservation Strategy for Restoration of the Sacramento-San Joaquin Delta Ecological Management Zone and the Sacramento and San Joaquin Valley Regions (DFG 2011)*, with minor alterations.

The Delta Stewardship Council may amend the Delta Plan to incorporate revised figures and text from the Ecosystem Restoration Program's Conservation Strategy as the strategy is revised.

ER P3 Actions other than habitat restoration, including new or amended local or regional land use plans, shall demonstrate that they have, in consultation with the Department of Fish and Game, avoided or mitigated within the Delta the adverse impacts to the opportunity for habitat restoration at the elevations shown in Figure 5-2. This policy does not apply within the following areas, defined as of January 1, 2012:

- Incorporated cities and their spheres of influence
- The Clarksburg Growth Boundary[43]
- The Contra Costa County Urban Limit Line[44]
- The Mountain House General Plan Community Boundary[45]

[43] Yolo County. 2009. *Yolo County 2030 Countywide General Plan.* Land Use and Community Character Element. Adopted November 10. Woodland, CA.

[44] Contra Costa County. *Contra Costa County General Plan 2005-2020.* Land Use Element. Urban Limit Line Map as amended November 7, 2006.

[45] Mountain House Master Specific Plan Map, on file with the San Joaquin Community Development Department.

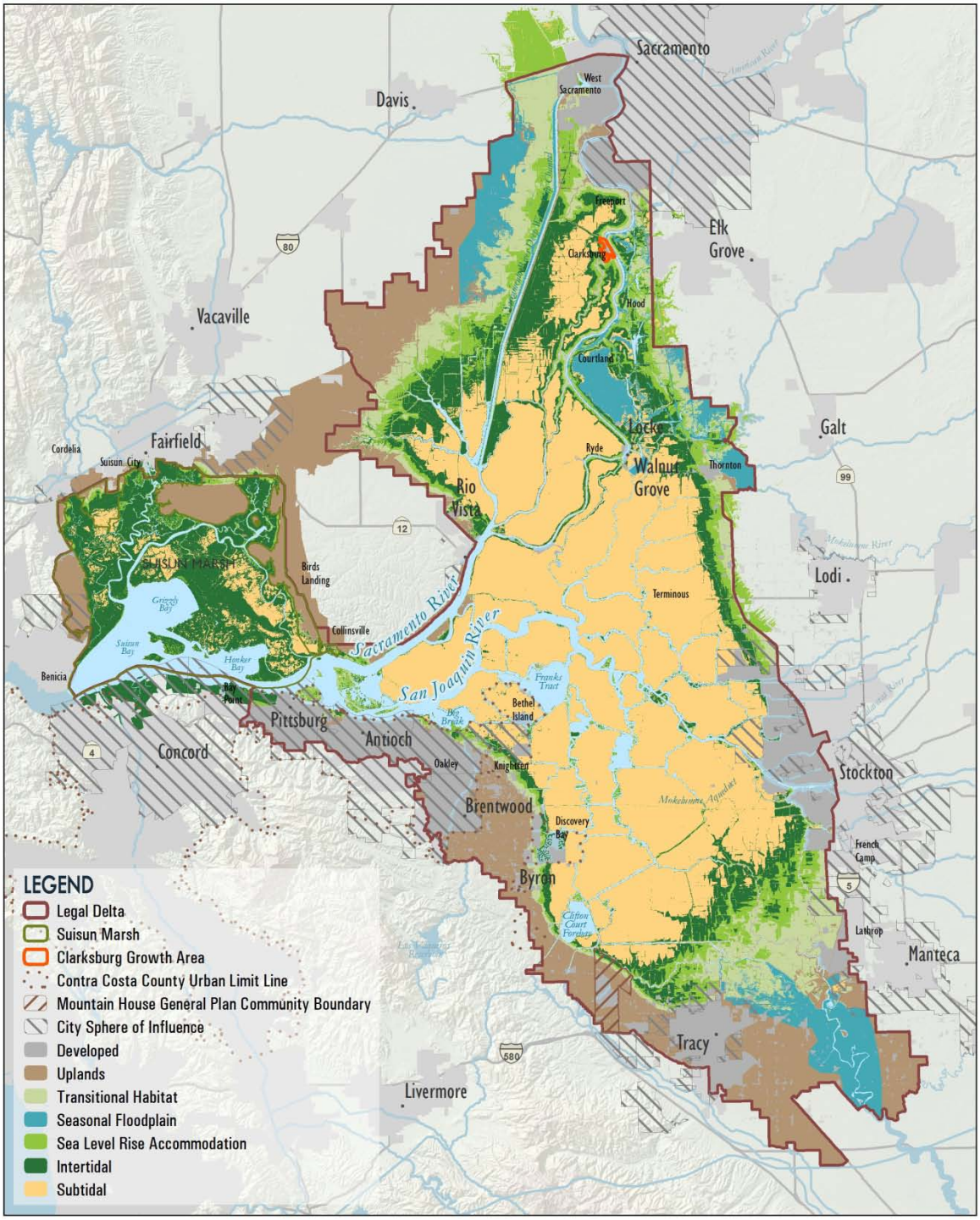

Figure 5-2
Habitat Types Based on Elevation, Shown with Developed Areas in the Delta and Suisun Marsh
Source: Adapted from DFG 2011

ER P4 State and local agencies constructing new levees, or substantially rehabilitating or reconstructing existing levees in the Delta shall evaluate and, where feasible, incorporate alternatives (including use of setback levees) that would increase the extent of floodplain and riparian habitats. When available, criteria developed under RR R4 shall be used for determining appropriate locations for setback levees.

Recommendations

ER R1 The Delta Stewardship Council acknowledges the importance of expediting habitat restoration in the Delta and its watershed and recommends the prioritization and implementation of habitat restoration projects in the following areas, shown in Figure 5-3. Habitat restoration projects should consider landscape elements including connectivity between areas to be restored and existing habitat areas needed for the full life cycle of species targeted to benefit from the restoration project. Where possible, restoration projects should emphasize the potential for water quality improvement. Restoration project proponents should coordinate with local vector control districts in implementing projects.

- **Cache Slough Complex.** The flood basins entering the Cache Slough Complex are the interface between river and tidally influenced portions of the Delta. A significant portion of the region should return to uplands with vernal pool and grassland habitats and broad nontidal, freshwater, emergent plant-dominated wetlands that grade into tidal freshwater wetlands, shallow subtidal and deep open water habitats. A restoration project in this area is the passively restoring Liberty Island. Projects in the planning stage include the Department of Water Resources' Prospect Island restoration project.

- **Cosumnes River–Mokelumne River Confluence.** Unregulated and minimally regulated rivers should allow frequent and regular winter and spring overbank flooding to create seasonal floodplain and riparian habitats grading into tidal marsh and shallow subtidal habitats. An existing restoration project is the Cosumnes River Preserve floodplain restoration. Projects in the planning stage include the Department of Water Resources' North Delta Flood and Ecosystem Restoration Project on McCormack-Williamson Tract.

- **Lower San Joaquin River Floodplain.** Historically, the south Delta and its connection to the lower San Joaquin River contained a complex network of channels with low natural berms, large woody debris, willows, and other shrubs with upland areas supporting open oak woodlands. Reconnection of significant portions of the floodplain, along with more natural flows, stimulates food webs that support native species. Projects in the planning stage include the Lower San Joaquin Flood Bypass proposed by the South Delta Levee Protection and Channel Maintenance Authority and partners.

- **Suisun Marsh.** The largest wetland area on the west coast of the contiguous United States, Suisun Marsh has been mostly disconnected from the estuary. Restoring significant portions of Suisun Marsh provides the brackish portion of the estuary with sea level rise accommodation space, opportunities for extensive land-water interface dynamics, and compressed chemical and biological gradients that support productive and complex food webs to which native species are adapted. An ongoing restoration project is the Department of Water Resources' Blacklock Restoration Project. Projects in the planning stage include the Department of Fish and Game's Hill Slough Restoration Project.

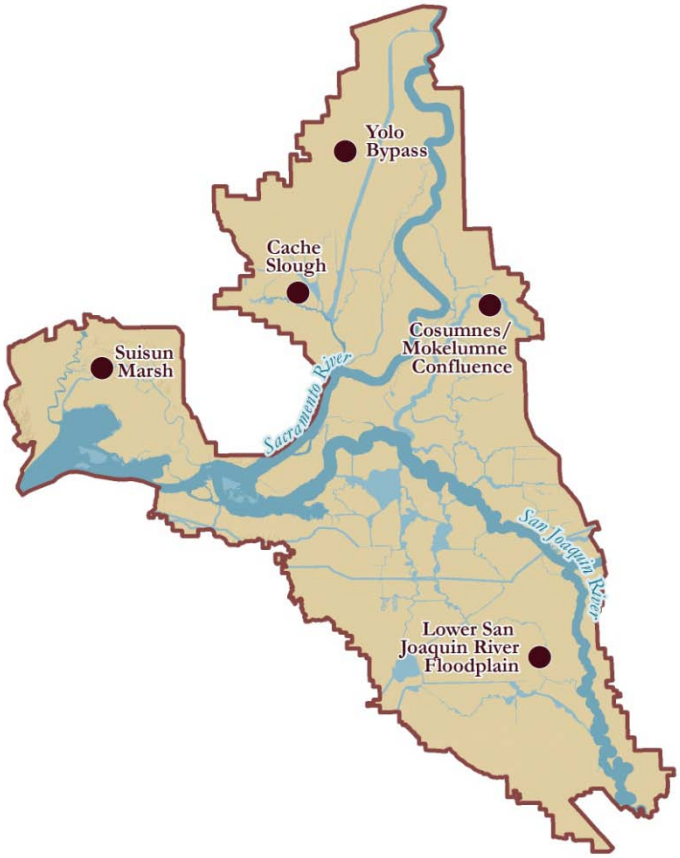

Figure 5-3
Recommended Areas for Prioritization and Implementation of Habitat Restoration Projects
Source: DFG 2011

- **Yolo Bypass.** The current operation of the Yolo Bypass as a flood control project provides substantial ecosystem benefits for Sacramento splittail spawning and rearing and salmon rearing (Sommer et al. 2001, Moyle et al. 2007). Enhancing the ability of Yolo Bypass to be "activated" by higher-frequency, lower-magnitude flood levels provides more opportunity for migrating fish, especially Chinook salmon, to use this system as a migration corridor rich in refugia and food resources. Projects in the planning stage include fish passage improvements, and various approaches, such as notching the Fremont Weir, to increase the frequency and duration of inundation during times of year critical for spawning and rearing of native fish.

ER R2 As part of its Strategic Plan, and subsequent Implementation Plan or annual work plans, the Sacramento–San Joaquin Delta Conservancy should:

- Develop and adopt criteria for prioritization and integration of large-scale ecosystem restoration in the Delta and Suisun Marsh, with sustainability and use of best available science as foundational principles.

- Develop and adopt processes for ownership and long-term operations and management of land in the Delta and Suisun Marsh acquired for conservation or restoration.

- Develop and adopt a formal mutual agreement with the Department of Water Resources, Department of Fish and Game, federal interests, and other State and local agencies on implementation of ecosystem restoration in the Delta and Suisun Marsh.
- Develop, in conjunction with the Wildlife Conservation Board, the Department of Water Resources, Department of Fish and Game, and other State and local agencies, a plan and protocol for acquiring the land necessary to achieve ecosystem restoration consistent with the coequal goals and the Ecosystem Restoration Program's Delta Conservation Strategy.
- Lead an effort to develop a habitat credit program that provides credit for each of these steps: acquisition in preparation for future restoration; preservation, management, and enhancement of existing habitat; restoration of habitat; and monitoring and evaluation of habitat evolution and ecological outcomes.
- Work closely with the Delta Science Program to:
  - Incorporate the best available understanding of the scales, patterns, and processes of the historical landscape to guide land acquisition strategies and restoration design.
  - Apply the best understanding of landscape ecology as a unifying perspective for restoring processes and functions on degraded landscapes.
  - Construct landscape-level conceptual models for key regions of the Delta and Suisun Marsh to clarify how more natural flows and ecosystem restoration confer resilience to native species while promoting processes of self-repair of modified landscapes. Conceptual design models should engage hydrodynamics, transport, particle tracking, and food web models to support and integrate the interdisciplinary perspectives.
  - Study available habitat reference sites to increase understanding of well-functioning habitats and to inform performance measure metrics and trajectories.

ER R3 State and federal fish agencies (California Department of Fish and Game, National Marine Fisheries Service, U.S. Fish and Wildlife Service) should complete ongoing negotiations toward a habitat credit agreement with water supply agencies.

ER R4 Considering the ecosystem value of remaining riparian and shaded riverine aquatic habitat along Delta levees, the U.S. Army Corps of Engineers should work with the Department of Fish and Game and the Department of Water Resources to develop and execute an agreed-upon variance process to exempt Delta levees from the U.S. Army Corps of Engineers' levee vegetation policy where appropriate.

ER R5 The Department of Fish and Game and the U.S. Fish and Wildlife Service should develop rules for voluntary Safe Harbor agreements with property owners in the Delta whose actions contribute to the recovery of listed threatened or endangered species.

Reducing Threats and Stresses

Ecosystem restoration is challenged by persistent threats and stresses to the processes, habitats, and species it seeks to restore. The current degraded ecological conditions for many native Delta species are the result of the combined impacts of multiple drivers and stressors. In a memo to the Council, "Addressing Multiple Stressors and Multiple Goals in the Delta Plan" (Appendix E), the Delta Independent Science Board (ISB) classified stressors in the Delta into four categories (Delta ISB 2011):

- **Globally determined stressors** that cannot be eliminated or mitigated within the purview of the Delta Plan (for example, effects of climate change, earthquakes, human population growth, or the California economy)
- **Legacy stressors** that result from past actions in the Delta watershed that cannot be undone (for example, habitat loss and alteration, changed pattern of flow, mercury pollution from historical gold mining, past selenium contamination, land subsidence, changing sediment loads, artificial levees and subsequent levee breaks, water management infrastructure including dams, agricultural policies, development and building codes, and past introductions of nonnative species)
- **Anticipated stressors** that scientists can anticipate will result from present or future activities (for example, future subsidence, Delta landscape change from changed land and water use, urban expansion, upstream land use, upstream dam operations, lifestyle choices, urban-rural migration patterns, and future nonnative invasive species)
- **Current stressors** that result from ongoing human activities (for example, changed hydrograph/reduced inflow and outflow, entrainment at diversions, more nitrate and ammonium and less phosphorus, selenium release, pesticide release, release of other trace metals and toxics, dredging, legal harvest, illegal harvest, hatchery impacts, agricultural policies, and development and building codes)

Controlling stressors in the first two categories is difficult or impossible, and management actions aimed at these stressors generally focus on adaptation and mitigation. Stressors in the last two categories should be managed to prevent or reduce their effects by changing human activities that cause the stresses or by allowing or planning for increased adaptation to the stresses. The Delta ISB also urged paying attention to all categories of drivers and stressors, including those acting over long temporal and broad spatial scales (Delta ISB 2011). The Delta ISB pointed out that it is difficult to assess and prioritize stressors because they interact with each other, affect ecosystem attributes in varying ways (what may be negative for one stressor may be positive for another stressor), and effects may change in different time periods or locations. The Delta ISB recommended tackling multiple stressors simultaneously, even if the outcomes are uncertain. According to the Delta ISB, there is "no reason to think that reducing one stressor, or several stressors, will solve even a particular problem such as the pelagic organism decline" in the Delta. Instead, "a large number of stressors need to be addressed" to achieve a healthier Delta ecosystem (Delta ISB 2011). Promoting the reduction of and adaptation to multiple threats and stresses, wherever possible, is therefore a critical step in meeting the coequal goal of a healthier Delta ecosystem.

One way to reduce stress on native species in the Delta is to reduce the impacts of established nonnative species and prevent the establishment of new nonnative invasive species. The ERP Delta Conservation Strategy described previously recommends a number of actions associated with reducing the negative ecological and economic impacts of established nonnative species in the Delta (see sidebar). The Delta Plan recommendation ER R7 (below) incorporates these actions and accompanying text, included as Appendix F of the Delta Plan.

Stage 2 Actions for Non-Native Invasive Species

The Conservation Strategy for Restoration of the Sacramento-San Joaquin Delta Ecological Management Zone and the Sacramento and San Joaquin Valley Regions recommends six actions to prevent the establishment of additional non-native invasive species and reduce the negative ecological and economic impacts of established non-native species (NIS) in the Bay-Delta estuary and its watershed (DFG et al. 2011):

Action 1: Continue implementing DFG's California Aquatic Invasive Species Management Plan (CAISMP) to prevent new introductions; limit or eliminate NIS populations; and reduce economic, social, and public health impacts of NIS infestation.

Action 3: Continue research and monitoring programs to increase understanding of the invasion process and the role of established NIS in the Delta's ecosystems.

Action 4: Continue studies on the effectiveness on the local treatment of zebra and quagga mussels using soil bacteria.

Action 5: Standardize methodology for sampling programs to measure changes in NIS populations over a specific timeframe.

Action 6: Collect and analyze water quality sampling data (e.g., velocity, salinity, turbidity and water temperature) for correlation analysis between NIS distribution and habitats.

Action 7: Complete an assessment of existing NIS introductions and identify those with the greatest potential for containment or eradication; this assessment also would be used to set priority control efforts.

Note: Actions are numbered in accordance with the non-native invasive species actions listed in DFG 2011 for the Sacramento-San Joaquin Delta Ecological Management Zone.

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Problem Statement

Although the Delta and the Suisun Marsh remain productive parts of the San Francisco Estuary ecosystem, their unique, native natural heritage and prized ecosystem services (such as the provisioning of native salmon as a food source, for recreation, and as a source of cultural, intellectual, and spiritual inspiration) are in danger of being irretrievably lost because of the interacting effects of multiple drivers and stressors. These include altered flows and reduced habitat quality and quantity (previously addressed in this chapter and Chapter 4, A More Reliable Water Supply for California), degraded water quality (addressed in Chapter 6, Improve Water Quality to Protect Human Health and the Environment), and the effects of nonnative invasive species, entrainment, predation, diminished food resources, migration barriers, and hatchery impacts.

Policies

ER P5 Agencies proposing covered actions shall demonstrate that the potential for new introductions of or improved habitat conditions for nonnative invasive species have been fully considered and avoided or mitigated in a way that appropriately protects the ecosystem.

Recommendations

ER R6 The Department of Fish and Game and other appropriate agencies should prioritize and fully implement the list of "Stage 2 Actions for Nonnative Invasive Species" and accompanying text shown in Appendix F taken from the *Conservation Strategy for Restoration of the Sacramento-San Joaquin Delta Ecological Management Zone and the Sacramento and San Joaquin Valley Regions* (Department of Fish and Game et al. 2011).

The Delta Stewardship Council may amend the Delta Plan to incorporate revised figures and text from the *Conservation Strategy for Restoration of the Sacramento-San Joaquin Delta Ecological Management Zone and the Sacramento and San Joaquin Valley Regions* as the strategy is revised.

ER R7 The Delta Science Program, in conjunction with the Department of Fish and Game, the Department of Water Resources, the State Water Resources Control Board, and other relevant agencies and stakeholders, should conduct workshops to develop recommendations to the Delta Stewardship Council for measures to reduce stressor impacts on the Delta ecosystem that would support and be consistent with the coequal goals. For example, workshops would consider options for varying salinity to reduce impacts of nonnative invasive species while providing overall ecosystem benefits and minimally disrupting water supply. The recommended measures could be adopted as policies or recommendations by the Delta Stewardship Council into an amended Delta Plan. The resulting recommendations should be provided to the Delta Stewardship Council by January 1, 2013.

The Bay Delta Conservation Plan

The Bay Delta Conservation Plan (BDCP) is an applicant-driven, multi-stakeholder Habitat Conservation Plan/Natural Communities Conservation Plan development process for the Delta that began in 2006. The California Natural Resources Agency has been leading the process in collaboration with other State, federal, and local water agencies, environmental organizations, and other interested parties.

The BDCP is a major project considering large-scale improvements in water conveyance and large-scale ecosystem restoration in the Delta. It has the dual purpose of achieving greater water supply reliability through an improved Delta export water conveyance system, and contributing to recovery of threatened and endangered species in the Delta. The BDCP will include a scientifically based adaptive management

program to ensure incorporation of new scientific information into decisions on water management and conservation measures.

The BDCP is a complex and challenging ongoing effort. The BDCP process is not expected to be completed until after the first Delta Plan is adopted by the Delta Stewardship Council. As described in Chapter 3, the BDCP will be incorporated into the Delta Plan if it meets the requirements of Water Code section 85320. If incorporated, the BDCP will become part of the Delta Plan and therefore part of the basis for future consistency determinations. For more information about the inclusion of the BDCP in the Delta Plan, refer to Chapter 3, Governance: Implementation of the Delta Plan; Chapter 4, A More Reliable Water Supply for California; and Appendix A.

Problem Statement

As described in Chapter 4, A More Reliable Water Supply for California, BDCP is expected to significantly affect the coequal goals. Specifically, the goal of the BDCP is to promote the recovery of endangered, threatened, and sensitive species and their habitats in the Delta in a way that also will provide more reliable water supplies. The BDCP planning process has been under way since 2006 and its completion date is uncertain.

Recommendation

ER R8 The relevant federal, State, and local agencies should complete the Bay Delta Conservation Plan, consistent with the provisions of the Delta Reform Act, and receive required incidental take permits by December 31, 2014. If the Bay Delta Conservation Plan process is not completed by this date, the Delta Stewardship Council will consider how to proceed with an alternative approach to develop and complete the ecosystem and conveyance planning process.

Performance Measures

Performance measures derive from the goals and objectives in the Delta Reform Act and from mandates for large-scale ecosystem restoration within the Delta. Ecosystem performance measures should address progress in achieving each of the following objectives in the Delta Reform Act:

> 85302(c) *The Delta Plan shall include measures that promote all of the following characteristics of a healthy Delta ecosystem.*
>
> (1) *Viable populations of native resident and migratory species.*
>
> (2) *Functional corridors for migratory species.*
>
> (3) *Diverse and biologically appropriate habitats and ecosystem processes.*
>
> (4) *Reduced threats and stresses on the Delta ecosystem.*
>
> (5) *Conditions conducive to meeting or exceeding the goals in existing species recovery plans and state and federal goals with respect to doubling salmon populations.*
>
> 85302(e) *The following subgoals and strategies for restoring a healthy ecosystem shall be included in the Delta Plan.*
>
> (1) Restore large areas of interconnected habitats within the Delta and its watershed by 2100
>
> (2) Establish migratory corridors for fish, birds, and other animals along selected Delta river channels.

(3) Promote self-sustaining, diverse populations of native and valued species by reducing the risk of take and harm from invasive species.

(4) Restore Delta flows and channels to support a healthy estuary and other ecosystems.

(5) Improve water quality to meet drinking water, agriculture, and ecosystem long-term goals.

(6) Restore habitat necessary to avoid a net loss of migratory bird habitat and, where feasible, increase migratory bird habitat to promote viable populations of migratory birds.

Performance measures for ecosystem restoration are placed into three general classes:

- Administrative performance measures describe decisions made by policy makers and managers to finalize plans or approve resources (funds, personnel, projects) for implementation of a program or group of related programs.
- Driver performance measures evaluate the factors that may be influencing outcomes and include on-the-ground implementation of management actions, such as acres of habitat restored or acre-feet of water released, as well as natural phenomena outside of management control (such as a flood, earthquake, or ocean conditions).
- Outcome performance measures evaluate ecosystem responses to management actions or natural drivers.

The distinction between performance measure types is not rigid. In some cases, an outcome performance measure for one purpose may become a driver performance measure for another purpose.

Ecosystem processes lend themselves to tracking with comprehensive ecosystem assessment and communication tools (for example, environmental report cards) that clearly and quickly communicate the status and trends of ecosystem recovery to managers and the public. Such tools have not yet been developed for the Delta. Many of the performance measures that follow use the phrase “progress toward” to indicate measures that are amenable to this type of assessment and reporting.

Favorable ecosystem responses are critical to achieving the coequal goal of protecting, enhancing, and restoring the Delta ecosystem. Performance measures for ecosystem restoration are presented in the administrative, driver, and outcome categories. If applicable, metrics (what we will measure) or targets (numerical value and/or date) are included with each performance measure that follows.

Development of informative and sensitive performance measures is a challenging task that will continue after the adoption of the Delta Plan. Performance measures need to be designed to capture important trends and to address whether specific actions are producing expected results. Efforts to develop performance measures in complex and large-scale systems like the Delta are commonly multi-year endeavors. The recommended performance measures are provisional and subject to refinement as time and resources allow.

Note that performance measures for ecosystem water quality are provided in Chapter 6.

Administrative Performance Measures

- The SWRCB adopts and implements Delta flow objectives by June 2, 2014 and adopts flow criteria for the major tributary rivers to the Delta by June 2, 2018.
- Proposed actions that include ecosystem restoration in the Delta are consistent with the sections from the Ecosystem Restoration Program’s Conservation Strategy for Stage 2 Implementation for the Sacramento-San Joaquin Delta Ecological Management Zone (DFG 2010) referred to in the Delta Plan.

- Proposed actions affecting floodplains in the Delta or in the Delta watershed clearly demonstrate that adverse impacts to the opportunity for habitat restoration have been fully avoided or minimized.
- The Delta Conservancy and others develop and adopt clear strategies (including prioritization) and spatial and temporal targets (locations, number of acres, schedule) for large-scale Delta ecosystem restoration.
- The Delta Science Program, in collaboration with others, completes recommendations for measures to reduce stressor impacts on the Delta ecosystem that support and are consistent with the coequal goals by January 1, 2013.
- The Delta Science Program supports and guides, with others, the development of a "regional ecosystem assessment and communication tool" (REACT) by January 1, 2014. This tool is intended to more clearly and rapidly communicate information about status, trends, and progress in achieving ecosystem goals and targets to managers and the public and would refine and incorporate metrics associated with ecosystem-related performance measures in the Delta Plan. In addition to incorporating flow, habitat, stressor, and species metrics, REACT development will also include the establishment of metrics to evaluate progress toward restoring and protecting important Delta ecosystem processes.

