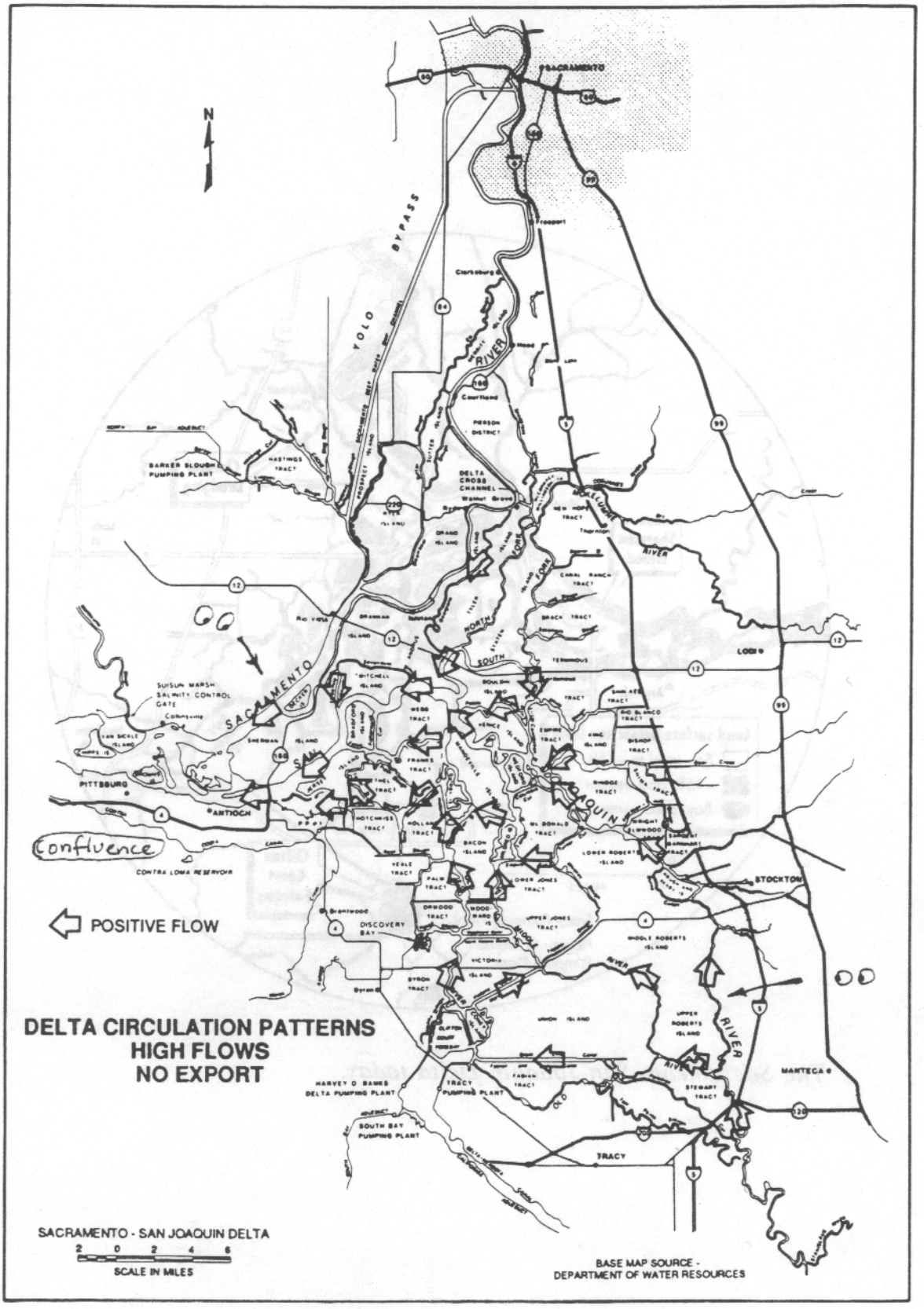
The Sacramento-San Joaquin Delta today.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PERSON DISTRICT
MIDDLE RIVER
NEW HOPE TRACT
Thornton
CANAL RANCH TRACT
BRACK TRACT
TERMINOUS
LODI
SUISUN MARSH SALINITY CONTROL GATE
Collinsville
SHERMAN ISLAND
SAN JOAQUIN
PITTSBURG
ANTIOCH
Confluence
CONTRA LOMA RESERVOIR
POSITIVE FLOW
DISCOVERY BAY
Brentwood
Byron
VICTORIA ISLAND
BYRON TRACT
HOTCHKISS TRACT
HOLLAND TRACT
BACON ISLAND
VERLE TRACT
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UPPER JONES TRACT
LOWER ROBERTS ISLAND
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MANTECA
TRACY
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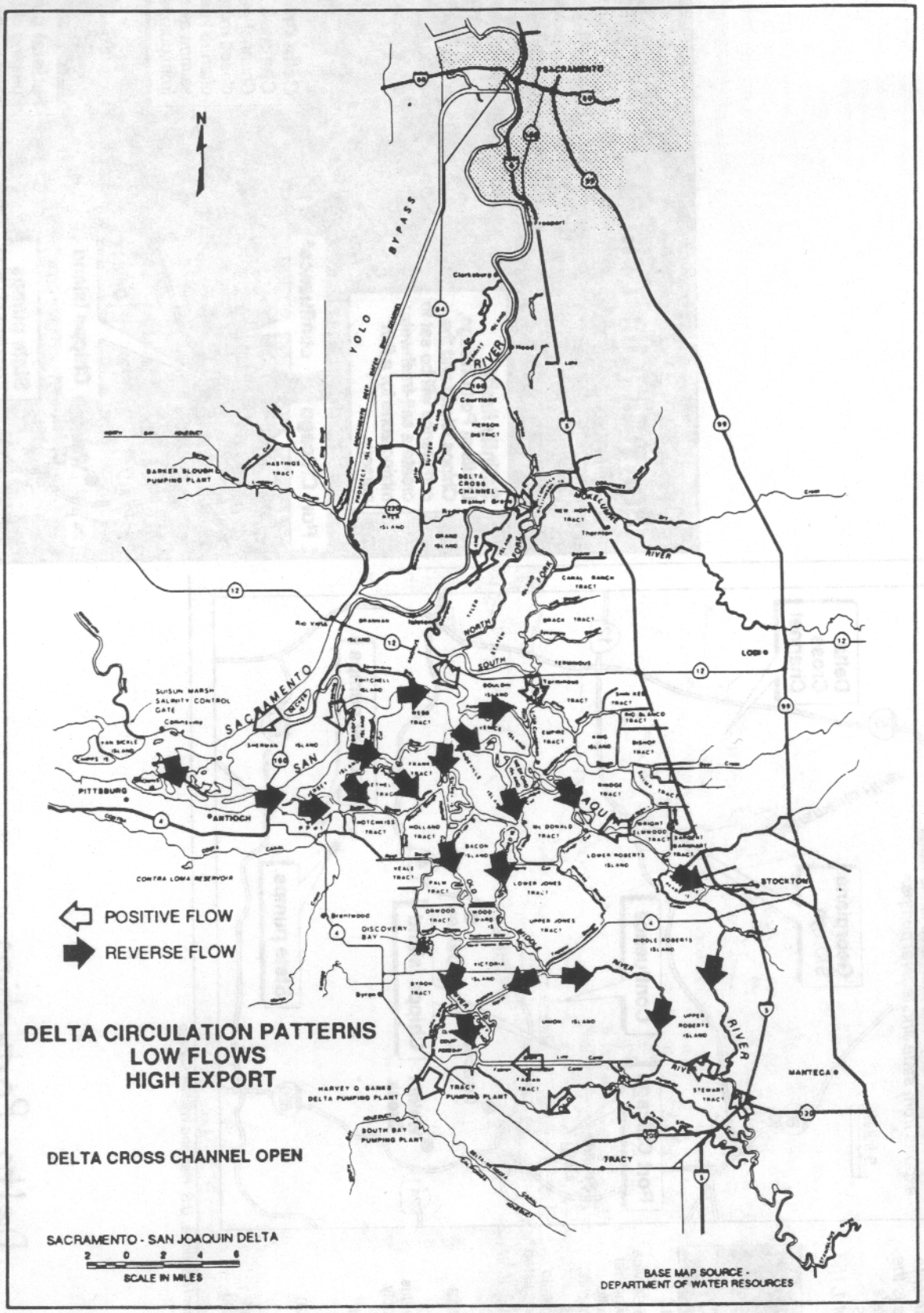
DEPARTMENT OF WATER RESOURCES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DELTA CROSS CHANNEL
MOKELUMNE RIVER
SACRAMENTO RIVER
SUISUN MARSH SALINITY CONTROL GATE
SAN JOAQUIN RIVER
PITTSBURG
ANTIOCH
CONTRA LOMA RESERVOIR
STOCKTON
LODI
MANTECA
TRACY
DISCOVERY BAY
HARVEY O BANKS DELTA PUMPING PLANT
TRACY PUMPING PLANT
SOUTH BAY PUMPING PLANT
POSITIVE FLOW
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DELTA CIRCULATION PATTERNS
LOW FLOWS
HIGH EXPORT
DELTA CROSS CHANNEL OPEN
SACRAMENTO - SAN JOAQUIN DELTA
2 0 2 4 6
SCALE IN MILES
BASE MAP SOURCE -
DEPARTMENT OF WATER RESOURCES