Driver Performance Measures

- Progress toward restoring in-Delta flows to more natural flow patterns to support a healthy estuary. Metrics: results from hydrological monitoring and hydrodynamic modeling.
- Pilot-scale Delta habitat restoration projects are developed and initiated in the priority areas described in ER R1. These projects include tidal brackish and freshwater marsh as well as floodplain restoration and have clear adaptive management plans aimed at improving outcomes and providing lessons for the development of large-scale restoration projects. Metrics: acres restored by habitat type, and lessons learned.
- Progress toward restoring large areas of diverse and interconnected habitats for native resident and migratory species in the Delta and its watersheds, including migratory bird habitat. Trends in the area of restored habitat (acres) and interconnections among them will be upward over the next decade.
- Progress toward protecting existing habitats that benefit native resident and migratory species, including migratory birds. Trends in the area of habitat used by native-species (acres) will remain stable or increase over the next decade.
- Progress toward establishment of permanent or appropriate seasonal connectivity along all major migratory routes. Trends in the number and extent (miles, acres) of connections will go up over the next decade.
- Progress toward establishment of contiguous corridors for migration of fish and birds. Trends in the number and extent (miles, acres) of connections will go up over the next decade.

Outcome Performance Measures

- Progress toward the documented use of protected and restored habitats and migratory corridors by native resident and migratory Delta species. Trends in occurrence and performance of native species in protected and restored habitats and corridors will be upward over the next decade. These trends will be derived from animal and plant monitoring surveys that are conducted as part of adaptive management strategies for the protection and restoration of these areas.

- Progress toward achieving viable populations of native resident and migratory species. Trends in native Delta species will be upward over the next decade. These trends will be derived from long-term animal and plant monitoring surveys conducted by the IEP agencies and others.
- Progress toward achieving the state and federal "doubling goal" for wild Central Valley salmonids. This performance measure contains a clear target: doubling the salmonid population relative to 1995 levels.[46] These trends will be derived from long-term salmonid monitoring surveys conducted by the National Marine Fisheries Service, U.S. Fish and Wildlife Service, and others.
- Progress toward decreasing the annual trend in number of new, uncontrolled harmful invasive species. Trends in new nonnative species arriving and proliferating in the Delta each year will be downward over the next decade. These trends will be derived from long-term animal and plant monitoring surveys conducted by the IEP agencies, the California Department of Boating and Waterways, the U.S. Department of Agriculture, the San Francisco Estuary Institute, and others.
- Progress toward decreasing abundance and distribution of harmful invasive aquatic and terrestrial species. Trends in the abundance and distribution of nonnative species in the Delta each year will be downwards over the next decade. These trends will be derived from long-term animal and plant monitoring surveys conducted by the IEP agencies, the California Department of Boating and Waterways, the U.S. Department of Agriculture, the San Francisco Estuary Institute, and others.

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Chapter 6
Improve Water Quality to Protect Human Health and the Environment

The protection and improvement of water quality is inherent to meeting the coequal goals of the State. Water quality plays a critical role in the achievement of a more reliable water supply, and protection, restoration, and enhancement of the Delta ecosystem. Water quality also contributes to the values of the Delta as an evolving place. The Sacramento-San Joaquin Delta Reform Act (Public Resources Code section 29702) directly calls for improving water quality in various sections of the statute:

> *85020. The policy of the State of California is to achieve the following objectives that the Legislature declares are inherent in the coequal goals for management of the Delta:…(e) Improve water quality to protect human health and the environment consistent with achieving water quality objectives in the Delta.*
>
> *85022(d) The fundamental goals for managing land use in the Delta are to do all of the following: …(6) Improve water quality to protect human health and the environment consistent with achieving water quality objectives in the Delta.*
>
> *85302(d) The Delta Plan shall include measures to promote a more reliable water supply that address all of the following: (3) Improving water quality to protect human health and the environment.*
>
> *85302(e) The following subgoals and strategies for restoring a healthy ecosystem shall be included in the Delta Plan…. (5) Improve water quality to meet drinking water, agriculture, and ecosystem long-term goals.*

1

Chapter 6
Improve Water Quality to Protect Human Health and the Environment

Impaired water quality is an influential stressor contributing to the problems of the Delta, and improved water quality is inherent in the coequal goals. Many agencies have a role in the regulation of water quality in the Delta. The State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Boards (RWQCB) have primary responsibility for water quality control in California with the oversight of the United States Environmental Protection Agency (USEPA). Drinking water supply is regulated by the California Department of Public Health.

This chapter is not intended to provide a complete overview of all water quality issues and regulatory programs associated with the Delta. Instead, focus is on three key areas where best available science shows the need for improved water quality to achieve the coequal goals:

- Salinity
- Drinking water quality
- Environmental water quality

The Delta Stewardship Council (Council) urges regulatory agencies to use these recommendations to build on their efforts to improve water quality by applying the best available standards in their programs.

In upholding the coequal goals, the Council envisions a Delta where improved water quality supports a healthy ecosystem and the multiple human uses of water. To support a more resilient and healthy ecosystem, salinity patterns should be consistent with a more naturally variable hydrograph with high-quality river inflows. Nutrient concentrations should not cause excessive growth of nuisance aquatic plants or blooms of harmful algae and should support diverse and productive aquatic food webs. Dissolved oxygen conditions, temperature maxima, turbidity levels, and other physical attributes of the aquatic environment should meet the needs of native species. At all times the Delta should be free of toxic substances that exceed toxic amounts. Discharge of treated wastewater, urban runoff, or agricultural return flows should be regulated so that they do not significantly affect the Delta. High water quality is crucial for beneficial uses of Delta water, successful restoration of aquatic habitats, and sustenance of native plants and animals.

Water quality in the Delta is influenced by a wide variety of factors:

- Freshwater inflows and outflows
- In-Delta land uses
- Dredging
- The Delta levee system
- Tides
- Point source inputs

- Nonpoint source inputs
- In-Delta water use
- Export diversions and operations

Overall, water quality is better in the northern Delta than in the central and southern Delta because higher-quality Sacramento River inflows are greater than inflows from the San Joaquin River, and because the proportion of agricultural water use and drainage in the San Joaquin Valley is greater than in the Sacramento Valley. The SWRCB has listed Delta waterways (various streams, rivers, and sloughs in the Delta), the Carquinez Strait, and San Francisco Bay as having impaired water quality pursuant to the federal Clean Water Act section 303(d) list[47] (SWRCB 2010). Current pollutants of concern include (but are not limited to) insecticides, herbicides, mercury, selenium, nutrients, and legacy organic pollutants such as DDT and PCBs. Additional water quality issues in the Delta include temperature, salinity, turbidity, low dissolved oxygen, bromide, dissolved organic carbon, pathogens, and harmful algal blooms. Amounts of these constituents that are too high or too low can impair the ability of these waters to support beneficial uses, such as municipal water supply, recreational use, agricultural water supply, and healthy fish and wildlife populations.

The RWQCBs develop water quality control plans (known as Basin Plans), which establish water quality standards and implementation plans for achieving standards for all surface water and groundwater within their respective regions. Water quality standards include identification of the affected beneficial use, numeric and narrative water quality objectives established to protect that use, and water quality control policies. In the Delta and the Suisun Marsh, the Sacramento and San Joaquin Rivers Basin Plan (Central Valley RWQCB 1998), the San Francisco Bay Basin Plan (San Francisco Bay RWQCB 2010), and the Water Quality Control Plan for the Sacramento-San Joaquin Delta Estuary (Bay Delta Water Quality Control Plan) (SWRCB 2006) establish water quality objectives for which implementation is best achieved through assigning responsibilities to water-right holders and water users. This is because the parameters to be controlled are significantly affected by flows and diversions; these responsibilities were established in Water Rights Decision 1641. The Bay Delta Water Quality Control Plan also provides reasonable protection for beneficial uses that require control of salinity and operations of the water projects in the Delta (SWRCB 2006).

Sources of pollution in the Delta include point and nonpoint sources, such as agricultural runoff, urban runoff, wastewater treatment plant discharges, and abandoned mines. The SWRCB and RWQCBs issue National Pollutant Discharge Elimination System (NPDES) permits for municipalities and industries. These permits include general and individual permits (for example, the general permits cover stormwater discharges from industrial and construction activities, and individual NPDES permits cover wastewater treatment facilities). These permits are reviewed and modified, if necessary, at 5-year intervals. The RWQCBs regulate other discharge of waste materials through issuance of Waste Discharge Requirements (WDRs) or waivers of WDRs. For example, the Irrigated Lands Regulatory Board of the Central Valley RWQCB regulates waste discharges from irrigated agriculture. This program grants conditional waivers of WDRs to growers if they comply either individually or as part of an agricultural coalition with program requirements.

Placement of a water body on the list of impaired water bodies, also known as the Clean Water Act section 303(d) list, initiates a process to develop a total maximum daily load (TMDL) to address each pollutant causing the impairment. A TMDL defines how much of a pollutant a water body can tolerate and still meet water quality standards. The TMDL must account for all the sources of a pollutant, including point sources and nonpoint sources (discharges from wastewater treatment facilities; runoff from urban areas, agricultural inputs, and runoff from streets or highways; “toxic hot spots”; and aerial

[47] The "303(d) list" is short for the list of impaired and threatened waters (stream/river segments, lakes) that states have identified as not meeting water quality standards and other requirements. Under section 303(d), the law requires that states establish priority rankings for waters on the list and develop Total Maximum Daily Loads (TMDLs) for these waters.

deposition). In addition to accounting for past and current activities, TMDLs may also consider projected future growth that could increase pollutant levels. The TMDL identifies waste load allocations for point sources and load allocations for nonpoint sources, and includes a margin of safety to account for uncertainty. An implementation plan is developed, which specifies a set of actions that must be carried out to ensure that the TMDL results in successful achievement of water quality standards. TMDLs are implemented through amendments to the appropriate Basin Plan.

The 2010 Integrated Report (SWRCB 2010) prioritizes TMDLs to be developed for each water body-pollutant combination on the Clean Water Act section 303(d) list, and establishes a schedule for completion of the TMDLs. Adopted TMDLs and TMDLs under development are listed in Table 6-1.

Table 6-1
TMDLs Approved and Under Development in the Central Valley, Delta, and Suisun Bay

Water Bodies	Pollutants
American River	Mercury
Cache Creek, Bear Creek, Harley Gulch	Mercury
Central Valley	Organochlorine Pesticides
Central Valley	Pesticides
Clear Lake	Mercury
Clear Lake	Nutrients
Grasslands	Selenium
North San Francisco Bay (includes Suisun Bay)	Selenium
Sacramento and Feather Rivers	Diazinon
Sacramento County Urban Creeks	Diazinon and Chlorpyrifos
Sacramento-San Joaquin River Delta	Diazinon and Chlorpyrifos
Sacramento-San Joaquin River Delta	Mercury
Salt Slough	Selenium
San Francisco Bay (includes Suisun Bay)	Mercury
San Francisco Bay (includes Suisun Bay)	PCBs (Polychlorinated Byphenyls)
San Francisco Bay Area Urban Creeks	Diazinon
San Joaquin River	Salt and Boron
San Joaquin River	Diazinon and Chlorpyrifos
San Joaquin River	Selenium
Stockton Deep Water Ship Channel (Phase I)	Dissolved Oxygen
Stockton Deep Water Ship Channel (Phase II)	Dissolved Oxygen
Stockton Urban Sloughs	Dissolved Oxygen
Stockton Urban Sloughs	Pathogens
Stockton Urban Water Bodies	Pathogens
Suisun Marsh	Dissolved Oxygen
Suisun Marsh	Mercury
Upper Sacramento River	Cadmium, Copper, and Zinc

Source: Central Valley RWQCB 2011; San Francisco Bay RWQCB 2011a

The USEPA recently issued an Advanced Notice of Proposed Rulemaking (USEPA 2011) as part of an effort to assess the effectiveness of current water quality programs designed to protect aquatic species in the Bay-Delta. The document identifies the key water quality issues affecting Bay-Delta aquatic resources

and summarizes current research for each of these issues, including total ammonia, selenium, pesticides, emerging contaminants, and other parameters affecting estuarine habitat and the migratory corridors of anadromous fish. The notice is intended to solicit public comment on possible USEPA actions to address water quality conditions affecting the Bay-Delta. USEPA may make changes to programs in the Bay-Delta through a formal rulemaking process as a result of further evaluation and consideration of public comment. These changes could affect federal water quality programs administered by the State.

Water quality in the Delta is also regulated by the San Francisco Bay Conservation and Development Commission (BCDC), which has jurisdiction on all tidal areas of the Bay, including Suisun Bay and Suisun Marsh. BCDC policies regarding water quality are intended to prevent the release of pollution into Bay waters to the greatest extent feasible. The BCDC makes decisions regarding water quality impacts based on evaluation by and the advice of the San Francisco Bay RWQCB. In addition to State actions, BCDC will review federal actions, permits, projects, licenses, and grants affecting the Bay, including Suisun Marsh, pursuant to the federal Coastal Zone Management Act.

The SWRCB and RWQCBs are the regulatory agencies with statutory authority to adopt water quality control plans, including regulating waters for which water quality standards are required by the federal Clean Water Act (Water Code sections 13170 and 13240). The Council recognizes the SWRCB's role and authority in regulating water quality, and supports and encourages the timely development and enforcement of programs (for example, water quality standards, TMDLs, WDRs, and NPDES permits) to reduce pollutant loads and progress toward compliance with reductions of pollutants that are causing water quality impairments in the Delta. The Council also supports and encourages the completion of the elements of the California Water Board's 2010 *Update to Strategic Plan 2008-2012* (June 2010) and the *Strategic Workplan for Activities in the San Francisco Bay/Sacramento–San Joaquin River Delta Estuary* (July 2008) prepared by the SWRCB, Central Valley RWQCB, and San Francisco Bay RWQCB.

This chapter discusses three major aspects of water quality needed to protect human health and to improve the environment of the Delta and the regions receiving export water: salinity, drinking water quality, and environmental water quality. Environmental water quality is subdivided into sections on nutrients, pesticides, mercury, selenium, and emerging pollutants.

Policies and Recommendations

Salinity

Like all estuaries, the Bay-Delta is a place where freshwater mixes with saltwater. The location, extent, and dynamics of the freshwater-saltwater interface are important drivers of many estuarine processes and an important consideration in water management for human uses. The location of the freshwater-saltwater interface along the upstream-downstream axis of the estuary shifts with the seasons and from year to year depending on the amount of precipitation and Delta outflow (Kimmerer 2004, Malamud-Roam et al. 2007, Stahle et al. 2011). This freshwater-saltwater gradient has changed over the past 150 years because of landscape modification, water management, and climate variability. Figure 6-1 is a representation of salinity over a range of concentrations relevant to suitability for water supply. It clearly shows the salinity gradient in the western Delta under high and low outflow conditions. Changes in seasonal inflow to the Delta caused by upstream diversions, storage of water behind the State and federal water project dams, and operation of the State and federal Delta pumps have generally shifted the salinity gradient upstream, and have changed seasonal and interannual salinity patterns (Enright and Culberson 2010). Even with these measurable shifts in the salinity gradient caused by diversion, storage, and conveyance of water, the primary driver of salinity variability in the western Delta and Suisun Marsh continues to be the amount of precipitation in the watershed.

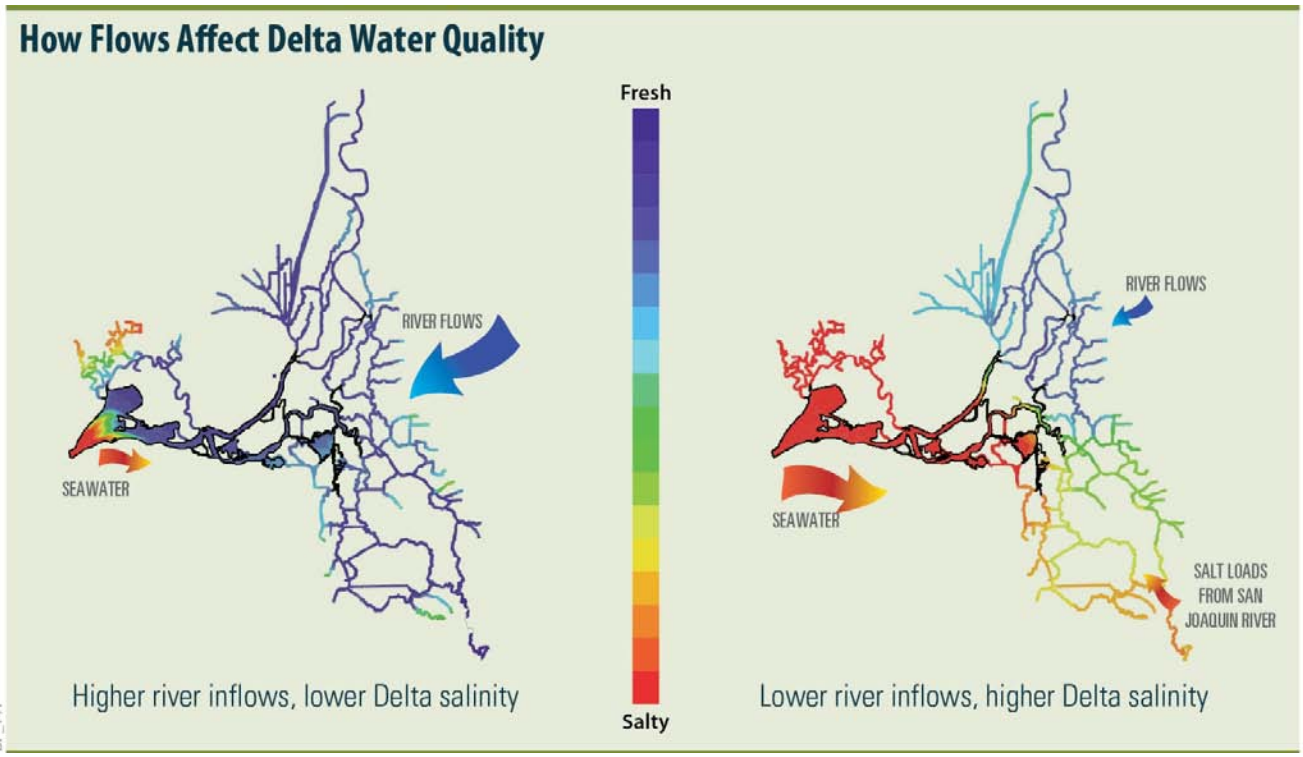

Figure 6-1
Salinity in the Delta Varies by Outflow Volumes
Delta salinity varies with inflow and outflow. Very high flows (right) push freshwater well into Suisun Bay and produce low salinity conditions throughout the Delta. During very low flow periods (left), seawater can be seen pushing into the interior Delta from Suisun Bay with high salinity also entering from the San Joaquin River in the southeastern Delta.
Source: Images created by Resource Management Associates, cited in CALFED Bay-Delta Program report to Central Valley Drinking Water Policy Workgroup, 2007.

The interface between freshwater and saltwater is a critical region of the estuary for native fish and other organisms. Although there is no broadly accepted definition, the low salinity zone (LSZ) of the estuary is generally considered to be the region with salinity ranging from freshwater up to about 5 practical salinity units (psu), about one-seventh the salinity of seawater. The part of the salinity gradient centered on 2 psu is considered to be of particular importance because it is hypothesized to be an area where suspended particulate matter and organisms accumulate. The location in the Bay-Delta where the tidally averaged bottom salinity is 2 psu is known as X2 (measured as distance in kilometers from the Golden Gate Bridge) and serves as a water quality standard to regulate Delta outflow. The endangered Delta smelt (*Hypomesus transpacificus*) show a preference for the LSZ. Their distribution during most of the year is centered near X2 (Nobriga et al. 2008). The position of X2 is also correlated with the abundance of several estuarine fish and invertebrates such as the bay shrimp (*Crangon franciscorum*) and longfin smelt (*Spirinchus thaleichthys*). That is, higher outflows (smaller X2 values) are correlated with greater abundance of longfin smelt and bay shrimp (Kimmerer 2004).

Examination of tree rings throughout the mountains of California provides a good indicator of precipitation over the last 650 years; however, tree rings alone cannot accurately reproduce the details of Delta salinity over this period (Stahle et al. 2011). The evidence is strong, however, that the Delta was a freshwater ecosystem in the western Delta for 2,500 years before human modification in the nineteenth and twentieth centuries (Malamud-Roam and Ingram 2004). Dredging of channels, reduction in the amount of tidal marsh, and construction of levees have changed the Delta salinity gradient by increasing the strength of tides in the Delta, increasing connections between channels, and reducing the moderating

effects of wetlands and floodplains on outflow. Consequently, simply allowing more variability in Delta outflow will not produce the same salinity gradient patterns that existed before development.

Although seawater is the primary source of salinity in the western Delta and Suisun Marsh, it is not the only source of salts. Agricultural drainage is another significant source of salinity, particularly in the San Joaquin Valley. Municipal and industrial discharges can also locally increase salinity, although such salinity increases are generally small compared to increases from brackish water inputs. All surface waters and groundwaters contain some amount of salt, and this salt is concentrated with use through evaporation and transpiration of water by plants (CALFED 2007). The remaining water in drainage, return flows, or percolated water has a higher salt concentration than the supply water. This normal increase in salinity with water use is exacerbated in some parts of the San Joaquin Valley by naturally occurring salts in soils and a Delta water supply that already has a significant salt load. The net result of these processes is elevated salinity in the San Joaquin River at the point where it enters the Delta; this level is much higher than in the Sacramento River and just meets applicable water quality standards for much of the year. Salinity from seawater mixing into the western Delta and salinity from the San Joaquin River creates, at times, a Delta with a "freshwater corridor" leading from the Sacramento River to the export pumps.

Water quality at the State Water Project (SWP) and Central Valley Project (CVP) export pumps in the southern Delta, while usually meeting all applicable standards for municipal and agricultural use, is significantly higher in salinity than Sacramento River inflow to the Delta. Allowing salinity to vary in a way that might benefit native fish species could impact agricultural and municipal uses of Delta water at SWP, CVP, and other Delta diversion points. Elevated salinity reduces crop yields (Hoffman 2010) or, if high enough, makes water unusable for agricultural purposes. As discussed in the following section on drinking water quality, salinity contamination of municipal water supplies can make water unpalatable, contributes to the formation of harmful disinfection byproducts, and increases corrosion of pipes and equipment. Removal of salts from water supplies is technically difficult and expensive, and the disposal of the concentrated salt waste stream remains a key challenge. Increased salinity affects the reliability of municipal and agricultural water supplies by reducing opportunities for water reuse and recycling (Healey et al. 2008).

In these ways, the salinity regime in the Delta is driven by natural flows, water management, and human land and water uses in the Bay-Delta and its watershed. Achievement of the coequal goals will require updated comprehensive flow standards and water quality control programs for salinity that balance ecosystem and water supply needs. Significant attention must be placed on the examination and resolution of this issue.

Problem Statement

The current salinity and flow regime of the Bay-Delta Estuary is creating conditions unfavorable for native estuarine fish and favorable to introduced species. Current salinity conditions, at certain times and locations, also negatively affect municipal and agricultural uses of Delta water. Allowing salinity to vary in a way that benefits native fish species might further degrade the quality of Delta water for agricultural and municipal uses.

Policies

ER P1 Development, implementation, and enforcement of new and updated flow requirements for the Delta and high-priority tributaries are key to the achievement of the coequal goals. The State Water Resources Control Board should update the Bay-Delta Water Quality Control Plan objectives and establish flows as follows:

a) By June 2, 2014, adopt and implement updated flow objectives for the Delta that are necessary to achieve the coequal goals.[48]

b) By June 2, 2018, develop flow criteria for high-priority tributaries in the Delta watershed that are necessary to achieve the coequal goals.[49]

Prior to the establishment of revised flow objectives criteria identified above, the existing Bay-Delta Water Quality Control Plan objectives shall be used to determine consistency with the Delta Plan.

By June 30, 2013, the Delta Stewardship Council will request an update from the State Water Resources Control Board on items ER P1 (a) and (b). If the Board indicates the items (a) or (b) cannot be met by the dates provided, the Delta Stewardship Council will consider and may amend the Delta Plan to achieve progress on the coequal goals in place of the updated flow objectives. For example, the Delta Stewardship Council could:

1. Determine that a covered action that would increase the capacity of any water system to store, divert, move, or export water from or through the Delta would not be consistent with the Delta Plan until the revised flow objectives are implemented.

2. Recommend that the State Water Resources Control Board cease issuing water rights permits in the Delta and the Delta watershed (or, if the absence of flow criteria is specific to one or more of the major tributaries, then the recommendation could be focused on the impacted areas).

Drinking Water Quality

The Delta is used as a drinking water supply, either solely or partially, for over 25 million Californians. It is also used extensively for body-contact recreation such as swimming and water skiing. At the current locations where Delta water is diverted for municipal use, it contains relatively high concentrations of bromide, organic carbon, nutrients, and dissolved solids (salinity). These drinking water constituents of concern are not directly harmful in drinking water, but they lead to formation of harmful chemicals during drinking water treatment or contribute to taste, odor, or other municipal water supply problems. Sources of these drinking water constituents of concern include natural processes, such as tidal mixing of seawater into the Delta, and the flux of water and organic matter from wetlands, as well as urban runoff, agricultural runoff, and municipal wastewater discharge. Pathogenic protozoa, bacteria, and viruses are also present in Delta waters and are a disease risk for both drinking water and body-contact recreation.

Disinfection of public water supplies is necessary to prevent disease caused by pathogenic organisms. However, bromide and organic carbon in municipal water supplies contribute to the formation of harmful disinfection byproducts when water is treated for domestic use (Healey et al. 2008, AWWA 2011). The disinfection byproducts of primary concern in tap water, such as trihalomethanes and haloacetic acids, are carcinogens subject to stringent public health standards. Treatment of water from the Delta is particularly challenging because it can contain elevated levels of both bromide and organic carbon (DWR 2007). Changes to drinking water treatment processes to reduce the amounts of disinfection byproducts in tap water are technologically challenging and can significantly increase the cost of drinking water treatment (Chen et al. 2010).

[48] Flow requirements could be implemented through several mechanisms including water rights hearing, FERC relicensing and negotiation and settlement. Implementation through hearings is expected to take longer than the deadline shown here.

[49] SWRCB staff will work with the Delta Stewardship Council to determine priority streams. As an illustrative example, priority streams could include the Merced River, Tuolumne River, Stanislaus River, Lower San Joaquin River, Deer Creek (tributary to Sacramento River), Lower Butte Creek, Mill Creek (tributary to Sacramento River), Cosumnes River, and American River (SWRCB 2011a, SWRCB 2011b).

Organic carbon (total or dissolved) is an aggregate measure of the amount of a wide variety of organic compounds in water. In freshwater, these compounds typically come largely from decaying plant material. Along with bromide, elevated concentrations of organic carbon contribute to formation of disinfection byproducts. The amount of disinfection byproduct varies with the type and source of organic carbon, but total organic carbon concentration is nearly always correlated with disinfection byproduct formation.

Salinity, frequently measured as electrical conductivity (EC) or total dissolved solids (TDS), has several significant effects on the use of water for domestic uses. Salts make water unpalatable at relatively low concentrations, with 500 milligrams per liter (mg/L) TDS set as the recommended maximum level in the California secondary drinking water standards (California Code of Regulations, Title 22, section 64449). Salinity also increases the cost of treatment and costs to the consumer due to corrosion and other factors (Howitt et al. 2009). One component of seawater, bromide, is a disinfection byproduct precursor that forms trihalomethanes and haloacetic acids with chlorine or chloramine disinfection, and forms bromate with ozone disinfection.

Pathogenic organisms and pathogen indicators are found in most surface waters. Two common protozoan pathogens that cause gastroenteritis, *Giardia lamblia* and *Cryptosporidium parvum*, have been found in Delta waters at generally low levels with respect to drinking water sources or body-contact recreation (Tetra Tech 2007). Source waters that exceed drinking water regulatory thresholds for *Cryptosporidium* trigger additional pathogen removal requirements (USEPA 2004). Pathogen indicators such as fecal coliforms or *E. coli* are frequently at levels of concern in urban stormwater runoff. Several urban creeks and Delta water bodies that receive urban runoff are listed as impaired due to the presence of indicator bacteria.

In the Delta, drinking water supplies with excessive levels of nutrients are primarily of concern because they, along with other factors such as residence time and temperature, can stimulate algae growth both in the Delta and in water storage reservoirs (Tetra Tech 2006a, Izaguirre and Taylor 2007). Algae blooms in storage reservoirs can disrupt treatment processes and cause taste and odor problems. Taste and odor complaints associated with Delta water supplies have been attributed to algae growth in reservoirs or in the Delta itself (DWR 2007).

The quality of Delta waters with respect to drinking water use varies considerably both geographically and with time. Average organic carbon and bromide concentrations are very low in the Sacramento River where it enters the Delta. San Joaquin River water is moderately high in bromide, salinity, and nutrients, and moderately high in organic carbon. Intakes in the west Delta can be strongly influenced by the estuarine salinity gradient. An intake for the City of Antioch is frequently out of use because of salinity intrusion. The North Bay Aqueduct intake on Barker Slough in the northwest Delta is strongly affected by the local watershed and has the highest average organic carbon concentrations of any Delta municipal water supply intake (Tetra Tech 2006b).

A major concern for municipalities using Delta water is what the future holds for water quality. Sea level rise, levee failure, salinity variability, and population growth in the watershed all pose a threat to drinking water quality. The Central Valley RWQCB is developing a drinking water policy that is, in part, intended to prevent the degradation of high-quality drinking water sources (Central Valley RWQCB 2010).

The drinking water supply from groundwater for many communities in the Delta and areas served by water exported from the Delta is contaminated by nitrates and other pollutants, particularly in the San Joaquin Valley. Survey findings show that a high financial burden is borne by low-income households with nitrate-contaminated water (Pacific Institute 2011). 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 (Pacific Institute 2011). Small community and private water systems throughout the Central Valley and in the Delta rely on groundwater as their primary source of drinking

water. They are affected by groundwater contamination to a greater degree than larger public water systems because many are in areas that are vulnerable to contamination (SWRCB 2011). Their wells are often shallower than larger community systems, and they have limited resources to treat or respond to contaminated groundwater problems.

Problem Statement

Delta drinking water supplies are degraded by inputs from regional soils and sediments; from agricultural, urban, and industrial sources from the watershed; and from in-Delta sources.

Policies

No policies with regulatory effect are included in this section.

Recommendations

WQ R1 The Central Valley Regional Water Quality Control Board should complete the Central Valley Drinking Water Policy by July 2013, with implementation to follow.

WQ R2 The Department of Water Resources should complete the North Bay Aqueduct Alternate Intake Project EIR by July 1, 2012, and begin construction as soon as possible thereafter.

WQ R3 The State Water Resources Control Board and/or Central Valley Regional Water Quality Control Board should complete development of a Strategic Workplan for protection of groundwater beneficial uses, including groundwater use for drinking water, by December 31, 2012.

WQ R4 The Department of Public Health, State Water Resources Control Board, and Department of Water Resources should prioritize funding for small and disadvantaged communities that lack access to safe drinking water supplies or resources for adequate wastewater treatment.

WQ R5 The State Water Resources Control Board and Central Valley Regional Water Quality Control Board should require all recipient regions that are supplied water from the Delta or the Delta Watershed or discharge wastewater to the Delta or the Delta Watershed to participate in the Central Valley Salinity Alternatives for Long-Term Sustainability Program (CV-SALTS).

Environmental Water Quality

The Delta ecosystem is affected by a variety of pollutants discharged into Delta and tributary waters. Pollutants of concern affecting Delta species and ecosystem processes include nutrients, pesticides, mercury, selenium, other substances in the food web, and newly identified pollutants of potential concern (often referred to as emerging contaminants).

Nutrients

The role of nutrients and nutrient loading for the Delta and Suisun Marsh has become a topic of much recent interest and debate. A recent review article on water quality in the Delta focused upon salinity, natural organic matter, suspended sediment, selenium, pesticides, and mercury (Luoma et al. 2008). Nutrients were not included in the review because light limitation was generally regarded as the main control on the productivity and structure of the photosynthetic communities in the aquatic ecosystems of the Delta. The generally lower rates of primary production in the open waters of the Delta when compared with many other estuaries worldwide have focused attention on light limitation rather than nutrient limitation.

Recent and current research is reconsidering the role of nutrients for aquatic ecosystems of the Delta. Several peer-reviewed scientific papers on nutrients in the Delta have been published recently, and some

hypothesized emerging roles for nutrients are much debated. This overview of nutrients in the Delta will highlight current hypotheses about their roles, various opinions of the significance of these roles, areas of uncertainty and research, and recommendations.

The chemical form of inorganic nitrogen in Delta waters is one area of current consideration and concern. Dugdale et al. (2007) showed that ammonium concentrations above 4 micrometers (μM) (~.056 parts per million) inhibit nitrate uptake in short-term incubations of water from Suisun Bay. However, time series of field data showed that phytoplankton blooms did not always occur when ammonium concentrations were below 4 μM, showing that other factors also prevent algal blooms in Suisun Bay. Phytoplankton is an important base to the food chain in many aquatic ecosystems including the Bay-Delta. Ammonium concentrations in Suisun Bay and the Delta have been increasing, primarily due to point source discharge loading from wastewater treatment facilities. It is not known, however, how much this inhibition extends to freshwater algae in the Delta. Current research in the Delta is addressing this question.

Glibert (2010) also examined the role of ammonium in impacting the food web of the Delta. Glibert used long-term data from the Interagency Ecological Program (IEP) to describe changes in the phytoplankton community over the past three decades. The phytoplankton community in the Delta has shifted from predominantly diatoms to green algae and cryptophytes to flagellates to cyanobacteria (blue-green algae). Glibert hypothesized an important role for ammonium concentrations and the ratio of inorganic nitrogen to inorganic phosphorus in the changing structure of the phytoplankton community and also hypothesized that those changes might be related to changes at higher trophic levels. This conclusion has been challenged by Cloern et al. (2011), who demonstrate that the statistical methods used to derive the food web relationships are inappropriate and generate false correlations, argue that no relationship between ammonium and fish abundance is apparent when untransformed data are examined, and list other peer-reviewed literature indicating that population collapses of native fish in the estuary are responses to multiple stressors including landscape change, water diversions, introductions of exotic species, and changing turbidity. Food web effects of ammonium in the Delta remain an open question with much active research and a healthy scientific debate.

Another concern with regard to impacts from nutrient loading in the Delta is the emergence of harmful algal blooms (HABs) over the past decade. The shift toward greater abundance of cyanobacteria in the Delta includes known HABs. In particular, *Microcystis aeruginosa* has become a common bloom-forming component of the phytoplankton of the Delta during the warm summer and early fall months (Lehman et al. 2005, 2008). *Microcystis* species prefer warm temperatures (Paerl and Huisman 2008), do well in lower-light regimes, and need higher concentrations of inorganic nitrogen like ammonium and nitrate to thrive (Ward and Wetzel 1980). Lehman et al. (2008) and Mioni and Paytan (2010) found that water temperature was positively correlated with *Microcystis* abundance and toxicity in the Delta and that water transparency, flows, and specific conductance were also potential drivers of *Microcystis* blooms in the Delta. In addition, resistance to grazing by mollusks (Vanderploeg et al. 2011) and Delta copepods (Ger et al. 2010) may give *Microcystis* selective advantage and may enhance or prolong *Microcystis* blooms in the Delta. The role of increasing concentrations of inorganic nitrogen in the Delta in stimulating HABs is an important question. Heisler et al. (2008) in a recent review of HABs worldwide made several conclusions:

- Degraded water quality from increased nutrient pollution promotes the development and persistence of many HABs.
- The composition (not just total quantity) of the nutrient pool impacts HABs.
- High-biomass blooms require an external source of nutrients to be sustained.
- Both chronic and episodic nutrient delivery promotes HAB development.
- Management of nutrient inputs to the watershed can lead to significant reductions in HABs.

Interactions between nutrients and HABs in the Delta deserve, and are receiving, significant current research support.

Nutrients also affect the productivity of aquatic macrophytes and the structure of the aquatic plant community (Wetzel 2001). The role of nutrients in the proliferation of nonnative aquatic macrophytes in the Delta is another emerging issue. Two nonnative macrophytes, Brazilian waterweed (*Egeria densa*) and water hyacinth (*Eichhornia crassipes*), have become particularly problematic in the Delta. Susan Ustin and colleagues (Underwood et al. 2006, Hestir et al. 2008, Khanna et al. 2011, and Santos et al. 2011) have documented the distribution and spread of these invasive macrophytes in the Delta. The role of nutrient enrichment in the spread and productivity of these nonnative aquatic macrophytes is unknown. Studies on *Egeria densa* in its native South America have shown that biomass is positively correlated with ammonium in the water (Feijoo et al. 1996) and that this submerged macrophyte absorbed more nitrogen from the water when it was present as ammonium than when nitrogen was present as nitrate (Feijoo et al. 2002). Potential links between invasive aquatic macrophytes in the Delta and nutrient inputs require further research.

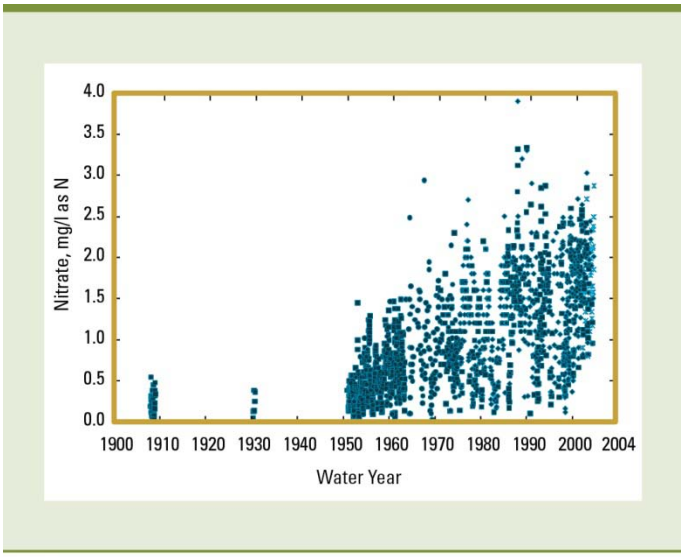

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Figure 6-2
Increasing Nutrients Create Delta Water Problems [UNDER DEVELOPMENT]
Nitrate concentrations at the point where the San Joaquin River enters the Delta dating back to 1908 show how much this important plant nutrient has increased. High nutrient concentrations are linked to a variety of problems including dissolved oxygen depletion, growth of nuisance aquatic plants, and taste and odor problems in drinking water. Symbols show the different data sources.
Source: Adapted by the Delta Science Program with data provided by USGS

The future role for nutrients in the Delta is another growing concern. Schoellhamer (2011) has documented the sudden clearing of estuarine waters of San Francisco Bay after 1999. The erodible sediment pool in the basin is declining as the legacy sediments from hydraulic gold mining are transported out of the system and the large rim dams capture and store large quantities of sediment. The paradigm of a turbid estuary with primary production limited by light availability may be shifting to a new paradigm where nutrients play an increasingly important role in regulating productivity as they do in other estuaries (Paerl 2009). Sustained long-term monitoring and research will be necessary to document effects from the sudden clearing that began after 1999 in the Bay-Delta.

Ongoing and recently funded research on the role of nutrients in the Delta will reduce the uncertainty around some of the key questions that have emerged in recent years concerning the role of nutrients in the Delta. Vigorous scientific debate and discussion is ongoing concerning three issues:

- The importance of phytoplankton bloom suppression from ammonium
- The role of nutrient loading on HABs in the Delta
- Possible linkages between nonnative aquatic macrophytes and nutrient inputs

The effects of increased nutrient inputs also need to be considered in light of a changing Delta with regard to lowered turbidity and warming temperatures. Nutrients have become an increasingly important component in the discussion of water quality issues in the Delta.

Pesticides

Although often used interchangeably with insecticide, a pesticide technically is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest and includes insecticides, herbicides, fungicides, and various other substances used to control pests. In the Bay-Delta region, the primary pesticides of concern include the organophosphorus (OP) pesticides (for example, diazinon and chlorpyrifos), pyrethroid insecticides, and the legacy organochlorine pesticides (for example, DDT, chlordane, and dieldrin), although any pesticide that contributes to water quality impairment is potentially of concern. These substances are known to have adverse impacts on aquatic organisms or, in some cases (as with the organochlorine pesticides), birds and mammals.

Delta waterways were placed on the Clean Water Act section 303(d) List for diazinon and chlorpyrifos due to aquatic toxicity (SWRCB 2010). The primary transport pathways of pesticides into Delta waterways are runoff from urban areas and agricultural irrigation return flows (Kuivila and Hladik 2008). OP pesticides and pyrethroid insecticides, which are the common replacements of the OP pesticides, have been implicated as the principal pesticides causing toxicity in surface water samples collected from throughout California (Hunt et al. 2010).

Invertebrates in the water column appear to be the aquatic organisms most affected by chlorpyrifos and diazinon exposure (Giddings et al. 2000), while pyrethroids—because of their high potential to stick to organic matter—can adhere, accumulate, and are transported with sediment and thus can impact sediment-dwelling organisms (Werner and Oram 2008, Weston et al. 2004). In recent years, pyrethroids at toxic concentrations have been detected in the majority of sediment samples collected from water bodies draining agricultural (Weston et al. 2004, 2005, 2010; California Valley RWQCB Agricultural Waiver Program 2007) and suburban areas of the Central Valley (Weston et al., 2005, 2010), as well as from urban creeks in the Bay-Delta region (Amweg et al. 2006; Woudneh and Oros 2006a, 2006b). Dissolved pyrethroid concentrations toxic to aquatic life were detected in water samples from Central Valley agricultural drains and creeks (Bacey et al. 2005, Central Valley RWQCB 2007), in tributaries to San Francisco Bay (Woudneh and Oros 2006a, 2006b; Werner et al. 2010), and in wastewater treatment plant effluent discharged into the Sacramento and San Joaquin Rivers (Weston et al. 2010).

The Sacramento, San Joaquin, and Feather rivers, the Delta, and numerous agriculturally dominated streams in the Central Valley either are listed as impaired or are currently covered under an existing TMDL for pesticides (Central Valley RWQCB 1998, 2006). Smaller agriculturally dominated waterways are particularly vulnerable to toxicity from pesticides. Although agriculture is considered the primary source of pesticide impairment in the Central Valley and Delta, urban sources are also locally important. Some of the highest pesticide concentrations have been observed in residential area creeks and waters receiving urban runoff (Weston et al. 2005).

The critical transport pathways identified for pyrethroids in the Delta and Central Valley regions include agricultural stormwater runoff or irrigation return water, drift from aerial or ground-based spraying, and

periodic release of agricultural return flows (tailwaters), which is a common practice in rice production (Oros and Werner 2005). Oros and Werner (2005) summarized the major pyrethroid sources as follows:

- Orchards during the winter dormant-spray season
- Summer irrigation return-flows in agricultural areas
- Rice fields when the fields are drained
- Urban and suburban area runoff

There has been discussion of the possible role of pesticides in the pelagic organism decline (POD) during the early years of the twenty-first century. Johnson et al. (2010) reported that insufficient chemistry, toxicity, and histological data are available to determine whether contaminants played an important role in the POD. The conclusion drawn from the analysis of chemical pollutants (primarily organophosphorus and pyrethroid pesticides) is that although contaminants are unlikely to be a major cause of the POD, they cannot be eliminated as a possible contributor to these declines in open-water fish populations in the Delta. Baxter et al. (2010) summarize the various ways in which pollutants may have played a role in the POD.

Mercury

The Delta and many Delta tributaries are included in the SWRCB's section 303(d) list of impaired water bodies due to mercury contamination (Central Valley RWQCB 2009). Historical mercury mining in the Coast Ranges and mercury use associated with gold mining in the Sierra Nevada have left an environmental legacy of pervasive mercury contamination in many Northern California watersheds (Alpers and Hunerlach 2000). The current regulatory environment for mercury includes development of a Delta methylmercury TMDL (Central Valley RWQCB 2008).

Sources of total mercury in the Delta and Yolo Bypass include tributary inflows from upstream watersheds, atmospheric deposition, urban runoff, and municipal and industrial wastewater. More than 97 percent of identified total mercury loading to the Delta and Yolo Bypass comes from tributary inputs; in-Delta sources are a very small component of overall loading (Central Valley RWQCB 2008). The Sacramento Basin, which comprises the Sacramento River and Yolo Bypass tributary watersheds, contributes 80 percent or more of total mercury fluxing through the Delta. Of the watersheds in the Sacramento Basin, the Cache Creek and upper Sacramento River (above Colusa) watersheds contribute the most mercury. The Cache Creek, Feather River, American River, and Putah Creek watersheds in the Sacramento Basin all have relatively large mercury loadings and high mercury concentrations in suspended sediment (Central Valley RWQCB 2008).

Concerns about mercury pollution stem largely from the potential adverse effects of dietary exposure to methylmercury, a highly toxic form of mercury that readily accumulates in biota and can biomagnify to harmful concentrations in organisms at the top of aquatic food webs including predators like bass, fish-eating birds, eagles, and humans (Mahaffey 2000, Clarkson 2002, Wiener et al. 2003, Davis et al. 2003). Health advisories issued by the Office of Environmental Health Hazard Assessment (OEHHA) recommend limiting the consumption of sportfish, including sturgeon and striped bass, caught in the Bay-Delta.

The level of methylmercury in the water column is controlled in part by the concentration of inorganic mercury in the sediment and the rate at which the inorganic mercury in sediment is converted to methylmercury by sulfate-reducing bacteria (Compeau and Bartha 1985, Gilmour et al. 1992, Pak and Bartha 1998, King et al. 2001). The most important sites of microbial methylation in the Bay-Delta ecosystem are generally oxic-anoxic (oxygenated and anaerobic) interfaces in aquatic sediments, wetlands, and seasonally inundated vegetated habitats (St. Louis et al. 1994, Hurley et al. 1995, Kelly et al. 1997, Gilmour et al. 1998).

There is general concern that increased concentrations of methylmercury in water, sediment, and biota might result from restoration of wetland and floodplain habitats in the Bay-Delta and from changes in the conveyance of freshwater across the Delta. For instance, the restoration of wetlands, particularly in areas where the abundance of mercury in soils or sediments is elevated, could accelerate the production of methylmercury and increase the contamination of aquatic biota (Naimo et al. 2000, Wiener and Shields 2000). In addition, flooding of vegetated wetlands or uplands or fluctuating water levels during tidal cycles could stimulate methylmercury production and transport, thereby increasing concentrations of methylmercury in water and biota (Hecky et al. 1991, Hall et al. 1998, Paterson et al. 1998, Bodaly and Fudge 1999).

Monitoring data for water and fish indicate that the central Delta is actually lower in methylmercury than tributary areas such as the Yolo Bypass, Cosumnes River, and San Joaquin River. Preliminary mass balance calculations indicated a net loss of methylmercury in water as it flows through the Delta, meaning that the Delta acts as a net sink for methylmercury (Central Valley RWQCB 2006, 2008). The main causes of methylmercury loss are currently thought to be photodemethylation and sedimentation (Central Valley RWQCB 2008).

The San Francisco Bay Regional Monitoring Program for Water Quality (RMP) routinely measures mercury and methylmercury downstream from the Delta in San Francisco Bay water and sediment. The Bay-wide average methylmercury concentration in 2009 was 0.03 nanograms/liter, while the Bay-wide average for the 4-year period 2006 through 2009 was 0.05 nanograms/liter (SFEI 2010). No regulatory guideline exists for methylmercury in water. For methylmercury concentrations in sediment, the Bay-wide average over the years 2002 through 2009 was 0.5 micrograms/kilogram (SFEI, 2010). In comparison, Bay-wide average concentrations of total mercury in sediment have ranged from 0.19 milligrams/kilogram in 2005 to 0.30 milligrams/kilogram in 2009.

Concentrations of methylmercury (quantified as total mercury) in several fish species recently sampled from the Bay-Delta and tributary streams exceed 0.3 milligrams/kilogram (parts per million) wet weight (Slotton et al. 2002a and 2002b, Davis et al. 2003), a fish-tissue criterion established by the USEPA for the protection of humans who eat noncommercial fish. In comparison, the most recent San Francisco Bay-wide average mercury concentration for striped bass was 0.4 milligrams/kilogram measured in 2009 (SFEI 2010).

Selenium

A naturally occurring element, selenium is an essential nutrient at low concentrations. However, higher concentrations can be toxic to fish and wildlife. Selenium was the root cause of fish mortality and deformities in ducks, grebes, and coots at Kesterson National Wildlife Refuge, which was once the terminus of the San Luis Drain (Ohlendorf et al. 1986; USGS 2004). The major sources of selenium loading in the north San Francisco Bay (North Bay) include the Sacramento River and San Joaquin River inflows, which receive selenium-laden agricultural drainage from the western San Joaquin Valley (Luoma and Presser 2000). Other sources of selenium loading include petroleum refineries, municipal and industrial wastewater, urban and nonurban runoff, atmospheric deposition, and erosion and sediment transport from within the North Bay. Improved wastewater treatment at petroleum refineries discharging into San Francisco Bay has reduced the amount of selenium discharged, but these facilities are still the most significant point source of this pollutant (San Francisco Bay RWQCB 2011b).

Marine sedimentary rocks of the Coast Ranges contribute selenium to soil, surface water, and groundwater in the western San Joaquin Valley (USGS 2004). Irrigated agriculture mobilizes selenium, and it accumulates to levels that can be potentially harmful in the agricultural drainage water from that area. Historically, portions of the San Joaquin River downstream of Grasslands, Salt Slough, and Mud Slough contained elevated levels of selenium from agricultural drainage (Saiki et al. 1993). The discharge of selenium from this area has also been significantly reduced from historical levels under a control

program administered by Central Valley RWQCB with plans for further reductions through 2019 (Reclamation 2009).

Recent monitoring results indicate that selenium water column concentrations in the North Bay are much lower than the current 5 µg/L standard for chronic exposure (San Francisco Bay RWQCB 2011b). The San Francisco Bay RMP recently reported that the highest selenium concentration observed in San Francisco Bay water from 2002 to 2009 was 1.15 µg/L, with a Bay-wide average concentration of 0.16 µg/L in 2009. However, levels of selenium in aquatic organisms and fish show that the current criteria may not be fully protective. In spite of progress to reduce selenium in the Bay-Delta system, levels in the food chain are still of concern. Selenium has been identified as a possible contributing factor to the observed decline of white sturgeon, Sacramento splittail, starry flounder, and diving ducks such as surf scoters. The focus of regulatory efforts at the State and national level are shifting from water-column concentrations to the concentration of selenium in the tissues of affected organisms (San Francisco Bay RWQCB 2011b).