Preserving the Delta

The Delta of the Sacramento and San Joaquin rivers is the crossroads of California's water system. It covers 738,000 acres or about 1,153 square miles.

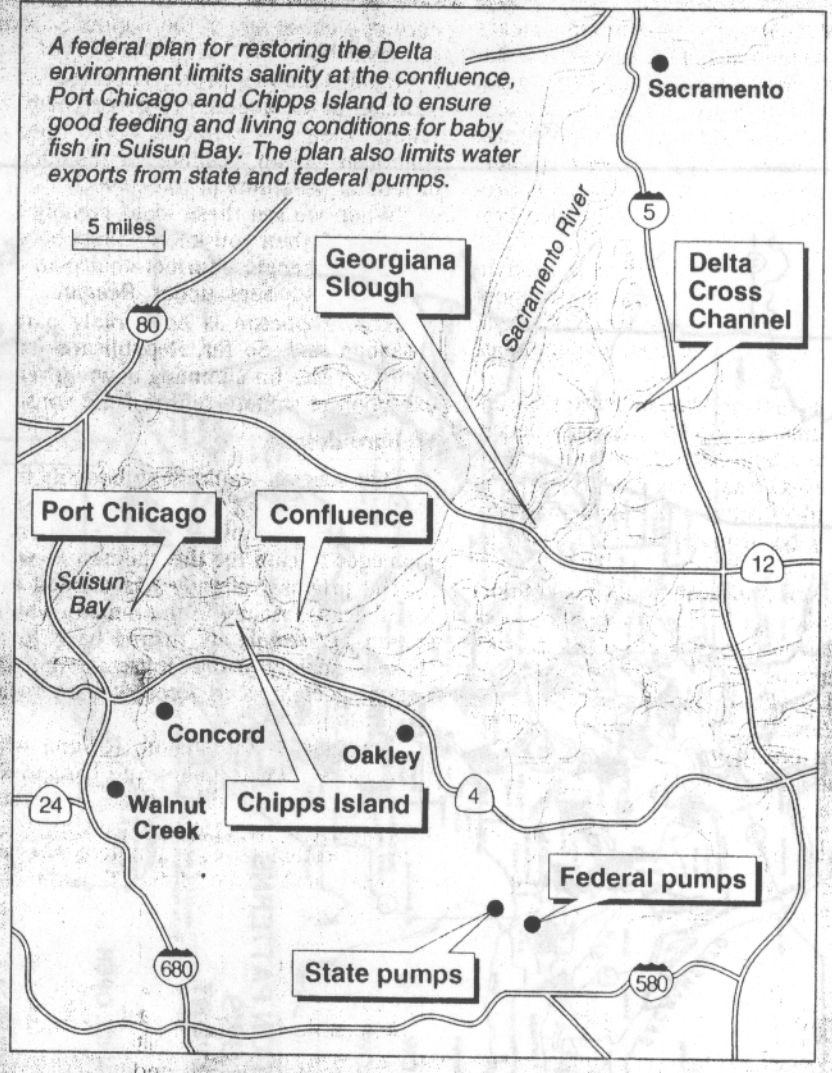
The Sacramento splittail

The U.S. Fish and Wildlife Service is to announce Thursday whether it will classify the Sacramento splittail as a threatened species. The Delta smelt is listed as threatened and the Sacramento winter-run chinook salmon is listed as endangered.

Importance of the Delta