Once selenium enters the aquatic environment, it has a high potential to bioaccumulate in zooplankton and benthic invertebrates and, subsequently, to biomagnify in the food web as it reaches top-level predators such as fish, birds, and mammals (Skorupa and Ohlendorf 1991, Fan et al. 2002, Hamilton 2004, Stewart et al. 2004, Paveglio and Kilbride 2007). Because bivalves have a slower rate constant for loss of selenium than do crustaceans such as copepods and mysids, bivalves tend to retain higher levels of selenium. Among the benthic-based food webs, the white sturgeon, which is a clam-eating bottom feeder, is particularly vulnerable to selenium exposure in the North Bay. Sturgeon feed predominantly on benthic organisms including the invasive clam *Corbula amurensis*, which is very efficient in accumulating and retaining selenium. Sturgeon exposure is exacerbated by its long reproductive cycle during which selenium is transferred and stored in developing eggs, forming a stable selenium reservoir in reproductive females. For the North Bay TMDL, a sturgeon-based fish-tissue numeric target has been proposed as the most direct way to address selenium impairment and assess protection of beneficial uses (San Francisco Bay RWQCB 2011b).

Emerging Pollutants

"Emerging pollutants" are a broad class of unregulated compounds where there is concern that adverse effects might occur at environmentally relevant concentrations. The potential for manufactured chemicals to alter the integrity of water and the ecosystem is high, given the large number of manufactured chemicals in high-volume use. Examples of manufactured chemicals found in water bodies include flame retardants, pesticides, human and veterinary pharmaceuticals, and ingredients in personal care products (Kolpin et al. 2002, Daughton 2004, Hoenicke et al. 2007).

Specific pollutants within the broad class of may be persistent, may have bioaccumulation potential, or may exhibit toxicity under certain conditions, including endocrine system disruption (Oros 2003). The primary sources for most emerging pollutants include effluents from wastewater treatment plants, agricultural fields, and stormwater runoff. Many chemicals identified as emerging pollutants have not been tested for their potential toxicological effects on aquatic biota. Most emerging pollutant maximum concentrations in the environment are well below established lethal concentration value for even the most sensitive aquatic species. The sublethal and chronic low-level exposures are of primary concern (Oros 2003; Brander et al. 2009; Ostrach 2009).

The San Francisco Bay RMP, which has been monitoring for emerging pollutants since 2001, has focused largely on several groups of emerging pollutants, including polybrominated diphenylethers (PBDEs), perfluorinated compounds, and pharmaceuticals. Additionally, region-specific monitoring studies from the San Francisco Bay ecosystem have reported on the occurrence of emerging pollutants. For instance, PBDEs, which are flame retardants that can bioaccumulate in human and animal tissues (Meerts et al. 2001), have been found in San Francisco Bay area mussels, clams, and oysters (Oros et al. 2005), fishes

(Holden et al. 2003), seabird eggs (She et al. 2004), and wastewater treatment plant effluent (North 2004). Concern is increasing over chemicals that disrupt natural endocrine system functions of humans and aquatic species, such as synthetic estrogens, detergent breakdown products, and pesticides (Jobling et al. 1998, Tyler et al. 2000, Kolodziej and Sedlak 2007, Remperl and Schlenk 2008, Vajda et al. 2008, Benotti et al. 2009). Such chemicals were routinely found in agriculturally impacted surface water samples from the Napa River and Sacramento River. Although their presence was not directly linked to observed fish feminization (Lovado et al. 2009), their occurrence in regional tributaries raises concern about the potential impacts of these compounds.

As a recommendation, regulatory and chemical monitoring programs should adapt to the quickly changing mix of emerging pollutants identified through current studies and the peer-reviewed scientific literature. Effective management of emerging pollutants in the Delta will require responsible agencies to perform appropriate panning level activities to prioritize a specific list of pollutants of highest concern and to develop or require work plans for appropriate special studies, and to conduct or require monitoring and special studies in accordance with the work plans.

Problem Statement

Pollutants contained in municipal, industrial, agricultural, other nonpoint source discharges and legacy sources flowing into the Delta and its tributary waterways, including pollutants that bioaccumulate and biomagnify in the food web, contribute to the impairment of the Delta ecosystem.

Policies

No policies with regulatory effect are included in this section.

Recommendations

WQ R6 The State Water Resources Control Board and the San Francisco Bay and Central Valley Regional Water Quality Control Boards are currently engaged in regulatory processes, research, and monitoring essential to improving water quality in the Delta. In order to achieve the coequal goals, it is essential that these ongoing efforts be completed and if possible accelerated, and that the Legislature and Governor devote sufficient funding to make this possible. The Delta Stewardship Council specifically recommends that:

- The State Water Resources Control Board and the San Francisco Bay and Central Valley Regional Water Quality Control Boards should develop and adopt objectives, either narrative or numeric, where appropriate, for nutrients in the Delta and Delta watershed by January 1, 2014.
- The State Water Resources Control Board and the Central Valley Regional Water Quality Control Board should complete the Central Valley Pesticide Total Maximum Daily Load and Basin Plan Amendment for diazinon and chlorpyrifos by January 1, 2013.
- The State Water Resources Control Board and the San Francisco Bay and Central Valley Regional Water Quality Control Boards prioritize and accelerate the completion of the Central Valley Pesticide Total Maximum Daily Load and Basin Plan Amendment for pyrethroids by January 1, 2016.
- The San Francisco Bay and Central Valley Regional Water Quality Control Boards have completed Total Maximum Daily Load and Basin Plan Amendments for selenium and methylmercury and efforts to support their implementation should be coordinated.

- The State Water Resources Control Board and San Francisco Bay and Central Valley Regional Water Quality Control Boards should continue to participate in efforts revise water quality objectives for selenium.

WQ R7 The State Water Resources Control Board and Regional Water Quality Control Boards should work collaboratively with the Department of Water Resources, Department of Fish and Game, and other agencies and entities that monitor water quality in the Delta to develop and implement a Delta Regional Monitoring Program that will be responsible for coordinating monitoring efforts so Delta conditions can be efficiently assessed and reported on a regular basis.

WQ R8 The Central Valley Regional Water Quality Control Board, consistent with existing Water Quality Control Plan policies and water rights law, should require responsible entities that discharge wastewater treatment plant effluent or urban runoff to Delta waters to evaluate whether all or a portion of the discharge can be recycled, otherwise used, or treated in order to reduce contaminant loads to the Delta by January 1, 2014.

WQ R9 The State Water Resources Control Board and Regional Water Quality Control Boards should conduct or require special studies of pollutants including selected emerging contaminants and causes of toxicity in Delta waters and sediments by January 1, 2014.

WQ R10 To comply with the San Francisco Bay Conservation and Development Commission water quality policies and facilitate the commission's impact determination, proponents of actions potentially affecting water quality in Suisun Marsh should consult with the San Francisco Bay Regional Water Quality Control Board and obtain all necessary authorizations early in the process.

Performance Measures

Performance measures for water quality are placed into three generals classes:

- Administrative performance measures.
- Driver performance measures evaluate the factors that may be influencing outcomes and include on-the-ground implementation of management actions, such as acres of habitat restored or acre-feet of water released, as well as natural phenomena outside of management control (such as a flood, earthquake, or ocean conditions.
- Outcome performance measures evaluate ecosystem responses to management actions or natural drivers. The distinction between performance measure types is not rigid.

In some cases, an outcome performance measure for one purpose may become a driver performance measure for another purpose.

Development of informative and sensitive performance measures is a challenging task that will continue after the adoption of the Delta Plan. Performance measures need to be designed to capture important trends and to address whether specific actions are producing expected results. Efforts to develop performance measures in complex and large-scale systems like the Delta are commonly multi-year endeavors. The recommended performance measures are provisional and subject to refinement as time and resources allow.

Administrative Performance Measures

- The SWRCB adopts and implements Delta flow objectives by June 2, 2014.

- Central Valley RWQCB and SWRCB adopt policies and regulations necessary to increase participation in CV-SALTS.
- Central Valley RWQCB completes the Central Valley Drinking Water Policy by July 2013.
- Progress toward providing safe drinking water to small and disadvantaged communities that lack access to safe supplies. Levels of annual funding for small and disadvantaged communities for providing safe drinking water supplies increase over the next decade.
- SWRCB and RWQCBs adopt objectives for nutrients in the Delta by January 1, 2014.
- TMDLs and Basin Plan Amendments for diazinon and chlorpyrifos are completed by January 1, 2013.
- The Central Valley Pesticide TMDL is completed by January 1, 2016.
- A Delta regional water quality monitoring program is developed and implemented within the first 5years of the Delta Plan.
- Department of Water Resources completes the North Bay Aqueduct Alternate Intake Project EIR.

Driver Performance Measures

- Progress toward increasing interannual variability of salinity in Suisun Bay and Suisun Marsh. In future years, salinity will trend higher during periods of low river flow and trend lower during periods of high river flow.
- TMDLs for critical pesticides (for example, diazinon, chlorpyrifos, and pyrethroids) in the waters and sediments of the Delta are met by 2020.
- Progress toward reducing concentrations of inorganic nutrients (ammonium, nitrate, and phosphate) in Delta waters over the next decade.
- Routine annual surveys of selected emerging pollutants within the Delta are designed and implemented during the first 5 years of adoption of the Delta Plan.
- Progress toward consistently meeting applicable dissolved oxygen standards in the Delta by 2020.

Outcome Performance Measures

- Trends in body loads of mercury and selenium in top predatory fish in the Delta will be downward over the next decade.
- Trends in the occurrence of spring diatom blooms in Suisun Bay and Suisun Marsh will be upward.
- Trends in measureable toxicity from pesticides and other pollutants in Delta waters will be downward over the next decade.
- Harmful algal blooms (HABs) will lessen in severity and spatial coverage in the Delta over the next decade.
- The spatial distribution and productivity of nuisance nonnative aquatic macrophytes will decline over the next decade.

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Chapter 7
Reduce Risk to People, Property, and State Interests in the Delta

Water Code sections 85305, 85306, 85307, and 85309 require the Delta Plan to include specific objectives.

> *85305. (a) The Delta Plan shall attempt to reduce risks to people, property, and state interests in the Delta by promoting effective emergency preparedness, appropriate land uses, and strategic levee investments.*
>
> *(b) The council may incorporate into the Delta Plan the emergency preparedness and response strategies for the Delta developed by the California Emergency Management Agency pursuant to Section 12994.5.*
>
> *85306. The council, in consultation with the Central Valley Flood Protection Board, shall recommend in the Delta Plan priorities for state investments in levee operation, maintenance, and improvements in the Delta, including both levees that are a part of the State Plan of Flood Control and non-project levees.*
>
> *85307. (a) The Delta Plan may identify actions to be taken outside of the Delta, if those actions are determined to significantly reduce flood risks in the Delta.*
>
> *(b) The Delta Plan may include local plans of flood protection.*
>
> *(c) The council, in consultation with the Department of Transportation, may address in the Delta Plan the effects of climate change and sea level rise on the three state highways that cross the Delta.*
>
> *(d) The council, in consultation with the State Energy Resources Conservation and Development Commission and the Public Utilities Commission, may incorporate into the Delta Plan additional actions to address the needs of Delta energy development, energy storage, and energy transmission and distribution.*

Based upon Water Code Section 85309, the Council shall consider a proposal from the Department of Water Resources, in consultation with the Corps of Engineers and the Central Valley Flood Protection Board, to coordinate flood and water supply operations of the State Water Project and the federal Central Valley Project.

1

Chapter 7
Reduce Risk to People, Property, and State Interests in the Delta

The Delta is an inherently flood-prone area at the confluence of the Sacramento and San Joaquin River rivers, which collectively drain approximately 43,000 square miles. As discussed in Chapter 5, the Delta was historically an intricate and variable system formed through the interaction of rising postglacial sea levels and an influx of alluvial sediments from river floods. It is now a complex labyrinth of islands and waterways created by the act of draining wetland areas through the construction of levees, many of which were initially constructed over a century ago using primitive materials and equipment.

The Delta (the legal Delta and Suisun Marsh) includes more than 1,335 miles of levees that protect approximately 839,591 acres of land. These levees face potential threats such as large runoff events, earthquakes, extreme high tides, wind-generated waves, subsidence, and sea level rise. Individually, each of these threats is enough to cause serious concern; together, they represent the potential for catastrophic disruption of the Delta and its economic and ecological services. A mass failure of the levee system would have real life-and-death impacts, and property losses that could total billions of dollars. Levee failures not only create direct damage and potential loss of life from flooding, but also change the configuration of the Delta—both water and land—and alter the mixing of fresh water with salt water. A failure could also have significant effects on California's economy from interruption of water supply service to 25 million urban water users and to approximately 3 million acres of irrigated farmland that depend, in part or in whole, on water conveyed through the Delta.

Preventing floods is impossible, but prudent planning and organization of flood management activities can significantly reduce vulnerabilities and risk. A portfolio of risk-reduction strategies for the Delta must consider urban and rural communities as well as agricultural lands during the process of identifying, evaluating, and prioritizing investments in the levee system. Risks can be reduced through an emergency preparedness, response, and recovery system; appropriate land uses; water management changes; reservoir reoperation; and strategic levee improvements.

This chapter provides an overview of the flood risk in the Delta and the ongoing State, federal, and local flood management efforts. Eight key strategies must be implemented to reduce risk to people, property, and State interests in the Delta:

- Floodplain and floodway protection
- Levee classifications for protection of land and resources uses
- Flood management investment
- Emergency preparedness and response
- Limitation of liability
- Financing and implementation of local flood management activities
- Subsidence reduction and reversal

- Reoperation of upstream reservoirs and peak flow attenuation

Flood Risk in the Delta

The concept of flood risk can be described as the likelihood of a flood event occurring and the consequences associated with the event. Consequences can entail loss of life and economic and environmental damage. Figure 7-1 illustrates the variables in understanding Delta annual flood risk, namely probability of flooding and financial consequences. Unchecked, risk of flooding in the Delta is likely to increase over time as a result of several factors:

- Continued development within the floodplains
- Inadequate levees
- Inadequate channel capacities
- Earthquake vulnerability
- Continuing land subsidence
- Climate change
- Sea level rise

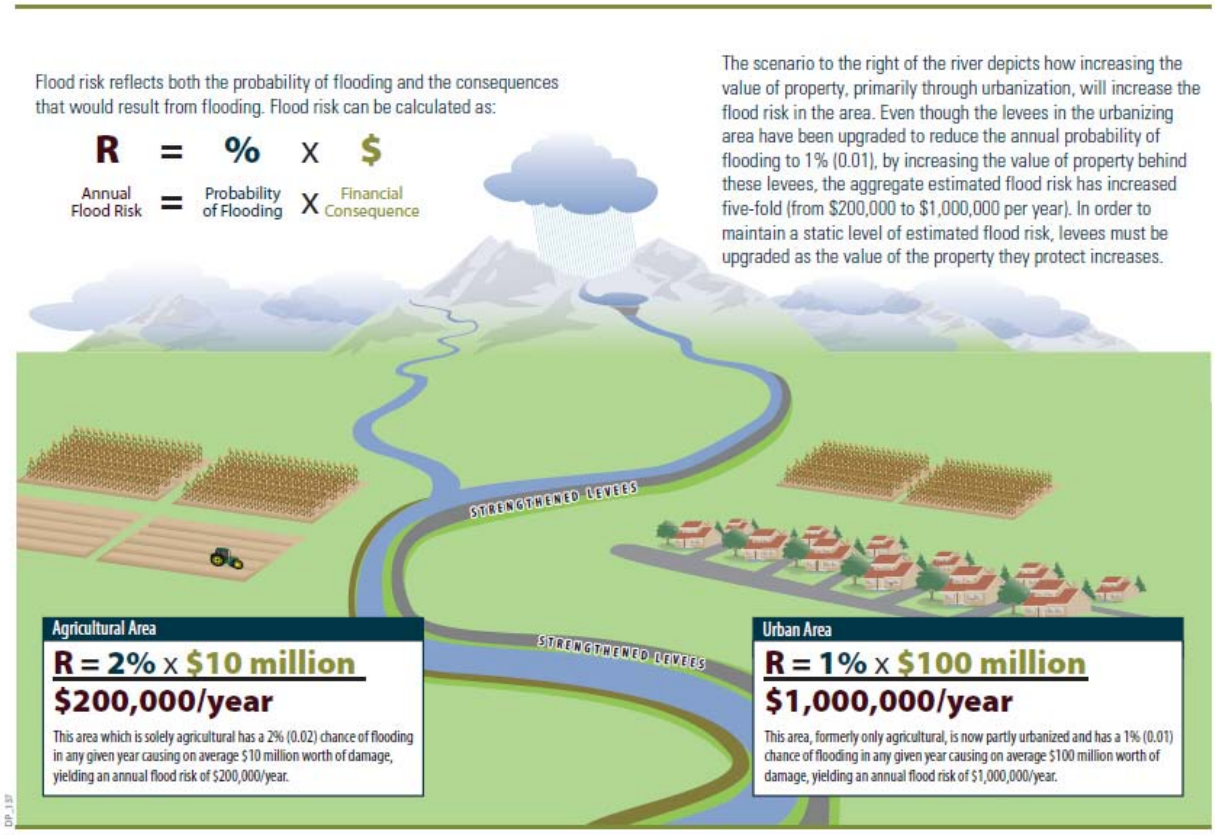

Figure 7-1
Understanding Delta Flood Risk
Source: DWR 2008

Climate change has major implications for the Delta, and especially for flood risk management. It is estimated that by the year 2100, sea levels may rise 55 inches (California Climate Action Team 2010, California Ocean Protection Council 2011). Additionally, scientific understanding of large-scale

precipitation events is growing, as demonstrated by the ARkStorm scenarios being investigated by the U.S. Geological Survey (USGS), which indicate that massive storms and subsequent flooding have occurred and are likely to occur again (USGS 2011). Failure of significant parts of the Delta's flood management system may be unavoidable. Additionally, potential levee failures resulting from an earthquake in the region are possible.

A potentially major adverse impact of Delta flooding would be an interruption in the conveyance of water through the Delta for the State Water Project (SWP), the federal Central Valley Project (CVP), in-Delta users, the Contra Costa Water District, the City of Antioch, and others who rely on the Delta as a water supply source. The Delta is the hub of these major water supply projects and provides drinking water to approximately 23 million people and irrigation water to several million acres of highly productive agricultural lands. A disruption caused by a single or multiple Delta levee failures could have devastating consequences for Californians who rely in whole or in part on Delta water supplies. These consequences would likely impact farms, communities, roads, railways, power and fuel transmission lines, wildlife resources and the Delta ecosystem, and the local and State economy.

Flood risk reduction efforts cannot guarantee protection from harmful inundation from floods, but can reduce its likelihood and social and economic impacts. History has shown that unavoidable structural failures in the system will occur as a result of extraordinary events, imperfect knowledge, and imperfect materials. Risks must be first understood, and then managed and controlled to the extent possible through public awareness, adequate emergency management planning, and structural and nonstructural improvements, such as enforcement of existing flood management regulations, and through physical repair, improvements, levee setbacks and levee rehabilitation efforts.

Risks must also be quantified, to the extent practicable, to better understand them and to facilitate the prioritization of flood management actions. Assessment tools such as Expected Annual Damage have great potential and should be incorporated into Delta flood risk management. Expected Annual Damage is discussed in more detail later in this chapter.

Ongoing Flood Management Efforts by Other Agencies

Many studies and planning efforts addressing flood management and emergency preparedness, response, and mitigation are underway, and will be considered by the Delta Stewardship Council (Council) for ongoing Delta flood risk management. These studies and efforts include:

- Central Valley Flood Protection Plan
- Various studies and projects from the Department of Water Resources' (DWR) FloodSAFE Initiative
- Sacramento-San Joaquin Delta Multi-Hazard Coordination Taskforce Report
- U.S. Army Corps of Engineers' (USACE) Delta Islands Levees Feasibility Study, Long Term Management Strategy for Dredging and Dredge Material Placement, Periodic Inspection (PI) system, and Levee Safety Portfolio Risk Management System.

The Council will consider the findings of these studies and may elect to incorporate them into future Delta Plan updates. It is important to note that the Central Valley Flood Protection Plan[50] and FloodSAFE include many concepts relevant to the Delta Plan; however, they largely focus on issues outside of the

[50] Due January 1, 2012, to the Central Valley Flood Protection Board for adoption by July 1, 2012.

Delta. At the federal level, the National Committee on Levee Safety (2009) has recently submitted a report to Congress on levee standards that is currently under review.

Policies and Recommendations

Floodway and Floodplain Protection

Adequate flood flow capacity is critical for managing flood risks and for overall Delta water management and ecosystem integrity. The Federal Emergency Management Agency (FEMA) and the State's Central Valley Flood Protection Board (Flood Protection Board) both play a role in designating floodways to accommodate flood flows in California. "Designated Floodway" refers to the channel of the stream and that portion of the adjoining floodplain, as shown in Figure 7-2, reasonably required to provide for the passage of a specified flood; it is also the floodway between existing levees as determined by the Flood Protection Board or the Legislature.

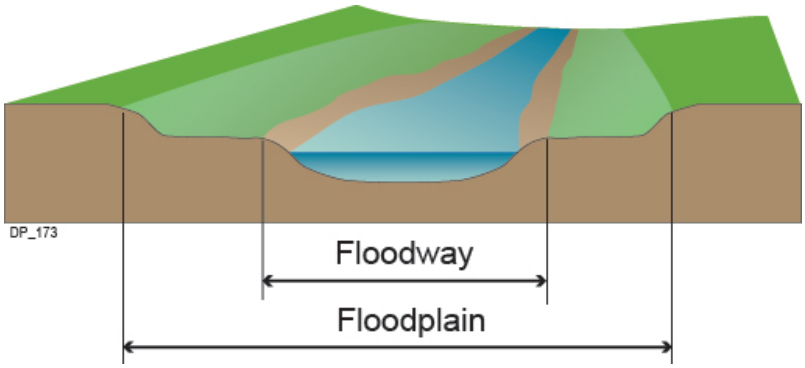

Figure 7-2
Conceptual Diagram of a Floodplain within a Floodway
The floodway is the channel of the stream and that portion of the adjoining floodplain reasonably required to provide for the passage of a specified flood; it is also the floodway between existing levees as determined by the Flood Protection Board or the Legislature.
Source: FEMA 2006

The Flood Protection Board, under Water Code section 8609, has the authority to designate floodways in the Central Valley, including the Delta. Under the National Flood Insurance Program, FEMA works with participating communities to regulate development within their floodways in accordance with federal regulations.[51]

Local land use policies guiding development in floodways are not consistent across Delta counties. Additionally, floodways have not been established for many of the channels in the Delta by FEMA or by the Flood Protection Board. In light of these inconsistencies, the Delta Plan addresses these issues and highlights the need for policies and recommendations that accommodate floodplain and floodway protection for adequate flood protection. Over the next 100 years, Delta floodways may expand and deepen because of sea level rise and changing precipitation patterns; these concerns must be addressed.

[51] 44 Code of Federal Regulations 60.3(b)(6,7,10) requires the following:
- Notify, in riverine situations, adjacent communities and the State Coordinating Office prior to any alteration or relocation of a watercourse, and submit copies of such notifications to the Administrator;
- Assure that the flood carrying capacity within the altered or relocated portion of any watercourse is maintained;
- Require until a regulatory floodway is designated, that no new construction, substantial improvements, or other development (including fill) shall be permitted within Zones A1-30 and AE on the community's Flood Insurance Rate Map (FIRM), unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community.

Development in existing or future designated floodplain or bypass locations in the Delta or upstream of the Delta can permanently eliminate the availability of these areas for future floodplain usage.

Problem Statement

Encroachments into floodways, critical floodplains, and potential future floodplain or bypass locations in the Delta could permanently reduce the flood carrying capacity of the Delta. Future Delta floodways and bypasses have not been formally identified and protected.

Policies

The following are policies as to the lands in the Delta, and recommendations as to the lands outside the Delta:

RR P1 Floodways[52] shall not be encroached[53] upon nor diminished without mitigating for future flood flows. This policy does not apply to ecosystem restoration projects or any ongoing agricultural or flood management activities unless they significantly decrease the existing level of flood protection.

RR P2 The following areas shall not be encroached upon because they are critical floodplains[54] and may also provide ecosystem benefit (refer to Figure 5-3). This policy does not apply to ecosystem restoration projects or any ongoing agricultural or flood management activities, or maintenance and repair of existing infrastructure, unless they significantly decrease the existing level of flood protection.

- Areas located in the Yolo Bypass from Fremont Weir through Cache Slough to the Sacramento River including the confluence of Putah Creek into the bypass
- The Cosumnes River-Mokelumne River Confluence, as defined by the North Delta Flood Control and Ecosystem Restoration Project (McCormack-Williamson), or as modified in the future by the Department of Water Resources or the U.S. Army Corps of Engineers. (DWR 2010a)
- The Lower San Joaquin River Floodplain Bypass, located on the Lower San Joaquin River upstream of Stockton immediately southwest of Paradise Cut on lands both upstream and downstream of the Interstate 5 crossing. This area is described in the Lower San Joaquin River Floodplain Bypass Proposal, submitted to the Department of Water Resources by the partnership of the South Delta Water Agency, the River Islands Development Company, RD 2062, San Joaquin Resource Conservation District, American Rivers, the American Lands Conservancy, and the Natural Resources Defense Council, March 2011. This area may be modified in the future through the completion of this project.

The Delta Stewardship Council may amend the Delta Plan to revise this list in the future if necessary to protect additional floodplain opportunity areas.

Policy ER P4 in Chapter 5 also addresses this problem statement by recommending that levee rehabilitation or construction include alternatives that increase the extent of floodplain and riparian habitats.

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[52] As defined by California Code of Regulations, Title 23, Division 1, Chapter 1, Article 2, Section 4: (n) Floodway. "Floodway" means the channel of a river or other watercourse and the adjacent land areas that convey flood waters.

[53] As Described in the Department of Water Resources' "Interim Levee Design Criteria for Urban and Urbanizing Areas in the Sacramento-San Joaquin Valley" (DWR 2010b): Encroachments and vegetation should be evaluated and managed so as to not impact levee safety, while recognizing their benefits.

[54] As defined by the FEMA National Flood Insurance Program: Floodplain: Any land area susceptible to being inundated by flood waters from any source. http://www.fema.gov/business/nfip/19def2.shtm.

Recommendations

RR R1 The Legislature should fund the Department of Water Resources and the Central Valley Flood Protection Board to evaluate and implement a bypass and floodways on the San Joaquin River near Paradise Cut that would reduce flood stage on the mainstem San Joaquin River adjacent to the urban and urbanizing communities of Stockton, Lathrop, and Manteca in accordance with Water Code section 9613(c).

RR R2 The current efforts to maintain navigable waters in the Sacramento River Deep Water Ship Channel and Stockton Deep Water Ship Channel, led by the U.S. Army Corps of Engineers and described in the *Delta Dredged Sediment Long-Term Management Strategy* (USACE 2007, Appendix G), should be continued in a manner that supports the Delta Plan and the coequal goals. Appropriate dredging throughout other areas in the Delta that would increase flood conveyance and provide potential material for levee maintenance or subsidence reversal should be implemented in a manner that supports the Delta Plan and coequal goals.

Levee Classifications for Protection of Land and Resource Uses

The 1992 Delta Protection Act designated the Delta as a flood-prone area and defined the most appropriate land uses as agriculture, wildlife habitat, and where specifically provided, recreation (Public Resources Code section 29704). However, the pressures of development and spreading urbanization continue to exist and pose challenges for the Delta.

Although levees were constructed in the Delta to reduce the risk of flooding, the historical performance of many levees in the Delta has been mixed. Many levee failures have been attributed to high flood flows, and some levees have failed in the absence of any type of flood. If a significant earthquake does occur on faults in or near the west Delta, one or more levees could fail (DWR 2009a). Figure 7-3 illustrates a potential flood scenario in which a 6.5-magnitude earthquake causes a 20-island failure. With this in mind, it is more important than ever that the levees in the Delta are designed, constructed, and maintained to provide the level of flood risk reduction commensurate with the land and resource uses they protect.

The Delta Protection Commission's Land Use and Resource Management Plan for the Primary Zone of the Delta describes land use and flood protection in its policies as follows: "Local governments shall carefully and prudently carry out their responsibilities to regulate new construction within flood hazard areas to protect public health, safety, and welfare. These responsibilities shall be carried out consistent with applicable regulations concerning the Delta, as well as the statutory language contained in the Delta Protection Act of 1992. Increased flood protection shall not result in residential designations or densities beyond those allowed under zoning and general plan designations in place on January 1, 1992, for lands in the Primary Zone" (DPC 2010).

While the Delta Protection Commission's land use plan covers the Primary Zone of the Delta, there is no such comprehensive flood-risk policy governing land use in the Secondary Zone. However, current engineering knowledge indicates that flood hazards in the Delta cannot be eliminated, and the safety of residents cannot be guaranteed without the expenditure of substantial and sustained funding for flood protection. The impacts of climate change—especially rising sea levels and increased precipitation and runoff patterns—will only exacerbate future threats to public safety associated with residential development in the Delta. Therefore, to be assured consistency with the Delta Plan, future land use decisions should not permit or encourage construction of significant numbers of new residences in the Delta in the face of the flood hazards.

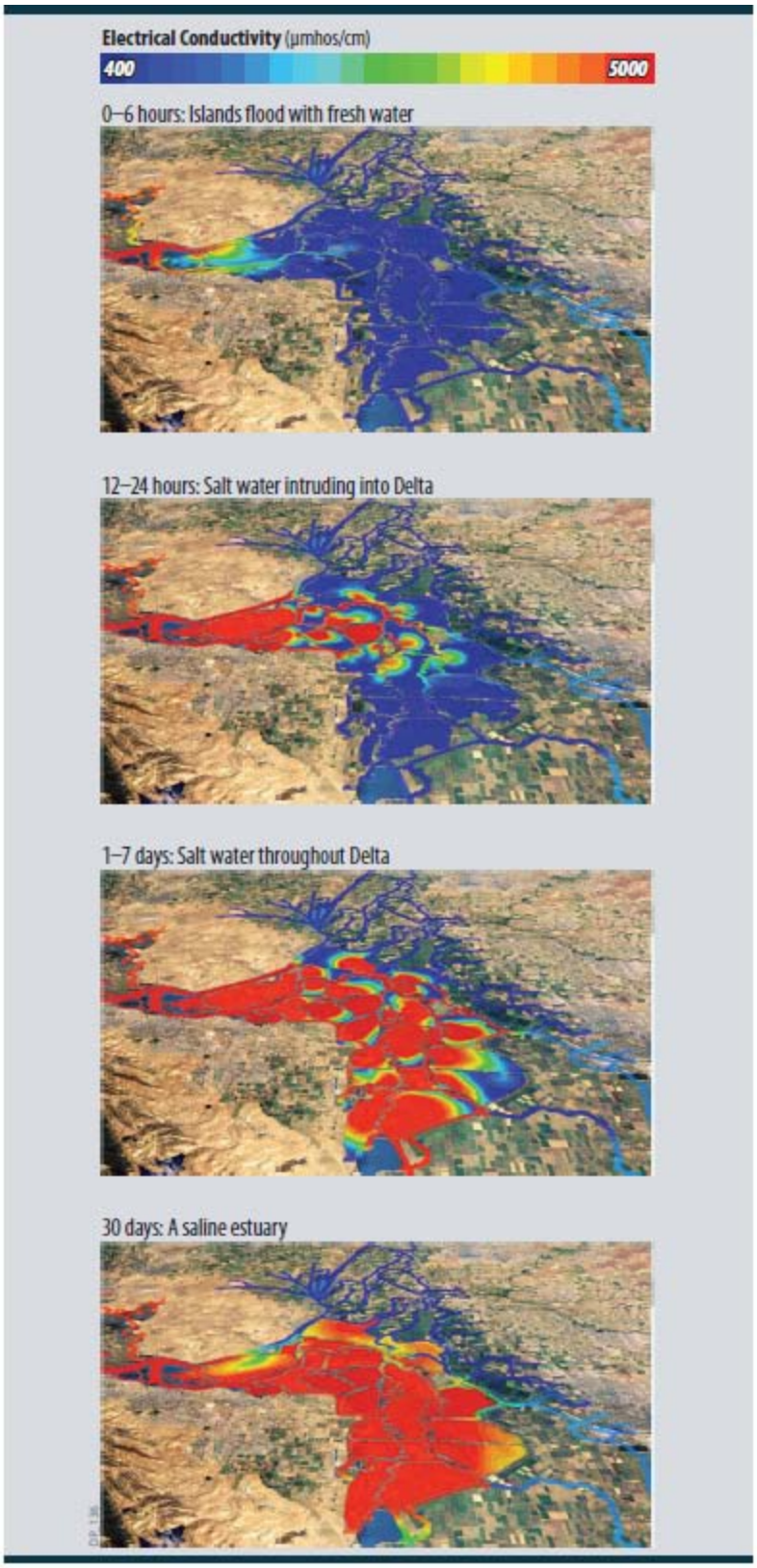


Figure 7-3
Simulation of Delta Salinity After a 20-island Failure Caused by a Magnitude 6.5 Earthquake
Source: MWD 2010

Existing Levee Standards and Guidance

The level of flood protection provided by levees should be related to an acceptable risk for the types of land use located behind the levee (Delta Vision Blue Ribbon Task Force 2008). During the last few decades, State and federal agencies have developed various levee guidance and standards. These were designed to either establish minimum criteria that would make the levees and the properties protected eligible for FEMA grants or USACE rehabilitation funds, or set minimum criteria that would allow development behind the levees. The four main applicable levee standards for the Delta are discussed below; they are ordered from lowest to highest level of flood protection.

- **FEMA Hazard Mitigation Plan (HMP) Guidance:** To be eligible for FEMA disaster grants and assistance after levee failures and island inundation, local communities must prepare an HMP and maintain their levees in accordance with the plan.

- **U.S. Army Corps of Engineers Public Law 84-99 (PL 84-99):** Meeting this standard allows the Delta island or tract to be eligible for USACE funding for levee rehabilitation and island restoration after levee failures and island inundation, provided that the reclamation district applies for and is accepted into the program and passes a rigorous initial inspection and periodic follow-up inspections. Eligibility for PL 84-99 was formerly based primarily on levee geometry with minimum freeboard and maximum steepness of slopes. The new USACE Periodic Inspection (PI) program has incorporated many other elements into eligibility, including presence of structure encroachments, vegetation, rodent control programs, and more. Although the geometry implies a minimum slope stability factor of safety, this standard is not associated with a level of protection and does not address seismic stability. This standard refers to the USACE's Delta-specific PL 84-99 guidance.

- **FEMA 100-year (Base Flood) Protection (FEMA 100 Year):** This "insurance" standard, often called the "1 percent annual chance flood" level of protection, is based on criteria established in the Code of Federal Regulations (44 CFR 65.10) and is often used with established USACE criteria to meet certain freeboard, slope stability, seepage/underseepage, erosion, and settlement requirements. A 100-year flood event is a flood event that has a 1 percent chance of being equaled or exceeded in any given year. Meeting this minimum level of flood protection means that communities will not be required to purchase flood insurance or be subject to building restrictions. This standard generally does not address seismic stability. Very few levees in the Delta meet this standard. Floodproofing, or elevating a structure above the flood elevation, is another way to achieve 100-year protection. Examples of floodproofing are provided in Figure 7-4.

- **DWR 200-year Urban Levee Protection (DWR 200 Year):** This standard (currently under development within the Central Valley Flood Protection Plan consistent with recent State legislation) is similar to the FEMA standard because it goes beyond geometric design criteria, but for a 200-year level of flood protection. It is generally based on established USACE criteria. However, unlike USACE criteria, the DWR 200-year Urban Levee Protection requires that seismic stability be addressed. Almost no levees in the Delta meet this standard, and under existing law most would not be required to do so because they do not protect urban areas.

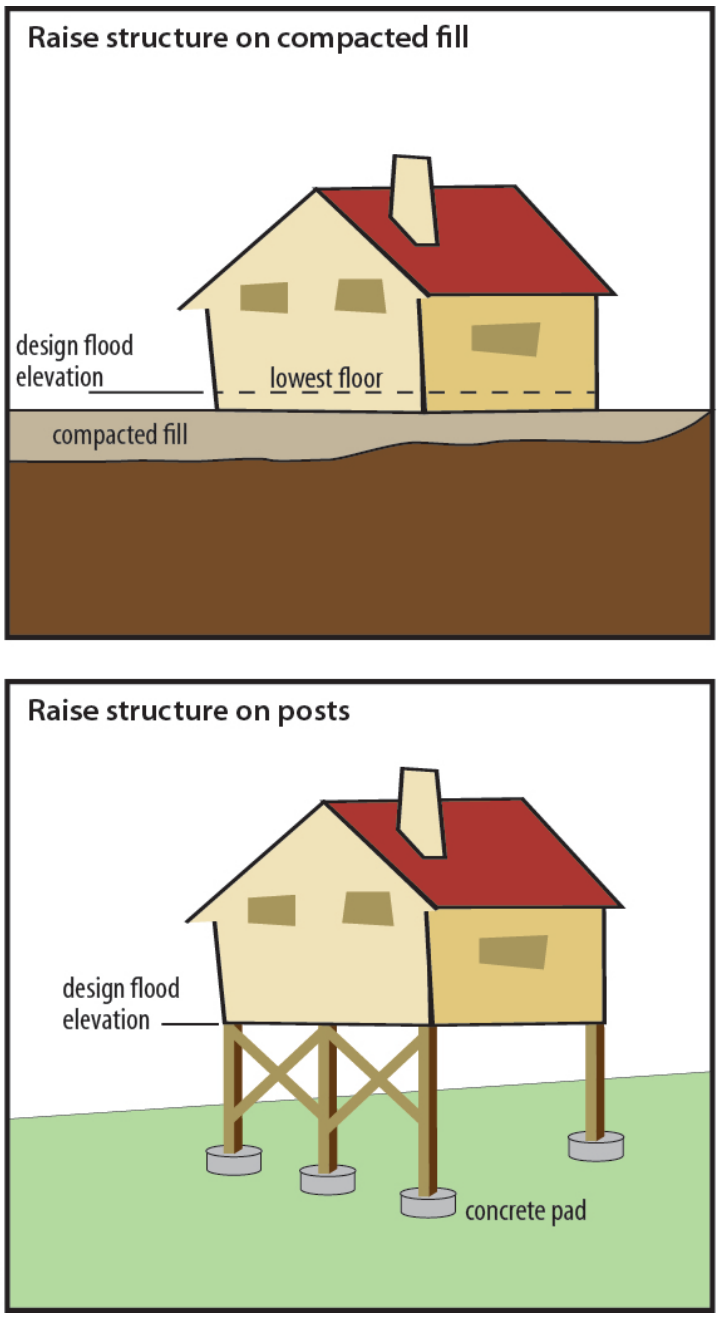


Figure 7-4
Examples of Floodproofing
Floodproofing in accordance with the National Flood Insurance Program can be achieved through several methods. The top illustration shows an example of floodproofing by constructing the lowest floor within a structure above the design flood elevation. The bottom illustration shows floodproofing by raising the bottom of the structure above the design flood elevation.
Source: FEMA 2001; FEMA 1994

Connecting Level of Flood Protection to Land Use

Aligning land and resource uses with specific levee design criteria will help ensure that appropriate minimum levels of flood risk protection are provided. Future alterations and changes to land and resource uses must remain aligned with appropriate levee design criteria (for example, adding new residences behind a levee minimally designed for agriculture is not acceptable). To that end, this section of the Delta

Plan provides policies that require alignment of land and resource uses with minimum levee design criteria, mostly in accordance with existing standards. The standards described above are highlighted in Figure 7-5.

However, to reduce the risk to lives, property, and State interests in the Delta, additional standards are needed to address future development and infrastructure. Sea level rise, subsidence, and the pressures of residential development on traditional agricultural lands can potentially put many more lives at risk. This Delta Plan introduces policies designed to reduce risk while preserving the Delta's unique character and agricultural way of life. It should be noted that these policies should be construed as those required to provide the minimum level of flood protection, and in no way should be viewed as encouraging development in flood-prone Delta areas, even if they have achieved 200-year flood protection.

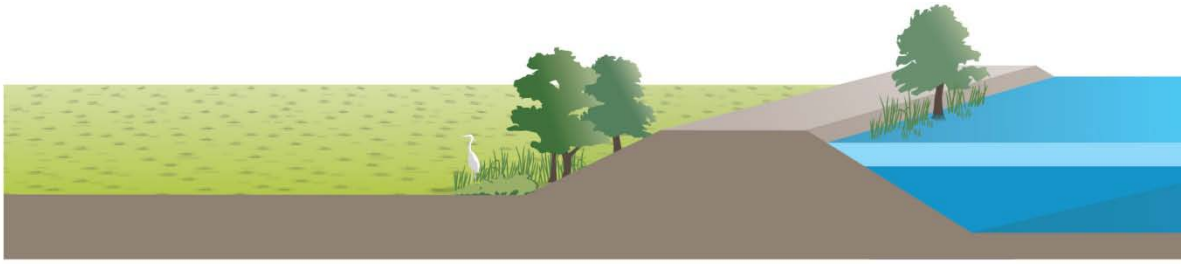
In light of what we understand about flood risk in the Delta, it is more important than ever to define appropriate minimum standards that correlate a level of flood risk to specific land uses. Existing levee standards and criteria are confusing, rarely integrated across government agencies, and do not sufficiently consider economic consequences:

- The HMP standard (based upon geometric criteria for the levees) was negotiated by FEMA, DWR, the California Office of Emergency Services, and the Delta Levee Maintaining Agencies between 1983 and 1987 to establish a minimal, short-term interim standard to reduce the risk of repeat flood damage. Although intended as an interim standard, no adjustments based on subsequent or projected flood elevations have been used to modify the standard. Some islands and tracts have full compliance, and in other areas a portion of the levees do not meet the requirements. If even a portion of the levee around the island or tract does not meet the HMP standard, FEMA will deny claims for levee damage.

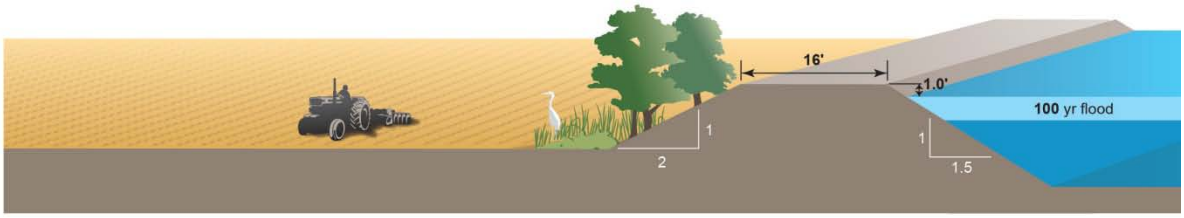
- The PL 84-99 standard is a minimum requirement for all federal flood control project levees, such as the Sacramento River or San Joaquin River flood control projects. The standard was developed for major rivers, such as the Mississippi River, and was not necessarily appropriate for the non-federal flood control project levees. In 1987, USACE developed a Delta-specific standard based on the Delta organic soils and levee foundation conditions. Compliance with this standard allows for USACE emergency assistance and levee rehabilitation expenses resulting from levee damage.

- Currently, the issuance of all building permits in the five Delta counties requires compliance with the FEMA 100-year minimum standard. This standard is based on geometric shapes of levees and projected flood elevations. This standard is currently used for all residential, commercial, and industrial buildings within incorporated and unincorporated areas of the Delta, including Legacy Towns.

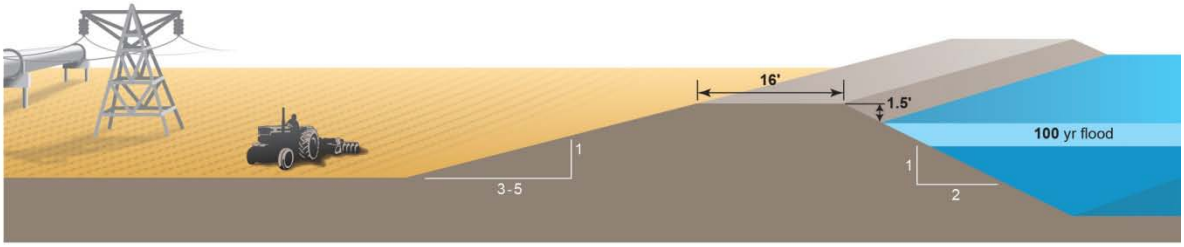
- Current law dictates that by 2025, development in urban areas must meet the 200-year flood protection standards defined in the Central Valley Flood Protection Act of 2008 (Government Code section 65865.5(a)(3)). This will likely be achieved by developing and upgrading levees to meet the 200-year design standard, under development by DWR (Interim Levee Design Criteria for Urban and Urbanizing Areas in the Sacramento-San Joaquin Valley, DWR 2010b). Containing development within existing urban areas where flooding can be minimized should be encouraged.



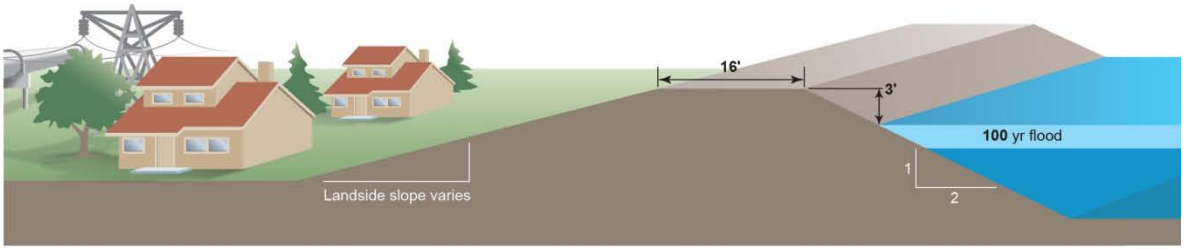
Class 1: Wetlands/Habitat



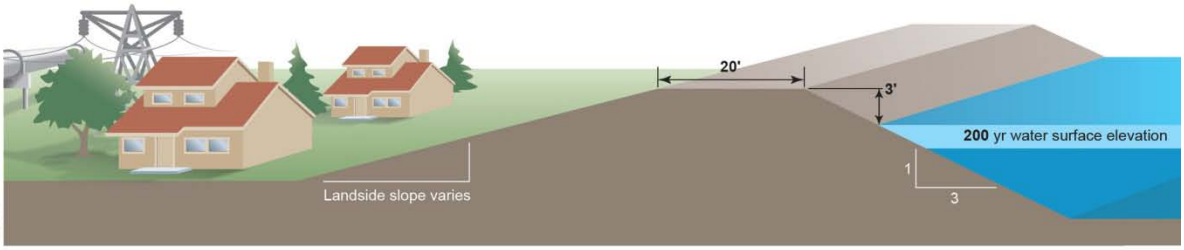
Class 2: Hazard Mitigation Plan (HMP)



Class 3: PL 84-99



Class 4: FEMA - 100 year



Class 5: DWR - 200 year[1]

[1] DWR Interim Levee Design Criteria, 2010

Figure 7-5
Levee Classifications for Covered Actions
Source: Adapted from Delta Vision Blue Ribbon Task Force 2008

- Currently, no State standards exist for incorporating flood protection design criteria into the management of State highways that traverse the Delta. Existing federal standards specify that to qualify for Federal Highway Administration funds, roads must meet standards that provide for protection from the 50-year flood event (23CFR Sec. 650.115). However, most roads in the Delta were constructed before these standards were developed; consequently, these roads do not meet this standard. Roads such as State Route 12 lay 10 feet or more below sea level in sections. A flood event on the islands this highway traverses could have major transportation impacts and put motorists at risk.

- Going forward, particularly in the Delta, State, federal and local agencies should relate flood risk to a recurrence interval (or probability of flooding) that can allow for the development of annual flood risk calculations (shown in Figure 7-1) to better communicate the economic risk of continued development in areas at risk of flooding. The calculation of annual flood risk is generally termed "Expected Annual Damage" (EAD), which is a method that combines the probability of flooding with financial consequences to provide an economic benchmark to draw attention to the costs of increasing development in flood-prone areas. EAD is discussed again later in this chapter (see RR R10).

Consistent with existing law, urban development in the Primary Zone should remain prohibited. Urban development in the Secondary Zone should be confined to existing urban spheres of influence where the 200-year design standard will take effect by 2025. For the several legacy communities in the Delta, flood protection remains difficult. They must meet the current legal standard of a 100-year level of protection, but doing so may be beyond their means. The Delta Protection Commission will address this special issue and may propose solutions that the Council will consider in the future.

Few Levee Standards Exist for Agriculture, Utilities, and Habitat

It is the policy of the Delta Protection Commission that local government general plans, as defined in Government Code Section 65300 et seq., and zoning codes shall continue to promote and facilitate agriculture and agriculture-supporting commercial and industrial uses as the primary land uses in the Primary Zone; recreation and natural resources land uses shall be supported in appropriate locations and where conflicts with agricultural land uses or other beneficial uses can be minimized.

Because levee and flood protection standards relating to agriculture are not well defined, in the future, the proposed Delta Flood Risk Management Assessment District (proposed in RR R10 later in this chapter), the Central Valley Flood Protection Board, and local levee maintaining agencies should consider standards based on economics and risk.

The Delta is also crisscrossed with utilities:

- Radio, cellular telephone and television transmission towers

- Electrical transmission lines, including Pacific Gas and Electric, Sacramento Municipal Utility District, and Western Area Power Administration lines

- Natural gas pipelines serving local gas fields and regional pipelines

- Petroleum transportation pipelines

- Water transportation canals, and pipelines conveying water from the Delta to regional users and to the State and federal water projects

Despite their high degree of importance, these uses do not have defined levels of flood protection associated with their placement in a flood-prone region.

While most of the attention is typically directed toward flood risk reduction for life and property, flood protection is also a consideration for habitat and ecosystem values and goals. Setback levees that expand flood conveyance capacity and reduce flood risk while providing ecosystem restoration and recreational opportunities are worthwhile (USACE 2002). Setback levees allow opportunities for construction of an improved levee foundation and section using modern design and construction practices, thereby reducing risk of failure.

Problem Statement

Existing standards and law are not sufficient to reduce flood risk to lives, property, and State interests in the Delta, particularly for residential, commercial, and industrial development outside of urban areas and for above-ground infrastructure.

Policies

RR P3 Covered actions in the Delta must be consistent with Table 7-1.

Recommendation

RR R3 The Delta Stewardship Council should coordinate with the Department of Water Resources, Department of Parks and Recreation, and other appropriate local agencies to develop a plan identifying appropriate levels of flood protection relating to specific land and recreation uses for State recreation facilities in the Delta. This plan should address emergency response and notification procedures for recreational users.

RR R4 The Department of Water Resources, in conjunction with the Department of Fish and Game and Delta Conservancy, should develop criteria to define locations for future setback levees in the Delta and Delta watershed. Until then, the siting of future permanent structures should provide adequate area to accommodate future setback levees.

Flood Management Investment

The Delta is inherently flood-prone, but its levees protect its residents, its agricultural land, water supplies, and energy, communications, and transportation facilities vital to the economic health of California (Public Resources Code section 32301(h)). Levee maintenance and levee improvements in the Delta are critical for reducing risks to acceptable levels. Depending on the ownership of the levee, the responsibilities for these activities—and the financial investment required—are assigned to federal agencies, State agencies, and/or local landowners and reclamation districts.

Approximately one-third of the levees in the Delta are “project” levees. Project levees, shown in Figure 7-6, were authorized as part of a federal flood-control project and are eligible for rehabilitation by the USACE under PL 84-99. The Central Valley Flood Protection Board serves as the non-federal partner to the USACE for all project levees in the Delta. Approximately 65 percent of the levees in the Delta and all levees in the Suisun Marsh are non-project (local) levees owned or maintained by local agencies or private owners. This means they are not part of the State and federal levee system and are not generally eligible for rehabilitation by USACE. Local agencies in the legal Delta (primarily reclamation districts) receive partial reimbursement for levee maintenance and rehabilitation from the State when funding is available. It is often difficult for local agencies to raise funds for the local cost share of State and federal assistance programs. In addition, few Delta properties have federal or private flood insurance; consequently, these uninsured property owners may be solely responsible for repairs and losses after a levee failure.