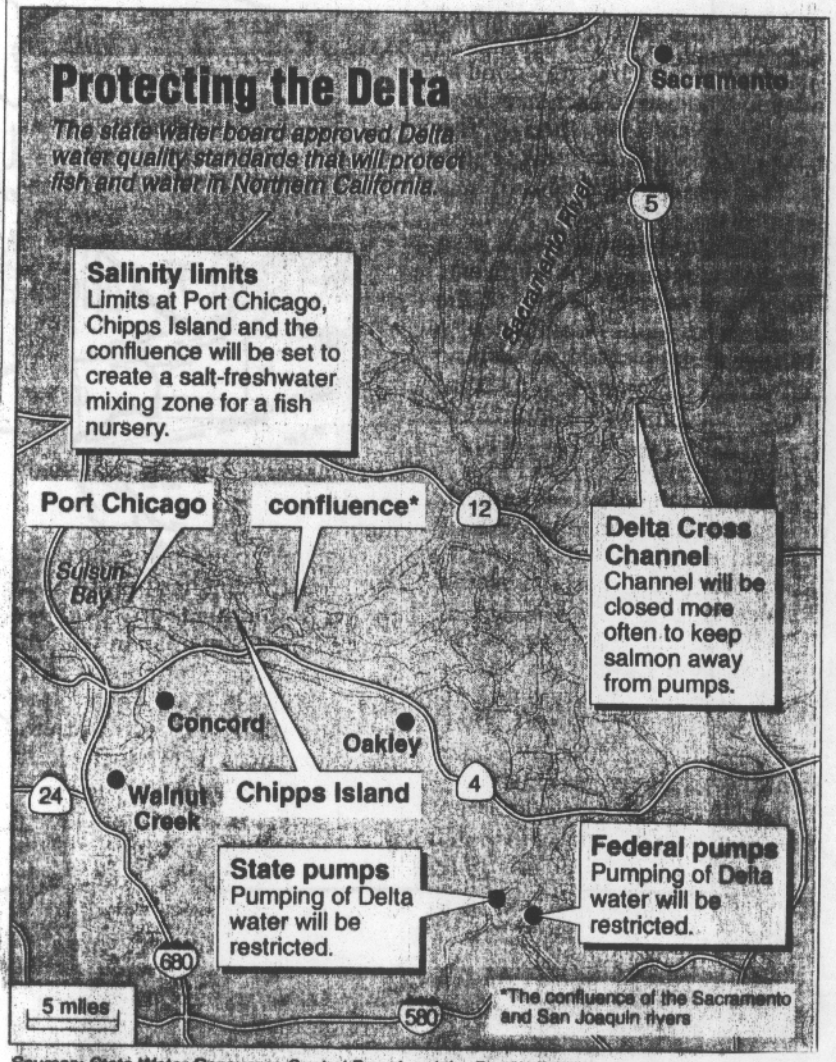
- Captures 47 percent of state's runoff and provides two-thirds of water supply
- Supplies 40 percent of state's drinking water
- Supports more than 120 species of fish
- Has the largest wetland habitat in western United States

A federal plan for restoring the Delta environment limits salinity at the confluence, Port Chicago and Chipps Island to ensure good feeding and living conditions for baby fish in Suisun Bay. The plan also limits water exports from state and federal pumps.