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Table 7-1
Levee Classifications for Covered Actions

Covered Actions[a]	Basis for the Minimum Levee Design Classifications				
	Class 1: No Specified Level of Flood Protection	**Class 2: HMP[b]**	**Class 3: PL 84-99[c]**	**Class 4: FEMA 100-Year[d]**	**Class 5: DWR 200-Year[e]**
Agriculture, recreation and ecosystem restoration actions designed to be periodically inundated	Designed on a site-specific basis to manage appropriate level of flood risk for individual projects				
Agriculture-related non-residential on-farm structures without substantial employees	Not acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Above-ground utilities and transportation facilities	Not acceptable	Not acceptable	Acceptable	Acceptable	Acceptable
Development of subdivisions of four or fewer parcels in non-urbanized areas[f]	Not acceptable	Not acceptable	Not acceptable	Acceptable	Acceptable
Development of subdivisions of more than four parcels in non-urbanized areas within Legacy Towns[f][g]	Not acceptable	Not acceptable	Not acceptable	Currently, non-minor subdivision development in non-urbanized areas in the Delta requires at least FEMA 100-Year standards. For the Delta Plan, specific levee design standards for Legacy Towns to be developed following completion of the Delta Protection Commission Economic Sustainability Plan. The Council should review this issue by January 1, 2013, in coordination with the development of the Central Valley Flood Protection Plan.	
Development of subdivisions of more than four parcels in non-urbanized areas not within Legacy Towns[f][g][h]	Not acceptable	Not acceptable	Not acceptable	Not acceptable	Acceptable These developments are highly discouraged and may be inconsistent with the Delta Plan regarding protection of lands that are or could be used for agriculture and/or ecosystem[i]
All development in urban areas[h]	Not acceptable	Not acceptable	Not acceptable	Not acceptable	Acceptable[i]

[a] Minimum Levee Design Classifications would only apply to new projects undertaken following the adoption of the Delta Plan and are not retroactive. All levee standards would need to be periodically modified to accommodate sea level rise and hydraulic effects of climate change.

[b] HMP (Hazard Mitigation Plan) standards are defined by geometric levee criteria were developed in the 1980s based upon historical flood elevations, and were to be interim standards through HMPs approved by FEMA. These standards have not been modified to reflect more recent flood events with higher elevations, such as the 100-year flood level.

[c] PL 84-99 standards as developed by USACE. These standards are defined by geometric levee criteria developed in the 1980s based upon historical flood elevations for major rivers, such as the Mississippi River, and modified in the 1980s for Delta soil conditions. These standards have not been modified to reflect more recent flood events with higher elevations, such as the 100-year flood level.

[d] FEMA 100-Year Standards in accordance with FEMA and National Flood Insurance Program regulations, including criteria defined in 44 CFR 65.10 for levees accredited by FEMA as providing 100-year flood protection.

Other actions which provide 100 year flood protection, such as floodproofing by elevating the structure above the flood elevation, may be considered on a project specific basis by appropriate local agencies.

[e] DWR 200-Year Standards based on current DWR urban levee design criteria for the 200-year flood event water surface elevation, in accordance with the Central Valley Flood Protection Act of 2008 (Senate Bill 5, 2008).

[f] Urban Areas and Non-Urbanized Areas as defined in California Government Code section 65007(e, j). Developed area as defined in California Government Code section 65007(c).

[g] Legacy Towns are defined for the purposes of Table 7-1 as the following communities along the Sacramento River: Clarksburg, Courtland, Freeport, Hood, Isleton, Locke, Ryde, and Walnut Grove.

[h] Levees for non-urbanized and urban areas should comply with requirements contained in the DWR's "Interim Levee Design Criteria for Urban and Urbanizing Areas in the Sacramento–San Joaquin Valley."

[i] Urbanized areas will be required to be fully compliant with DWR 200-Year standards by 2025 to be consistent with the deadline established for Urban Areas by Central Valley Flood Protection Act of 2008.

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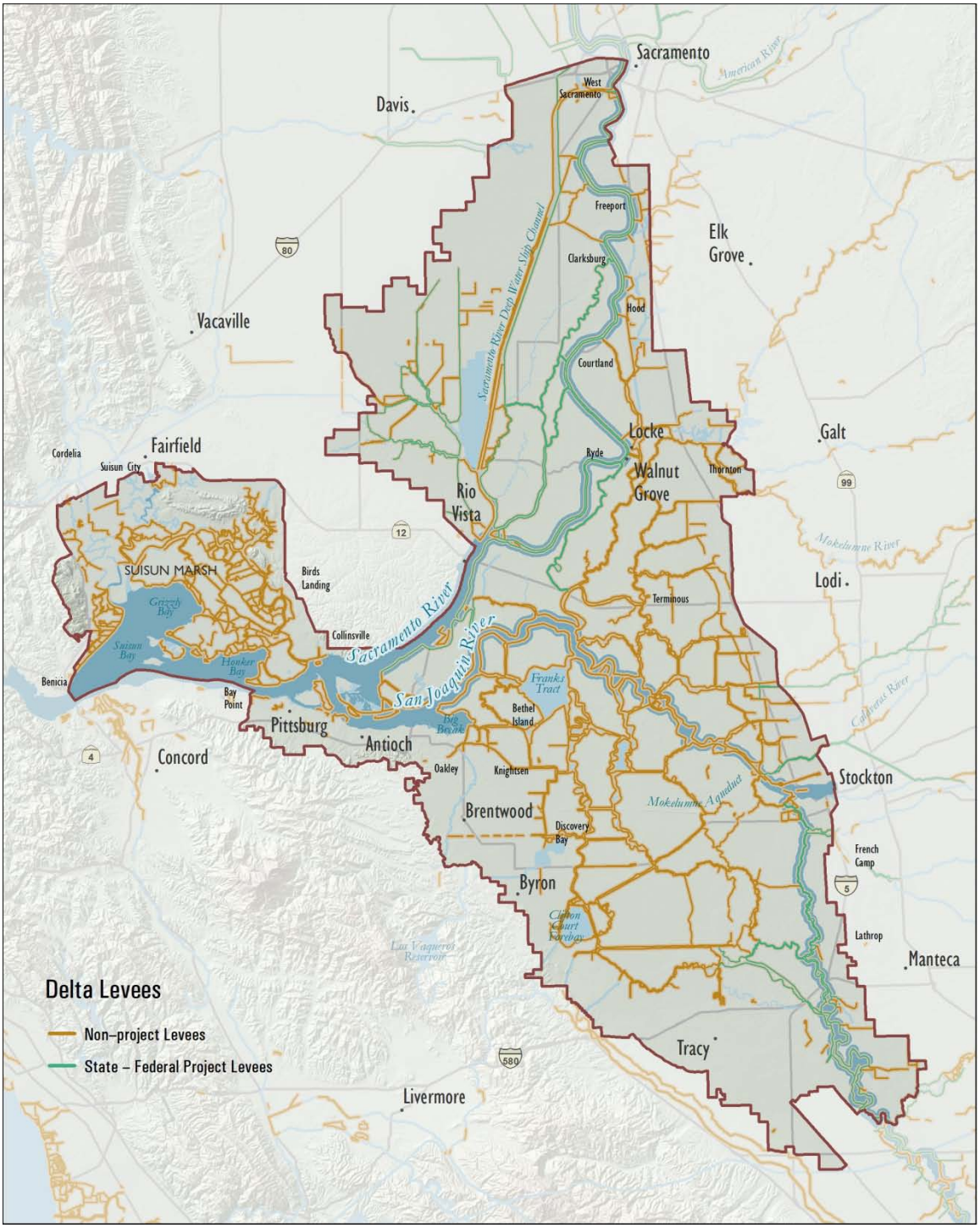


1 Figure 7-6
2 Project and Non-Project Levees in the Delta
3 *Source: DWR 2009b*

What is needed is an effective means for prioritizing limited public funds for use in operating, maintaining, and improving Delta levees with a systemwide approach. With the passage of the Delta Reform Act, the State is now required to promote effective strategic levee investments and recommend prioritization of State investments (Water Code sections 85305(a) and 85306). Although the State has expended over $250 million since the early 1970s on Delta levee operation, maintenance, and improvement, significant funding would be necessary to raise all Delta levees to PL 84-99 standards. Given the potential threats faced by Delta levees, risk must be reduced through a set of management policies that prioritize strategic and focused investments of resources into levees in a manner that best balances the multitude of uses in the Delta.

Problem Statement

To promote strategic State investments in levee operations, maintenance, and improvements in the Delta, a Delta-wide prioritization framework is needed.

Policies

RR P4 Prior to the completion of the Department of Water Resources' *A Framework for Department of Water Resources Investments in Delta Integrated Flood Management*, guidelines for the Delta Levee Special Flood Control Projects and Subventions programs (included as Appendix H) shall be used to determine consistency of projects using state funds with the Delta Plan. This Framework shall be completed by the Department of Water Resources, in consultation with the Central Valley Flood Protection Board and Delta Stewardship Council, by January 1, 2013. Upon completion, the Framework shall be considered by the Delta Stewardship Council for adoption to direct State investments for levee operation, maintenance, and improvements in the Delta. If this Framework is not completed by January 1, 2013, the Delta Stewardship Council will define a strategy for State investments.

Recommendations

RR R5 The Department of Water Resources' *A Framework for Department of Water Resources Investments in Delta Integrated Flood Management* should:

- Define State interests related to flood and levee management in the Delta. These State interests should, at a minimum, include:
  - Reducing risk of loss of life.
  - Protecting water supply. This should address identifying and assessing critical water supply corridor levee operations, maintenance, and improvements for all existing municipal and industrial water diversions in the Delta.
  - Protecting water quality and the ecosystem.
  - Protecting critical infrastructure of statewide importance (including pipelines, energy transmission facilities, aqueducts, and State highways).
  - Protecting property.
- Define a long-term levee policy for the Delta, which, at a minimum, should determine those levees critical for protecting State interests.
- Recognize the wide variability of conditions across the Delta including depth of inundation upon failure; current condition of existing levees; and degree of exposure to seismicity, sea level rise, climate change, and river flood levels.

- Define a methodology for assessing existing Delta levee conditions, as well as on a systematic, routine, and coordinated basis, to develop a sound technical understanding and assessment capability to base levee related decisions. This information should be collected and reported in a transparent manner, and shall include the production of a Delta levee conditions map.
- Define a methodology for proactively identifying, developing, prioritizing, and scheduling specific levee operations, maintenance, and improvement projects.
- Define a method for determining project costs, cost share, and project partners, if appropriate.
- Define procedures that distinguish Delta Levees Special Flood Control Projects from routine levee maintenance projects.

Emergency Preparedness and Response

Even with the best-engineered levees, channels, and floodways, a residual risk from flooding will always remain; flood risk can never be eliminated. Therefore, it is imperative that federal, State, and local governments—and the citizens themselves—be prepared for a variety of emergency situations. Emergency response should be routinely tested and practiced.

To effectively and reliably reduce risks to people, property, and State interests in the Delta, a multifaceted strategy of coordinated emergency preparedness, appropriate land use planning, and prioritized investment in flood protection infrastructure is necessary. Delta levees not only protect life and property, but also play a large role in protecting vital infrastructure, including the State's water conveyance system and major elements of the state and regional transportation system.

Despite the risks of levee failure, no published emergency action plan exists that addresses the consequences to federal and State water supply deliveries in the event of catastrophic levee failure in the Delta. Such a failure could lead to long-term salinity intrusion in the southern Delta, where the federal and State water supply pumps are located. Although investment in flood protection infrastructure can considerably reduce the likelihood of a catastrophic levee failure, failures are inevitable and will require the implementation of well-coordinated and carefully developed emergency-response planning efforts. To reduce response time while optimizing the effectiveness of the response effort, such plans will need to leverage the unique capabilities of each agency with a mission in the Delta.

Despite the vital importance of adequate preparation, no Delta-wide emergency response plan exists. The California Emergency Management Agency, DWR, and several local agencies are preparing individual emergency response plans for the Delta, but the development of these should be coordinated, tested, and practiced. Strategies being prepared as directed by SB 27 (Water Code Section 12994.5) are anticipated to address this issue and will be considered in the Delta Plan.

As an example of planning efforts being conducted at the local agency level, San Joaquin County has developed flood contingency maps and urban evacuation maps as part of its coordinated flood emergency planning efforts. These maps and plans could be used as an example by other Delta counties and State and federal agencies to prepare a Delta-wide emergency response plan.

Problem Statement

Levee failures and flooding can and will place human life and property in danger, and can have potentially significant implications for the State's water supply and infrastructure and the health of the Delta ecosystem. Currently, no coordinated Delta-wide emergency response plan exists to address the potential for levee failures and flooding.

Policies

No policies with regulatory effect are included in this section.

Recommendations

RR R6 The following actions should be taken by January 1, 2013, to promote effective emergency preparedness and response in the Delta:

- Responsible local, State, and federal agencies with emergency response authority should consider and implement the recommendations of the Delta Multi-Hazard Coordination Task Force (Water Code section 12994.5). Such actions should support the development of a regional response system for the Delta.

- The California Emergency Management Agency, Department of Water Resources, U.S. Army Corps of Engineers, appropriate Operational Areas and other State and local partners should cooperatively participate in Delta-specific emergency preparedness activities. These activities should include but not be limited to the development and maintenance of a Sacramento-San Joaquin Delta Flood Catastrophic Incident Plan, a Regional Mass Evacuation Plan and an Interoperable Communications Plan; adoption and implementation of a Delta Multi-Agency Coordination System (MACS); participation in federal and State flood and evacuation contingency mapping; and regularly scheduled all-hazards drills and exercises. Public education and outreach program topics should include flood risk awareness, emergency preparedness, alert and notification.

- Cal EMA in collaboration with local, State and federal emergency response agencies in the Delta region should develop a training plan that is consistent with SEMS and NIMS requirements and compliments the development of plans, procedures and protocols that address all hazards that pose a threat to the Delta.

- In consultation with local agencies, the Department of Water Resources should expand its emergency stockpiles to make them regional in nature and usable by a larger number of agencies in accordance with Department of Water Resources' plans and procedures. The Department of Water Resources, as a part of this plan, should evaluate the potential of creating stored material sites by "over-reinforcing" west Delta levees.

- State and local agencies and regulated utilities that own and/or operate infrastructure in the Delta should prepare coordinated emergency response plans to protect the infrastructure from long-term outages resulting from failures of the Delta levees. The emergency procedures should consider methods that also would protect Delta land use and ecosystem.

RR R7 The Delta Stewardship Council should convene a working group to develop and evaluate recommendations to the Department of Water Resources to address appropriate response actions to both routine and catastrophic Delta levee failures. The working group should include the Delta Protection Commission and other interested parties, and the recommendations should be completed by January 1, 2013.

Limitation of Liability

The Delta Reform Act requires that the Delta Plan attempt to reduce risks to people, property, and State interests in the Delta by, among other things, recommending priorities for State investments in levee operation, maintenance, and improvements in the Delta, including project and non-project levees (Water Code sections 85305, 85306, 85307). The law expressly states that its provisions do not affect the liability of the State for flood protection in the Delta or its watershed (Water Code section 85032(j)). Consequently, no action taken by a State agency as required or recommended by, or otherwise in

furtherance of this Delta Plan, shall affect the State's flood protection liability in the Delta or its watershed.

The USACE and other federal agencies are generally afforded some immunity from liability for damages arising from flood events through the concept of sovereign immunity and through provisions of the Flood Control Act of 1928 (FCA 1928) 33 U.S. Code Section 702c. Congress provided immunity to federal agencies for some but not all tort damages, and not for inverse condemnation. However, this immunity is not enjoyed by agencies outside of the federal government.

The most notable recent court decision on flood liability was the California Court of Appeal decision in *Paterno v. State of California* (2003) 113 Cal.App.4th 998. The court found the State was liable to flooded landowners for inverse condemnation damages caused by the failure of a Yuba River levee that the State did not design, build, or even directly maintain. This decision makes it possible that the State will ultimately be held responsible for the structural integrity of much of the federal flood-control system in the Central Valley—approximately 1,600 miles of State-federal project levees that protect more than half a million people and property exceeding $50 billion in value.

In *Arreola v. County of Monterey* (2002) 99 Cal.App.4th 722, the court held local agencies and the California Department of Transportation (CalTrans) liable in July 2002 for 1995 flood damages to property owners that resulted from a failure to properly maintain the Pajaro River project. This case also held CalTrans liable for some of the damages.

The State's FloodSAFE Strategic Plan stated, "Local communities are responsible for land use decisions, but generally have not been found liable for failure of the flood protection system. Continued development within the floodplains can increase flood risk, even if levees and other flood protection works are improved. Recent legislation passed in 2007 addresses the need to connect land use planning with diligent and factual consideration of flood risks for areas of proposed development" (DWR 2008).

Problem Statement

As the risks of levee failure and corresponding damage increase, California's courts have generally exposed public agencies, and the State specifically, to significant financial liability for flood damages (DWR 2005).

Policies

Although no policies with regulatory effect are included in this section, implementation of the levee standards in Table 7-1 and protections of floodways as provided in RR P1 and RR P2 may substantially limit liability for the State of California.

Recommendations

RR R8 The Legislature should provide specific immunity for public safety flood protection activities, similar to that provided for police and fire protection services.[55]

RR R9 The Legislature should require an adequate level of flood insurance for residences, businesses, and industries in flood-prone areas.

[55] Sections 850 – 850.8 (Fire Protection Services). Section 850 provides immunity for the government not providing fire protection services. Sections 850.2 through 850.8 provide governmental immunity related to the actual provision of fire protection services (i.e., failure to maintain sufficient fire protection facilities, injuries sustained while transporting a person from a fire to medical facility, etc.).

Section 845 (Police Protection Services). Section 845 provides governmental immunity for the failure to provide police protection services or the provision of insufficient police protection services.

Finance and Implementation of Local Flood Management Activities

No regional authority currently exists to facilitate the assessment and disbursement of funds for Delta levee operations, maintenance, and improvements, or to collect and provide timely data and reporting on levee conditions. Such an authority could act to consolidate activities relating to levees conditions assessment, data-collection efforts, maintenance of regional emergency response systems and procedures on behalf of, and in coordination with, implementing California's Standardized Emergency Management System (SEMS) jurisdictions, public notification, and fee authority. This could provide for a more centralized and responsive entity managed on a local basis for Delta interests.

Traditionally, local levee-maintaining agencies have managed the financing and ongoing maintenance, rehabilitation, and repair of Delta levees, and have done an admirable job in improving the levels of levee integrity and reducing overall Delta flood risk. Additional assistance has been provided by the State over the last few decades through DWR's Delta Levee Special Flood Control Projects Program and its Delta Levees Maintenance Subventions Program. These programs have most recently been funded through State general obligation bond financing, which faces an uncertain future. The development of an alternative funding mechanism and authority would provide for a more stable funding process in which local direction is more broadly incorporated.

Currently, standardized data for flood risk measurement is not being developed for the Delta. Standardized methods such as Expected Annual Damage should be incorporated into Delta flood risk management, and can help serve to identify those areas most critically in need of resources, and then allow for the allocation of resources to the most appropriate areas. A systematic process for data collection and reporting should be developed to support ongoing understanding of overall Delta levee conditions. This can then facilitate an orderly allocation of resources to those areas most in need.

Problem Statement

Financing of local levee operations, maintenance, and related data collection and reporting efforts need improvement and a high degree of coordination in order to provide for a more functional, regional-based approach to Delta flood risk management.

Policies

No policies with regulatory effect are included in this section.

Recommendations

RR R10 The Legislature should create a Delta Flood Risk Management Assessment District with fee assessment authority (including over State infrastructure) to provide adequate flood control protection and emergency response for the regional benefit of all beneficiaries, including landowners, infrastructure owners, and other entities that benefit from the maintenance of the levees, such as water users who rely on the levees to protect water quality.

This district should be authorized to:

- Develop, fund, and implement a regional plan of flood management for both Project and non-project levees of the Delta in cooperation with the existing reclamation districts, cities, counties, and owners of infrastructure and other interests protected by the levees;
- Conduct levee elevation surveys and inspections at least every 5 years, and report data to Department of Water Resources;

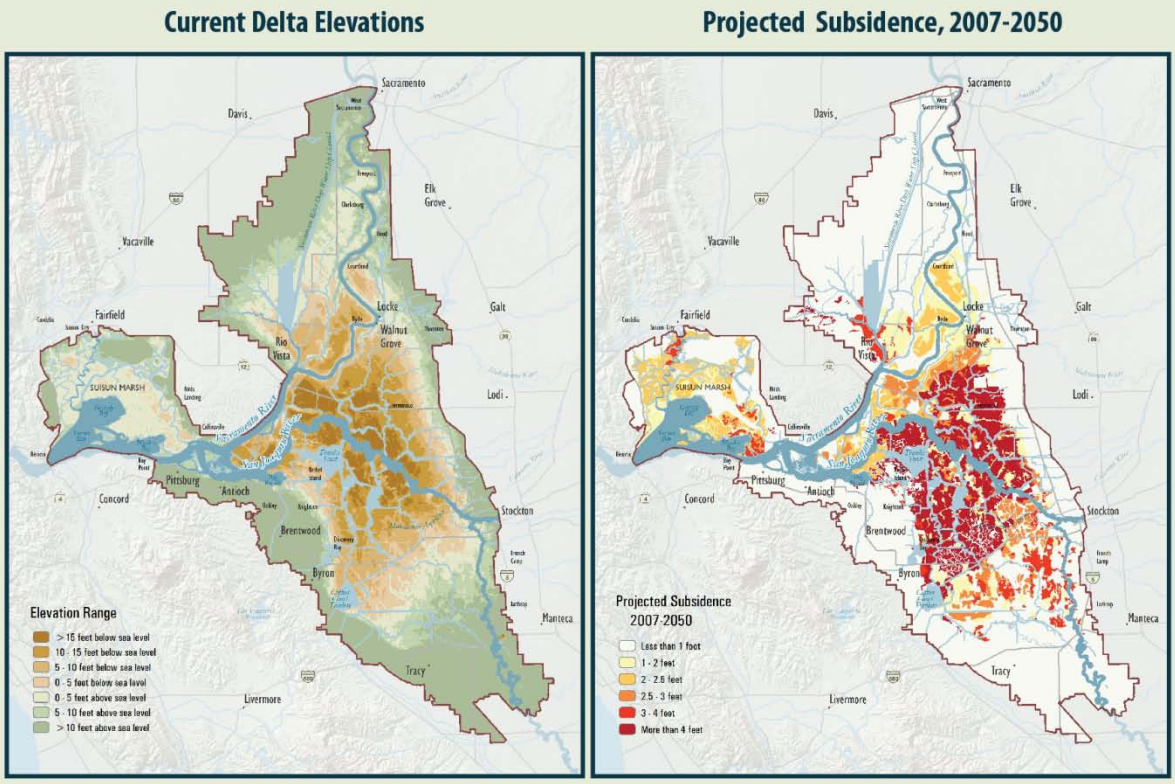
- In coordination with Department of Water Resources and the U.S. Army Corps of Engineers, establish standardized flood risk measurement data. This data should support the development of Expected Annual Damage and loss of life values for the Delta, to be conducted by the District annually. Expected Annual Damage is a measure of risk that integrates the likelihood and consequences of flooding, and is a standard measure of the benefits of reducing flood risk (USACE 1996, USACE 2006). The U.S. Army Corps of Engineers is currently developing a levee risk management system, including means to evaluate and rank risk of loss of life and flood damages for levee systems;
- Notify residents and landowners of flood risk, personal safety information, and available systems for obtaining emergency information before and during a disaster on an annual basis; and
- Potentially implement the recommendations of the Delta Multi-Hazard Coordination Task Force (Water Code section 12994.5) in conjunction with local, State, and federal agencies and maintain the resulting regional response system and components and procedures on behalf of SEMS jurisdictions (reclamation district, city, county, and State) that would jointly implement the regional system in response to a disaster event.
- Identify and assess critical water supply corridor levee operations, maintenance, and improvements.

Subsidence Reduction and Reversal

Portions of Delta lands are composed of peaty soils that exist naturally as fibrous, low-density, compressible soils usually in a saturated state. Agricultural practices have promoted deep subsidence over the last 150 years to the extent that many islands now more closely resemble bowls, with high sides (levees) and deep hollowed-out bases. To grow crops in such soils, farmers constructed levees and dikes around the tracts and drained the fields. This process of drying the saturated peat reduced its volume by approximately 50 percent. Early cultivation practices included burning, which further reduced the volume of the soil and altered its structure. Over time, long-term oxidation reduced the peaty soils to small particles and gases. Although subsidence has slowed or halted in many areas, some regions of the Delta continue to subside. Some recent land-management practices that can gradually reverse subsidence have been investigated. The State is participating in subsidence-reversal pilot studies on Sherman and Twitchell islands and other areas (Miller 2008).

Today, much of the central Delta is below sea level, with some islands commonly 12 to 15 feet below sea level, requiring levees that are 20 to 25 feet high to hold back water every day, acting as dikes (refer to the sidebar about subsidence.) As subsidence progresses, levees must be continually maintained, strengthened, and periodically raised to support the increasing hydraulic stresses being placed upon them.

Subsidence in the Delta



Oxidation of peat soils through natural processes and human activities has caused the Delta to drop. Much of the central Delta is currently at or below sea level. Future subsidence has been projected in these areas. As subsidence progresses, levees must be continually maintained, strengthened, and periodically raised to support increasing hydraulic stress.

Source: (left) DWR 2009; (right) adapted from Deverel and Leighton 2010

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Problem Statement

Deep subsidence has led to increasing stress on Delta levees.

Recommendations

RR R11 State agencies should not renew or enter into agricultural leases on Delta or Suisun Marsh islands if the actions of the lessee promote or contribute to subsidence on the leased land, unless the lessee participates in subsidence-reversal or reduction programs.

Reoperation of Upstream Reservoirs and Peak Flow Attenuation

Reservoir operations upstream of the Delta can have substantial impacts on flood flows through the Delta; therefore, operation procedures among government agencies should be well coordinated, and where possible, focused more on flexibility to prevent flooding in the Delta. Some non-federal, non-State upstream reservoirs can offer flood control benefits even when they have no specific designated flood control space in their reservoir. Federal and State agencies have initiated evaluations to modify flood control management procedures on an individual stream basis but have not completed a comprehensive, coordinated Delta watershed analysis. Factors caused by climate change will modify runoff patterns, including the timing and duration of runoff, which highlights the need for additional attention to reservoir operations.

Currently, DWR, the National Weather Service California-Nevada River Forecast Center (CNRFC), and USACE are working to improve flood operation coordination among Central Valley reservoirs through DWR's Forecast-Coordinated Operations program.

Reoperation of upstream reservoirs requires intense planning and environmental studies as well as dam safety studies to ensure no increase in dam safety risk. Reoperation evaluations would need to be coordinated with federal, State, and local agencies and with hydropower utilities.

Development of increased upstream (and possibly offstream) storage can also help to attenuate peak flows during major storm events, reducing pressure on Delta levees.

Problem Statement

Flood and water supply operations of upstream reservoirs are coordinated among USACE, DWR, the federal Bureau of Reclamation, local agencies, and hydropower utilities. However, these operations need to be revised, modeled, evaluated, and improved based on the coequal goals and changing conditions, including climate change and other factors.

Policies

No policies with regulatory effect are included in this section.

Recommendations

RR R12 U.S. Army Corps of Engineers, Bureau of Reclamation, Department of Water Resources, and local agencies and hydropower utilities should evaluate and modify flood control management procedures for reservoirs upstream of the Delta with consideration for sea level rise, changes in timing and form of precipitation, and changes in water supply operations to alleviate potential Delta flooding.

Performance Measures

Performance measures for reducing flood risk in the Delta are placed into two general classes:

- Administrative performance measures describe what resources (funds, programs, projects) are being implemented (or plan to be implemented) for a program or group of related programs.
- Outcome performance measures evaluate responses to management actions.

The distinction between performance measure types is not rigid.

Recommended performance measures for reducing risk to people, property, and State interests in the Delta are described below.

Development of informative and sensitive performance measures is a challenging task that will continue after the adoption of the Delta Plan. Performance measures need to be designed to capture important trends and to address whether specific actions are producing expected results. Efforts to develop performance measures in complex and large-scale systems like the Delta are commonly multi-year endeavors. The recommended performance measures are provisional and subject to refinement as time and resources allow.

Administrative Performance Measures

- Progress toward increasing the percentage of Delta levees that comply with the protection classifications shown in Table 7-1 based on corresponding land and resource uses. Trends in Delta levee miles complying with the Table 7-1 classifications will be upward as Delta levees are improved while maintaining appropriate land uses.
- Progress toward increasing the percentage of residential and commercial structures covered by flood insurance in the Delta. This trend will be upward should the Legislature require insurance coverage in flood-prone areas.
- Completion and implementation of DWR's A Framework for Department of Water Resources Investments in Delta Integrated Flood Management by January 1, 2013.
- Implementation of the Delta Multi-Hazard Coordination Task Force recommendations by the appropriate authority (Water Code section 12994.5).
- Development of a Delta Flood Risk Management Assessment District.
- Development of a Delta-wide levees conditions map that allows for the assessment of levees on an ongoing basis. The trend will indicate an improvement in Delta levee conditions over time.

Outcome Performance Measure

- Progress toward decreasing Delta area flood risk over time as measured by Expected Annual Damage. The Expected Annual Damage methodology is intended to more clearly quantify flood risk in terms of expected damages given probabilities of flooding. Trends in the reduction of Expected Annual Damage will be developed using data collected by appropriate State and local authorities.

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Chapter 8
Protect and Enhance the Unique Cultural, Recreational, Natural Resources, and Agricultural Values of the California Delta as an Evolving Place

The Delta Protection Act of 1992 declared state policy for the resources and values of the Delta (Public Resources Code section 29702, amended 2009):

> *(a) Achieve the two coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.*
>
> *(b) Protect, maintain, and, where possible, enhance and restore the overall quality of the Delta environment, including, but not limited to, agriculture, wildlife habitat, and recreational activities.*
>
> *(c) Ensure orderly, balanced conservation and development of Delta land resources.*

Inherent in the coequal goals, the legislature declares the following objectives inherent in the coequal goals for management of the Delta (Water Code section 85020):

> *(a) Manage the Delta's water and environmental resources and the water resources of the state over the long term.*
>
> *(b) Protect and enhance the unique cultural, recreational, and agricultural values of the California Delta as an evolving place.*

Water Code section 85302(h) provides direction on the implementation of measures to promote the coequal goals and inherent objectives.

> *(h) The Delta Plan shall include recommendations regarding state agency management of lands in the Delta.*

Public Resources Code section 29703.5 declared the Delta Protection Commission's role in providing recommendations to the Delta Stewardship Council.

> *(a) The Delta Protection Commission created pursuant to Section 29735 provides an existing forum for Delta residents to engage in decisions regarding actions to recognize and enhance the unique cultural, recreational, and agricultural resources of the Delta. As such, the commission is the appropriate agency to identify and provide recommendations to the Delta Stewardship Council on methods of preserving the Delta as an evolving place as the Delta Stewardship Council develops and implements the Delta Plan.*
>
> *(b) There is a need for the five Delta counties to establish and implement a resources management plan for the Delta and for the Delta Stewardship Council to consider that plan and recommendations of the commission in the adoption of the Delta Plan.*

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Chapter 8
Protect and Enhance the Unique Cultural, Recreational, Natural Resources, and Agricultural Values of the California Delta as an Evolving Place

The history of the Delta, dating back from the Gold Rush era to today, has shown that it is a constantly evolving place, adapting to local and regional economic trends, reacting to flooding threats, and preserving a quality of life that reflects local values. Since the mid-1800s, the Delta's economy and culture have been defined by managing water to create farmable land, and by using the Delta's waterways to move people and goods between the San Francisco Bay Area and Central Valley. In the past 100 years, the importance of the Delta region has been elevated by a growing network of infrastructure, such as roadways, freshwater conveyance, power transmission lines, and pipelines that connect the Delta to other regions of the state. More recently, the population of some Delta communities has grown as people who work in the San Francisco Bay Area, Sacramento, and Stockton regions relocate to enjoy the rural lifestyle offered by the Delta.

The Delta provides a unique environment that is enjoyed by residents, people who work in the Delta, and visitors. Each Delta community has its own key areas for community life and socialization, including the various schools, churches, and community centers scattered throughout the Delta. These locations play host to the full range of standard community activities including seasonal celebrations, prayer groups, 4-H and scout meetings, potlucks, pageants, and festivals. In many communities, the primary commercial area (typically a "Main Street") serves to host the larger activities such as seasonal fairs and parades. While some smaller activities are intended to bring only the local residents together, most activities serve to bring residents (and visitors) from throughout the Delta to the various communities and increase social ties and a sense of interrelation among Delta residents, strengthening the Delta's sense of place.

People who live outside of an established community are socially tied to the community through general proximity and public services, such as school districts, volunteer fire departments, and similar civil networks. In addition to recognized cities and communities, the Delta is home to a number of small but important recreational areas including campgrounds, marinas, RV parks, and vacation homes that are popular throughout spring and summer and foster their own sense of place and community.

Many Delta residents and visitors are drawn to the area by the recreational opportunities afforded by the approximately 1,000 miles of waterways and 57 islands of the Delta. Recreation opportunities are related to waterways, wildlife, and legacy communities. Figure 8-1 shows the variety and distribution of some of these opportunities in the Delta. Boating and water-dependent recreation represent the highest percentage of existing recreation activities in the Delta. In the California Department of Boating and Waterways'

2002 study, annual boating-related visitor days to the Delta were estimated at 6.4 million in 2000, with a projected growth to 8 million visitor days by 2020 (DBW 2002). According to a 2001 survey, there were 95 public and private marinas within the Primary Zone, with more than 11,000 boat slips, more than 2,000 campsites, 324 day-use picnic facilities, and 78 launch ramp lanes (DBW 2002). Passed in 2006, Senate Bill 1556 (Torlakson) requires the Delta Protection Commission to establish "a continuous recreation corridor, including bicycle and hiking trails, around the delta." The bill also requires the Great Delta Trail to link the San Francisco Bay Trail system to planned Sacramento River trails in Yolo and Sacramento counties.

Wildlife-oriented recreation, including hunting, wildlife viewing, bird watching, and viewing natural scenery (interpretive, walking, and driving trails), represents another category of recreation in the Delta. There are more than 125,000 acres of public wildlife areas and numerous private hunting clubs within the Delta. Some of the most visited wildlife areas include the following:

- Yolo Bypass Wildlife Area with more than 30,000 visitors annually
- Lower Sherman Island that primarily offers hunting and fishing for approximately 2,000 hunters and 3,000 visits for fishing annually.
- Calhoun and Acker Island, although closed to public access, includes a public waterway that transverses Calhoun and Acker Island to Lost Isle, a currently closed private resort.
- Stone Lakes National Wildlife Refuge hosts guided tours and special events for 6,000 to 7,000 annual visitors (Hopperstad 2011).
- Cosumnes River Preserve is partially located within the Delta and has a visitor center with picnic areas, interpretive displays, and restrooms, and three designated hiking trails (Cosumnes River Preserve 2011).
- Solano Land Trust owns Jepson Prairie and Rush Ranch Open Space provide guided tours.
- Suisun Marsh provides numerous water-oriented recreation opportunities including waterfowl hunting, fishing, boating, kayaking, wildlife observation, and hiking.
- Various private hunting clubs are located throughout the Delta.

The unique landscape, heritage, and recreational opportunities found in the Delta combine to create a distinctive environment that supports its own social and cultural character. The combination of the physical and biological environment along with the social, economic, and cultural character of the Delta communities work to create a unique regional framework that is often described as a special place. A sense of place is a concept that integrates the many ways in which a region may take on special meaning to people. The unique history, its geographic setting and natural/physical features, and standards of living within the Delta all contribute to a sense of place; a shared sense of place is often used to define a community.

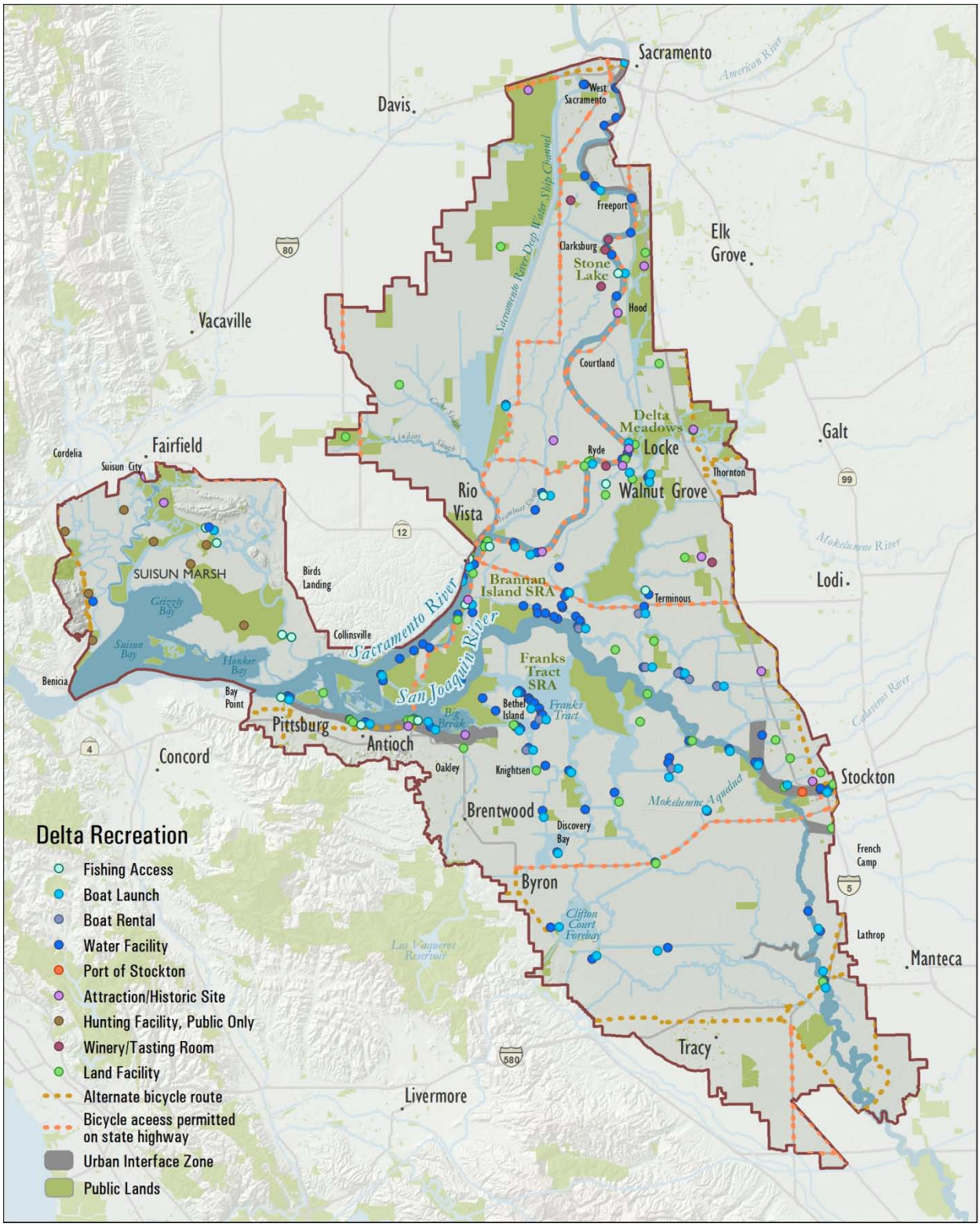

Figure 8-1
Major Delta Resources and Recreation
Sources: California Chambers and Visitors Bureau 2010, California Department of Boating and Waterways 2010, California Resources Agency 2007, DPC 2006, Discover the Delta Foundation 2010, DWR 2009

The economy of the Delta also reflects this diversity and economic importance of the Delta to California. The Administrative Draft *Delta Economic Sustainability Plan* (Delta Protection Commission 2011) described that 45 percent of all jobs in the Delta are within the retail, education, health care, and accommodations and food services industries. Within the Primary Zone, agriculture supports 45 percent of all jobs. In the five Delta counties, agriculture supports 13,700 direct and indirect jobs and contributes more than $4.6 billion to the economic output of California. Delta recreation and tourism supports over 2,700 direct and indirect jobs in the five Delta counties and contributes more than $0.6 billion to the economic output of California.

As the region has evolved over the decades, the Delta's predominant land use has remained agriculture, the extent of which is evident in Figure 8-2. Its varied crops continue to surround small unincorporated and "legacy communities," towns with distinct natural, agricultural, and cultural heritage. Cultural events, specialty local businesses, and recreational opportunities near these towns attract many visitors. Industries in the Delta serve the region's agricultural, transportation, and recreation sectors. The Delta is also an important industrial area. The manufacturing sector has close ties to agriculture and recreation and includes businesses such as agricultural implement design and fabrication, construction of boats and accessories like covers, tops, and canopies, and wine production. Energy transport, storage, and production (natural gas, wind power, electric generation), and levee maintenance activities also support the local economy. The Delta also is a benefit to the entire state with multiple corridors and crossroads for utilities and highway and rail transportation that serve and connect the Delta with other parts of California.

A growing appreciation of the Delta's character and role in California's history has moved the Legislature to act to protect and enhance the Delta "as an evolving place" and to consider pursuing federal designation of the Delta as a place of special significance to communicate the Delta's stature as one of America's most distinctive and culturally significant regions and encourage regional investment.

However, future risks to the Delta are increasing concerns for many residents and individuals who rely upon the Delta. Urbanization at the edges of the Delta, an aging levee system (described in Chapter 7) that could become more vulnerable with climate change and rising sea levels, an aging population in the Primary Zone, and concerns about continued viability of some aquatic and terrestrial species in the Delta lead to the need for a long-term management plan to address these concerns. No clear, consistent regional or statewide plan collectively addresses these concerns. Also, the ways in which these concerns are addressed could affect the very culture and natural heritage the Legislature seeks to protect and enhance.

This chapter discusses methods to address the challenges to the Delta's unique sense of place and major issues that must be addressed for the Delta to evolve to meet these challenges.

Critical plans completed by others have been considered by the Delta Stewardship Council (Council) during the development of the recommendations in this section:

- Plan to establish State and federal designation of the Delta as a place of special significance (development by the Delta Protection Commission [DPC]; Water Code section 85301(b)(1)), Phase 1 Report, December 16, 2010.
- Proposal to expand the network of state recreation areas in the Delta (development by the California Department of Parks and Recreation; Water Code section 85301(c)(1)), Draft for Public Review, May 3, 2011. (Final proposal is scheduled to be completed in June 2011.)
- Land Use and Resource Management Plan for the Primary Zone of the Delta (development by the DPC, Public Resources Code section 29760 et seq.), adopted February 25, 2010.
- Delta Economic Sustainability Plan (development by the DPC; Public Resources Code section 29759), Phase I – Framework Study, Final Draft, December 6, 2010.

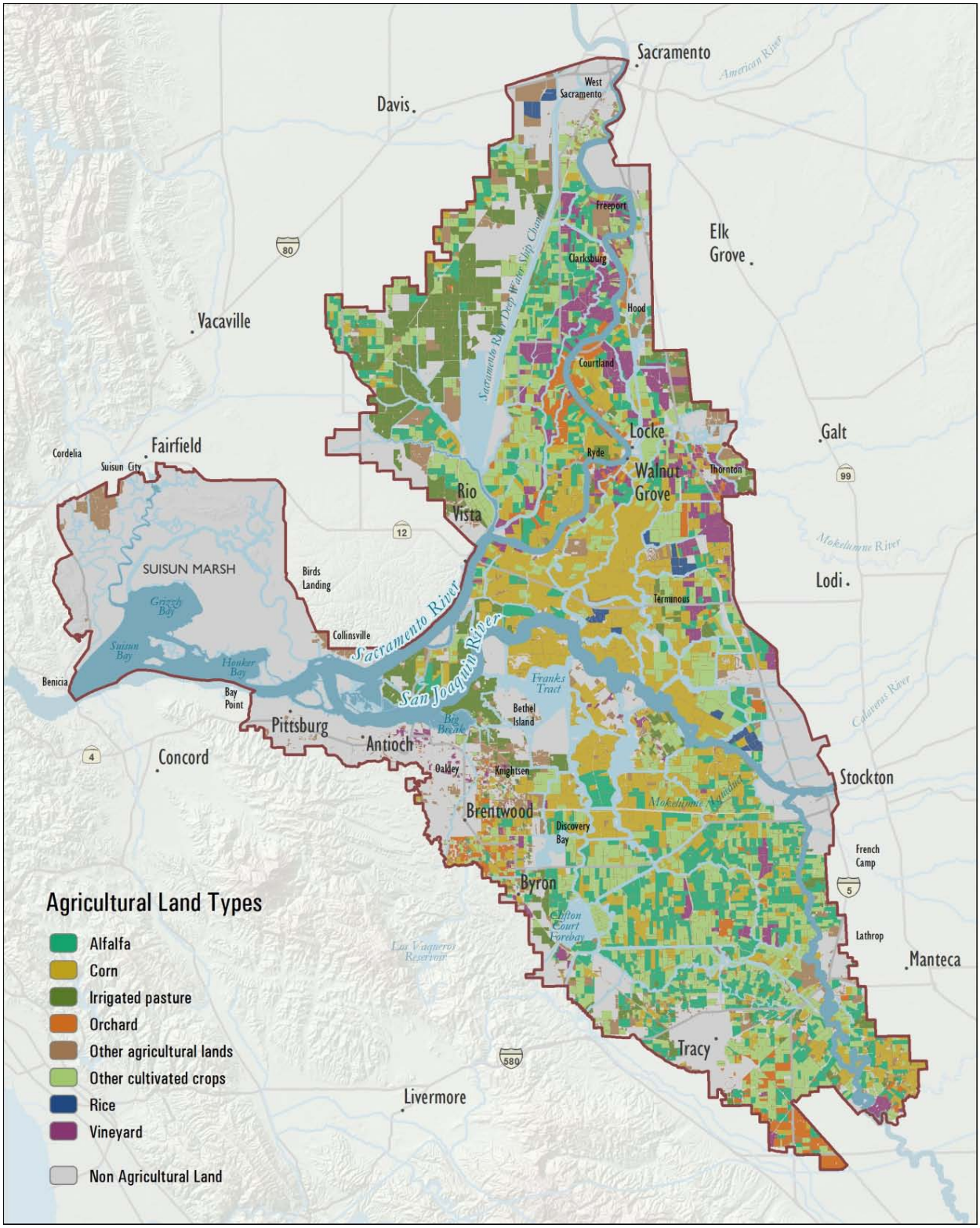

Figure 8-2
Agricultural Land Use in the Delta
Source: FMMP 2008

- Proposal to establish market incentives and infrastructure to protect and enhance the economic and public values of Delta agriculture (California Department of Food and Agriculture; Water Code section 85301(c)(2)), transmitted to the DPC and Delta Stewardship Council on March 21, 2011 (Sumner and Rosen-Molina 2011).

Other critical plans now being developed by others will be considered by the Council to inform future Delta Plan policies:

- Delta Economic Sustainability Plan (development by the DPC; Public Resources Code section 29759), Phase II, including Working Papers and the Final Economic Sustainability Plan. (Final Plan is scheduled to be completed by September 2, 2011.)
- Plan to establish State and federal designation of the Delta as a place of special significance (development by the DPC; Water Code section 85301(b)(1)), Phase II or Management Plan.
- Proposal to protect, enhance, and sustain the unique cultural, historical, recreational, agricultural, and economic values of the Delta as an evolving place in a manner consistent with the coequal goals (development by the DPC; Water Code section 85301(a)).

Policies and Recommendations

Economic Sustainability

To protect people, property, and State interests in the Delta, the Legislature has directed State agencies to assist with maintaining the socioeconomic sustainability of agriculture, infrastructure, and legacy communities in the Delta. Plans are underway to encourage economic growth in the Delta region through investments in tourism and recreation, but concerns have been identified about balanced development and prioritized investment. For example:

- The DPC's Land Use and Resource Management Plan for the Primary Zone of the Delta (2010) identifies concerns about funding availability for maintenance of recreational facilities and for the provision of new facilities.
- The Department of Food and Agriculture's proposal to establish market incentives and infrastructure to protect and enhance the economic and public values of Delta agriculture (Sumner and Rosen-Molina 2011) raises concerns about the ability of public investments in recreation or local marketing to provide additional revenue to support Delta agriculture.

The Legislature established that the DPC "is the appropriate agency to identify and provide recommendations to the Delta Stewardship Council on methods of preserving the Delta as an evolving place as the Delta Stewardship Council develops and implements the Delta Plan" (Public Resources Code section 29703.5(a)). The DPC is developing an Economic Sustainability Plan, which will inform the Council's policies for economic sustainability in the Delta. The plan will define a baseline of economic values for Delta activities, propose alternative planning scenarios to sustain legacy towns, and prioritize improvements in flood control and public safety critical to counteract the potential impacts of climate change and seismic risks on the economic sustainability of the Delta. The Economic Sustainability Plan will also identify and recommend investments in capital and ongoing operation and maintenance necessary to achieve sustainability goals (California State Lands Commission 2011, University of the Pacific 2011). The California Department of Parks and Recreation also includes economic sustainability recommendations in their proposal, described below.

Public Resources Code section 29778.5 established the Delta Investment Fund in the State Treasury, which can be used for implementing the Economic Sustainability Plan once adopted by the DPC. The Legislature, however, has yet to make appropriations to the fund.

Maintaining public services is vital to sustaining the Delta's culture and public safety. Local governments have expressed concern about lost tax revenue from land converted from agriculture to ecosystem habitat. Additionally, more land has gone into public ownership in recent years. When federal or State government agencies purchase land, they are generally exempt from paying property taxes to the county that originally had jurisdiction over the land. Acquisition can therefore represent a loss of significant funds for the county, making the provision of vital services difficult. The State currently administers a payment-in-lieu-of-taxes program to compensate county governments, but only lands acquired by the California Department of Fish and Game (DFG) for wildlife areas qualify, and budget constraints may affect payments on an annual basis (Working Landscapes Subcommittee 2005).

Problem Statement

Economic development planning and investment are required to sustain the economic vitality of the Delta while achieving the coequal goals as economy of the Delta and California change. As described above, the Legislature established the DPC as the agency to provide recommendations to the Delta Stewardship Council through the completion of the *Economic Sustainability Plan.* However, that plan is currently being developed. Therefore, the Fifth Staff Draft Delta Plan can only be informed by the initial findings of the *Economic Sustainability Plan Framework Study*.

Policies

At this time, no policies with regulatory effect are included in this section. The Delta Plan will rely heavily on local and regional direction to achieve the recommendations listed below, and relies on the regulatory policies of other sections of the Delta Plan to ensure progress toward the coequal goals.

Recommendations

DP R1 The Economic Sustainability Plan should include, but not be limited to, planning for the following items:

- Public safety recommendations, such as flood protection recommendations
- The economic goals, policies, and objectives in local general plans and other local economic efforts, including recommendations on continued socioeconomic sustainability of Delta agriculture and its infrastructure to support the proposed economic strategies and legacy communities in the Delta
- Comments and recommendations to the Department of Water Resources concerning its periodic update of the flood management plan for the Delta.
- Identification of ways to encourage recreational investment along the key river corridors, as appropriate

Natural, Agricultural, Recreational, and Cultural Heritage

The Delta's history is rich with a distinct natural, agricultural, and cultural heritage. It is home to the community of Locke, the only town in the United States built primarily by early Chinese immigrants. Other legacy communities include Bethel Island, Clarksburg, Courtland, Freeport, Hood, Isleton, Knightsen, Rio Vista, Ryde, and Walnut Grove (Public Resources Code section 32301(f)). The Legislature declared that the cities, towns, and settlements within the Delta are of significant historical,

cultural, and economic value and that their continued protection is important to the economic and cultural vitality of the region (Public Resources Code section 29708).

These communities, together with the Delta's landscape and heritage, form a unique and valued area, warranting recognition and special legal status from the State of California (Delta Vision Blue Ribbon Task Force 2008). In 2010, the DPC initiated a study to consider application to the National Park Service for designation of the Legal Delta as a National Heritage Area. Subsequently, Senators Feinstein and Boxer introduced Senate Bill 3927 to designate the Sacramento-San Joaquin Delta National Heritage Area to include the Delta, Suisun Marsh, and an area within Contra Costa County managed by the Carquinez Heritage Preservation Trust. The National Heritage Area could increase the visibility of the Delta in adjacent communities and throughout the state and the nation. This support may develop support for programs to preserve, protect, and enhance the Delta, and educate people outside the Delta about its recreational and cultural opportunities.

Future recreational opportunities were described by the California Department of Parks and Recreation in the Draft *Recreation Proposal for the Sacramento-San Joaquin Delta and Suisun Marsh* (California Department of Parks and Recreation 2011). This report was submitted to the DPC for consideration during completion of the *Delta Economic Sustainability Plan*. The Draft *Recreation Proposal for the Sacramento-San Joaquin Delta and Suisun Marsh* recommended that DPC gain approval for, establish, and manage a National Heritage Area in the region, and the DPC is now conducting a feasibility study. Designation may lead to partnerships and funding for elements that increase recognition and cultural understanding, such as interpretive signage, historic preservation, regional branding, and heritage trail development while still allowing the Delta's agricultural economy and culture to thrive. Future studies should be considered by State and local agencies to document and evaluate cultural landscape resources, consistent with the federal National Park Service Historic Landscape initiative.

To guide and draw visitors to the area, the California Department of Parks and Recreation recommends that communities on the edge of the Delta or Suisun Marsh with access to major transportation routes be developed as "gateways" to provide supplies and information to visitors about recreation opportunities available in an area (California Department of Parks and Recreation 2011). Gateways identify entrances to a region at transition points in topography or land use and provide a unique sense of identity, transition, and anticipation. Gateway communities could include Antioch, Brentwood, Clarksburg, Oakley, Pittsburg, Rio Vista, Sacramento, Stockton, and Suisun City. Parks also could serve as gateways to the waterways, such as Solano County's Sandy Beach Park near Rio Vista or Belden's Landing boat launch in Suisun Marsh.

Within the Delta, towns could serve as "base camps" for recreation and tourism activities and develop or improve services such as boat rentals, parking, restrooms, and picnic sites. Ecological reserves and wildlife areas could attract visitors by improving environmental interpretation (California Department of Parks and Recreation 2011). Increased visitation to museums, recreational trails, community parks, farm stands, community centers, and water access facilities in the Delta would support its cultural heritage, agricultural and economic base, recreational resources, and biological diversity (DPC 2010b, Land Use Policy P-1).With increased visitation and tourism, recreation facilities and public services must be improved, and public safety must be maintained on land and water. The improved infrastructure and other services would need to be developed in a manner that is consistent with other policies described in the Delta Plan to protect habitat and reduce flood risk to Delta residents and visitors. Increasing numbers of boaters in the area may require the Department of Boating and Waterways to enhance patrol efforts.

Problem Statement

The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resources, and agricultural values of the California Delta as an evolving place. To encourage economic investment in the rich cultural values of the Delta, including recreational and

agricultural activities, the Delta needs recognition, special legal status, and enhanced visibility and identity. Recreation access and facilities must be improved as with increased regional population and tourism.

Policies

At this time, no policies with regulatory effect are included in this section.

Recommendations

DP R2 The Delta Protection Commission should complete the evaluation and initiate recommendations related to designation of the Delta and Suisun Marsh as a National Heritage Area. If the recommendation is to proceed with the designation, the federal government should complete the process in a timely manner.

DP R3 The Department of Transportation should partner with local cities and counties to establish major gateways and improve connecting transportation routes, bike lanes, sidewalks, and trails to promote the Delta's identity, visibility, and access.

DP R4 The Department of Parks and Recreation should develop funding sources and partner with other State and federal agencies, counties, conservancies, and nonprofits to conduct definitive and consistent recreation use surveys every 5 years and add and/or improve recreation facilities in the Delta, including facilities to meet public recreational needs as part of State Water Project facilities, and add three new parks at Barker Slough, Elkhorn Basin, and in the Southern Delta.

DP R5 The Department of Fish and Game should collaborate with other agencies and nonprofits, private landowners, and business partners to expand wildlife viewing, angling, and hunting opportunities.

DP R6 The Department of Boating and Waterways should coordinate with the U.S. Coast Guard and State and local agencies on an updated marine patrol strategy for the region.

Performance Measures

Performance measures for protection and enhancement of the unique cultural, recreational, natural resources, and agricultural values of the California Delta as an evolving place are placed into three general classes:

- Administrative performance measures describe what resources (funds, programs, projects) are being implemented (or plan to be implemented) for a program or group of related programs.
- Driver performance measures evaluate the factors that may be influencing outcomes and include on-the-ground implementation of management actions, such as acres of habitat restored or acre-feet of water released, as well as natural phenomena outside of management control (such as a flood, earthquake, or ocean conditions)
- Outcome performance measures evaluate ecosystem responses to management actions or natural drivers.

The distinction between performance measure types is not rigid. In some cases, an outcome performance measure for one purpose may become a driver performance measure for another purpose.

Development of informative and sensitive performance measures is a challenging task that will continue after the adoption of the Delta Plan. Performance measures need to be designed to capture important trends and to address whether specific actions are producing expected results. Efforts to develop

performance measures in complex and large-scale systems like the Delta are commonly multi-year endeavors. The recommended performance measures are provisional and subject to refinement as time and resources allow.

Recommended performance measures for protection and enhancement of the unique cultural, recreational, natural resources, and agricultural values of the Delta as an evolving place are described below.

Administrative Performance Measures

- The DPC initiates implementation of recommendations of the *Delta Economic Sustainability Plan* in 2012.
- The DPC completes recommendations regarding designation of the Delta and Suisun Marsh as a National Heritage Area by January 1, 2012.

Driver Performance Measures

- Progress toward increased guided visitation and visual identity in the Delta. "Gateways" to the Delta are established at Antioch, Brentwood, Clarksburg, Oakley, Pittsburg, Rio Vista, Sacramento, Stockton, Suisun City, and possibly at waterside parks by 2020.
- Progress toward meeting the DPC's Economic Sustainability Plan recommendations with adequate funding of essential public services to adequately provide for Delta residents, visitors, agriculture, and industries.

Outcome Performance Measures

- Progress toward improving the economic sustainability of Delta land uses and protection of the Delta's agricultural values. Total agricultural acreage and gross revenue in the Delta will be maintained or increased in the future.
- Progress toward improving economic sustainability of Delta land uses and protection of the Delta's recreational values. Total annual gross revenue, adjusted for inflation or deflation, from Delta recreation activities will be maintained or increase.
- Progress toward improving Delta economic sustainability and enhancing Delta culture by increasing ecotourism and agritourism opportunities. Annual visitation and total annual gross revenue, adjusted for inflation or deflation, from ecotourism and agritourism will maintained or increased.
- Progress toward achieving balanced land use and resource management in the Delta and protecting the Delta's natural resource values. Total acres of undeveloped agricultural, habitat, recreational, and open space lands will be maintained in the future and not converted to municipal and industrial uses.

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Chapter 9
Finance Plan Framework to Support Coequal Goals

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Chapter 9
Finance Plan Framework to Support Coequal Goals

America is slowly recovering from a severe recession, and California's economy lags behind the nation's recovery. Together with a multiyear State budget crisis in which annual spending exceeds available revenue, financing infrastructure and new programs becomes immensely challenging for the State and local governments.

The current economic climate will limit the ability to quickly develop the full range of water or ecosystem improvements necessary to achieve the coequal goals. However, the planning time frame for the Delta Plan runs to the year 2100. This time frame allows time for gradual steps toward improving the situation, and to stage actions, policies, and projects over time, which fits with an adaptive management structure based on science—a system that constantly modifies, adjusts, and changes actions and projects as new information becomes available.

The Delta Plan includes policies and recommendations for water conveyance, conservation, storage, and efficiency together with ecosystem restoration, protection and enhancement of the Delta as an evolving place, flood risk reduction, water quality protection, science, and governance. The Finance Plan Framework proposes strategies to generate ongoing revenue and capital construction funds for these policies and recommendations.

The Finance Plan Framework is based on the following key tenets:

- Beneficiaries (those who benefit from the water resources of the Delta and its watershed) should pay for the benefits they receive.
- Stressors (those whose actions adversely affect the Delta ecosystem) should pay for the harm they cause the ecosystem.

However, simply stating the principle that beneficiaries pay and those who stress the Delta ecosystem should also pay does not resolve the necessary or appropriate level of the fees. Nor does it adequately ensure funds to pay for statewide and regional public benefits. Some funds are currently available and should be spent in ways that truly focus on the coequal goals and support significant actions that implement the Delta Plan.

This chapter outlines the principles of a financing system, background information on federal, State, and local funding for water and Delta ecosystem purposes, and recommendations for financing a staged Delta Plan through the year 2100. It is intended that the implemented Finance Plan will be integrated with other ongoing programs by related agencies.

Guiding Principles

As the costs of Delta improvements are determined, development of the Finance Plan should be shaped by a set of guiding principles:

- Implementation of the Delta Plan will require an array of funding sources and new statutory authority. Broad-based financing and diversity in funding sources will enhance revenue stability. Likewise, State and federal funds for activities that implement the Delta Plan must be reserved for public benefits not otherwise required for project mitigation or by law for other purposes. Appendix I describes potential funding sources.
- The "beneficiary pays" principle is a common financing approach for water projects. The challenge is to determine the beneficiaries and design a cost-allocation method scaled to the benefit.
- A companion principle to "beneficiary pays" is "stressors pay." Human activity that causes negative operational or environmental impacts should be assessed a fee to repair the damage. An example of the stressors pay approach might be a surcharge on pesticides that are found to negatively impact the Delta ecosystem.
- Capital construction projects, whether for water reliability purposes or improvement in the Delta ecosystem, should be undertaken simultaneously with the development of beneficiary and user fees. Delay in establishing a beneficiary/stressor fee structure will inevitably delay any needed capital improvement projects. The development of information related to financing (such as the identification of beneficiaries and stressors and detailed financing scenarios) should be undertaken simultaneously with the development of major capital decisions so that it can inform planning efforts.
- The Finance Plan should include mechanisms to ensure that user fees are legally dedicated to their intended purpose. Given State and federal budget constraints, statutory protections must be enacted to assure users that their assessments will not be diverted to other purposes.
- Targeted finance plans should be developed for major Delta Plan activities (ecosystem restoration, flood risk reduction, regional water supply investments, science, administration, and water conveyance). Beneficiaries and stressors should be identified in each of these areas, and user fees should be developed to match these stressors and beneficiaries with planned investments in each of these areas.
- Existing expenditures for closely related activities identified in the plan should be considered as a credit against future assessments. Site-specific expenditures by agencies should not be credited against future payments (for example, the installation of fish screens and waste treatment costs).
- To the extent possible, user fees should be based on the amount of water used, or for stressors, the volume of the contaminants discharged. Tiered fee structures should also be explored where applicable.

Background

Operations, maintenance, and capital expenditures for water infrastructure consume a significant amount of resources in California. A cursory review of financial data from selected entities that provide water-related services in California shows that expenditures in California exceed $20 billion annually (Table 9-1). This total likely includes some overlap, but the expenditures are significant.

Table 9-1
Annual Budgets/Expenditures in California for Selected Agencies ($ Millions)

Agency	Budget/Expenditures		Source
	Operating	Non-operating	
Local cities, counties, and special districts water	$10,100	$2,000	California State Controller 2011a, 2011b, 2011c
Local cities, counties, and special districts wastewater	$5,400	$1,100	California State Controller 2011a, 2011b, 2011c
Local Cities, counties, and special districts flood control	$1,000	$300	California State Controller 2011a, 2011b, 2011c
California Department of Water Resources	$3,599	$3,623	California Department of Finance 2011
State Water Resources Control Board	$793		California Department of Finance 2011
Department of Fish and Game	$400	$2	California Department of Finance 2011
Federal Bureau of Reclamation	$300		Reclamation 2008
U.S. Army Corps of Engineers	$100	$100	USACE 2008
Total	**$25,000**	**$4,000**	

Since the CALFED Bay-Delta Program was instituted in 1995 to restore ecological health and improve water management in the Delta, significant expenditures have been made in the Delta. Roughly $400 million has been spent on average annually by federal, State, and local water users. The Bay Delta Conservation Plan (BDCP) estimates that $3.6 billion total plus $46 million annually needs to be spent on Delta ecosystem restoration (BDCP Steering Committee 2010).

Traditionally, the State has financed water infrastructure with general fund obligation bonds supported by tax revenues. These bonds were approved by the voters, and repayment is guaranteed by the State's general taxing power. For the State Water Project (SWP), however, even though guaranteed by taxes, general obligation bonds were paid back mainly by user fees. Since 2000, the State has sold nearly $20 billion in general obligation bonds for water-related purposes spread over six separate bonds (not all of these bonds have been issued yet) (LAO 2008). One benefit of financing water projects with general obligation bonds is that any costs allocated to the public good (such as some ecosystem benefits) are repaid by taxpayers, the primary beneficiaries.

Because of the State's current fiscal condition, California general obligation bonds carry a higher interest rate than most other states, and existing bond funds are near depletion. Coupled with the reduced likelihood of voter approval for new general obligation bonds, new approaches to water infrastructure financing are needed. As new revenue sources are developed, the use of revenue bonds may become more prevalent. This creates the need to find an approach to funding ecosystem costs previously paid for by general obligation bonds.

Financing Needs

The Finance Plan Framework for the Delta Plan has two parts:

- Immediate needs over the next 5 years
- Near-term expenditures that might occur through 2025

This framework allows time to develop a finance plan that establishes financing for operational needs while developing a broader-based financing approach for long-term improvements based on phasing, adaptive management, and integration with ongoing programs.

The costs of the Delta Plan will be further refined when a final BDCP is completed and incorporated into the Delta Plan. To meet state and federal requirements, BDCP will identify implementation costs and funding sources. Implementation costs will be determined for planning and construction of a conveyance facility; conservation actions to avoid, minimize, and mitigate the effects of activities covered by the BDCP on species and natural communities addressed by the BDCP; and actions to provide for the conservation of those species. The State and federal contractors have committed to funding the conveyance facility and related mitigation costs. Substantial public and private sources of funding are expected to contribute to the cost of implementing the other elements of BDCP that provide benefits to the public and the State and federal contractors. If the BDCP is not completed by January 1, 2014, consistent with the Delta Reform Act, the Delta Stewardship Council (Council) will consider how to proceed with ecosystem and conveyance planning.

Immediate Needs

Three immediate financing needs exist:

- **Urgent expenditures for water reliability and ecosystem protection:** Immediate steps should be taken to protect the existing Delta water export system from flood risks, and protect ecosystem improvements being implemented pursuant to existing mitigation commitments of the SWP and the Central Valley Project (CVP). Those immediate needs are discussed in the various chapters of the Delta Plan. These recommendations are in addition to other ongoing efforts that should continue to be funded. Examples include implementing the federal biological opinions, funding levee subventions, funding science, and many more.

- **Funding a strong Delta Science Program**, including funds for the Independent Science Board and the State's share of the Interagency Ecological Program (IEP). Funding for the Delta Science Program and Delta Independent Science Board would require approximately $27 million per year. Funding for the IEP should continue from relevant agencies.

- **Continuing the existing operational duties imposed by the 2009 Delta Reform Act.** The Act created the Delta Stewardship Council (which includes the Delta Science Program and Independent Science Board) and the Delta Conservancy, and modified the duties of the existing Delta Protection Commission. Annual operating costs for all of these functions are approximately $50 million per year. This includes $27 million for the Delta Science Program and the Delta Independent Science Board (mentioned above), $8 million to administer the Delta Stewardship Council, $5 million for the Delta Protection Commission, and $10 million for the Delta Conservancy. Projected 5- year budgets for these agencies are shown in Appendix J.

Continuation of Near-term Planning, Science, and Related Needs

The Council supports completion of the BDCP. The scope or type of any facility improvements, related Delta ecosystem mitigation, and other habitat improvements to be included is very preliminary at this time. The BDCP's ongoing planning costs are currently funded by State and federal water contractors. Currently available information from the BDCP indicates that once the BDCP is completed, the first 5 years of implementation will require between $5.7 and $5.9 billion total for capital outlays, of which approximately $5.2 billion is for water conveyance. The BDCP will include a funding plan that will address estimated BDCP implementation costs and sources of funding that will be relied upon to cover these costs. The Council will reconsider recommendations for interim State funding once the funding plan is completed.

Bay Delta Conservation Plan Costs and Existing Funding Sources

Potential future funding sources for the BDCP will likely compete with funding required for implementation of some elements of the Delta Plan, and for the plans and projects of state, federal, and local agencies. The Council does not consider any funding source to be solely available for the BDCP, or for any other program or plan. They are solely considered to be options at this stage.

Based on current information from the BDCP, the approximate costs of a facility and related ecosystem improvements needed for state and federal approval is approximately $15.8 to $16.7 billion in capital costs and an additional $4.9 to $5.6 billion in operating costs over the 50-year permit period. These costs are divided among the Bay Delta Conservation Plan's four primary functions—water conveyance, habitat restoration, management of other stressors, and program oversight—as shown in the table below. The Council notes that preliminary cost estimates are just that: preliminary. Going forward, refined estimates will be required in order to complete this planning process.

Options for Bay Delta Conservation Plan Funding

The BDCP is premised on the pledge of participating state and federal water contractors to pay the full cost of any new Delta export facility and the associated Delta ecosystem mitigation required to meet the requirements imposed on the BDCP by federal and state law. Habitat and ecosystem restoration activities, beyond mitigation requirements, are considered to provide a general benefit to the state and should be funded accordingly.

Prior to completion of the BDCP and a full understanding of the Delta ecosystem improvements related to the BDCP, it is impossible to project the detailed funding options that might be necessary. However, it is highly likely that user fees, revenue bonds, and sources other than the state General Fund will be the primary source of funding.

Summary of BDCP Costs and Existing Funding Sources ($ millions)

	Bay Delta Conservation Plan[a]		
Program Function	**Capital Costs**	**Operating Costs**	**Total**
Water Conveyance[b]	$12,691	$2,936	$15,627
Habitat Restoration[c]	$3,108–$4,009	$346–$437	$3,454–$4,446
Other Stressors[c]	$12–$15	$1,213–$1,769	$1,225–$1,784
Program Oversight[c]		$404–$548	$404–$548
Total	**$15,810–$16,712**	**$15,810–$16,712**	**$20,706–$22,310**

[a] Over 50-year permit period [b] Midpoint cost estimate [c] Range of low-high estimate given

Source: BDCP Steering Committee. Progress Report on the Bay Delta Conservation Plan. November 18, 2010.

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Recommended Financing Strategy for the Delta Plan

The Council considers it unlikely that the General Fund or general obligation bonds will indefinitely fund implementation of the Delta Plan.

In general, human activities that stress the system should be the starting point for a financial strategy. Large federal and State contributions should be secondary. Because the Delta Plan will be implemented and water system improvements and Delta ecosystem improvements will occur through 2100, any new fees established should be staged over that time.

Recommended actions of the next 5 years, funding needed, and the source of funding is summarized in Figure 9-1.

Figure 9-1
Five-year Actions, Funding Needed, and Funding Source [UNDER DEVELOPMENT]

Immediate Funding Recommendations

Flood Management and Prevention

FP R1 Public and private agencies with infrastructure crossing the Delta should protect their assets from flooding and other natural disasters.

- The Public Utilities Commission should immediately commence formal hearings to impose a reasonable fee for flood and disaster prevention on regulated privately owned utilities with facilities located in the Delta. Publicly owned utilities should also be encouraged to develop similar fees. The Delta Stewardship Council, in consultation with the Public Utilities Commission and the Delta Protection Commission, should allocate these funds between State and local emergency response and flood protection entities in the Delta. If a new regional flood management agency is established by law, a portion of the local share would be allocated to that agency.
- The Public Utilities Commission should direct all regulated public utilities in their jurisdiction to immediately take steps to protect their facilities in the Delta from the consequences of a catastrophic failure of levees in the Delta, in order to minimize the impact on the State's economy.
- The Governor, by Executive Order, should direct State agencies with projects or infrastructure in the Delta to set aside a reasonable amount of funding to pay for flood protection and disaster prevention. The local share of these funds should be allocated as described above.

FR R2 A Delta Flood Risk Management Assessment District (as described for RR R9) should be created and initially funded with $10 million dollars to develop a benefit assessment plan for the Delta. The Council also recommends an additional $100 million for implementation of flood management improvements to be funded by Propositions 1E and 84 and matched up to 50 percent with non-State funding.

FP R3 The Legislature should appropriate $50 million of Proposition 1E funds to the Department of Water Resources and direct the Department of Water Resources to begin the acquisition of land and easements for the proposed San Joaquin/South Delta Flood Plain.

FP R4 Long-term non-General Fund and non-general obligation bonds stable funding should be established to support the Department of Water Resources' Delta Levees Subventions and Special Projects, FloodSAFE, and the Central Valley Flood Protection Board. Until this long-term funding is secure, the existing funding for the Delta Levees Subventions and Special Projects, FloodSAFE, and the Central Valley Flood Protection Board should be provided until the bonds funds are completely allocated by extending the deadline of July 1, 2013.

Financial Needs Assessment

FP R5 As part of the California Water Plan Update, the Department of Water Resources should prepare an assessment of the state's water infrastructure needs. This should include an assessment of the existing infrastructure's rehabilitation/replacement costs, as well as new improvements to meet projected demands over the planning period. The Department of Water Resources should consider a survey of agencies requesting information on small-scale projects (such as storage or conveyance) that allow the State to improve water supply reliability. In the future, a provision should be added to Urban Water Management Plans and Agricultural Water Management Plans to include information on potential local water reliability projects. This could form the basis of future State bond funding decisions and be used to inform the Legislature and the public of systemwide needs.

User Fees

FP R6 User Fees/Stressors Fees should support the coequal goals and the Delta Plan.

- The Legislature should authorize the Delta Stewardship Council to develop reasonable fees for beneficial uses and reasonable fees for those who stress the Delta ecosystem, and apply these fees to the operational costs of the Delta Stewardship Council, the Delta Conservancy, and the Delta Protection Commission to allow implementation of the Delta Plan. These fees would be developed in an open and transparent process. Operating costs of the Delta Stewardship Council, Delta Conservancy, and Delta Protection Commission should be pre-funded for a period of 10 years. As previously discussed, the annual budget of the new governance structure is approximately $50 million.

- Repayment of these costs, with interest, would be made annually commencing in 2022 from collected fees. Repayment could begin sooner if revenue from fees were available before 2022. Repayment should be completed no later than 2032.

- Revenue bond authority should be granted to implement the Delta Plan should a fiscal partner be found.

FP R7 The Legislature should amend AB 3030 and SB 1938 to allow local agencies to assess fees under Proposition 218.

Delta Conservancy

FP R8 Sufficient funding should be provided to the Delta Conservancy to commence implementation of the ecosystem restoration portion of the Delta Plan. This would include building the capabilities to administer and monitor the Conservancy's projects, as well as funding initial early start projects approved by the Conservancy Board. Funding should be no less than $50 million and should be allocated from existing bond funds, or from any new funds authorized by voters. Total dollar amount allocated for this purpose will depend on all available funding sources and may well exceed $50 million.

FP R9 The Delta Conservancy, in conjunction with other appropriate agencies, should investigate carbon offsets as a revenue source for Delta islands.

Delta Protection Commission

FP R10 The Legislature should consider appropriate funding for implementation of the Economic Sustainability Plan consistent with the Delta Plan.

Payment-in-Lieu-of-Taxes

FP R11 The Legislature should consider reasonable payments-in-lieu-of-taxes to replace lost local government revenues resulting from the removal of properties from property tax rolls for ecosystem habitat or water supply purposes in the Delta.

Near-term Funding Recommendations

Public Goods Charge

FP R12 Establish a statewide public goods charge (or broad-based user fee) for water. The Legislature should create a public goods charge (similar to the energy public goods charge created in 1996) on urban water users and agricultural users. This charge could provide for ecosystem costs that were once paid with general obligation bonds, or could be used for State water management costs such as developing the California Water Plan Update or science programs. Before the charge would be put in place, efforts would be necessary to determine administrative details of the program, including how the charge would be assessed, who would be assessed, what type of costs would be recovered, and how revenues collected would be applied. These efforts would take place in an open and transparent process.

Prioritized Levee Investments

FP R13 By January 2015, the Department of Water Resources should complete a Delta-wide comparative benefit/cost analysis based on recommendations for prioritized State investments for levee operations, maintenance, and improvements in the Delta developed in accordance with RR P4. Benefits should be specifically identifiable and calculable, and include an analysis of the value of lands behind levees. Such a report should be developed in collaboration with the Delta Stewardship Council, local agencies, federal agencies, and the proposed new Delta Flood Risk Management Assessment District.

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