Sources: State Department of Water Resources, U.S. Fish and Wildlife Service

Delta Protection



Sources: State Water Resources Control Board and the Bay Institute

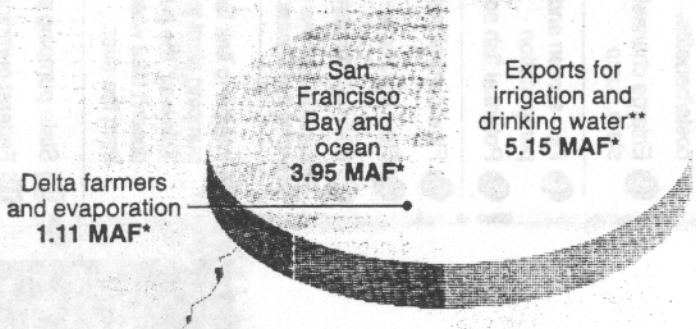
The Delta

San Francisco Bay and the Delta form the West Coast's largest estuary, the mixing ground for fresh water from rivers and salt water from the ocean. Man and nature rely on the giant Delta pool for many uses that sometimes conflict. The Delta supplies water to 20 million people and 4.5 million acres of farmland. The estuary also serves as California's largest fish habitat.

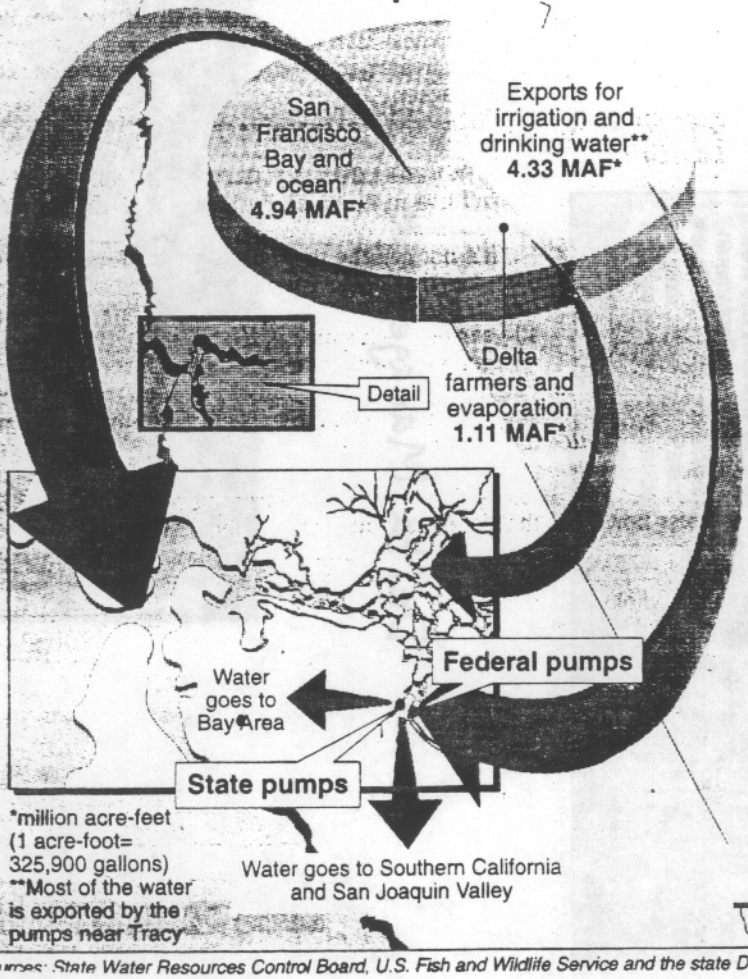
Delta water distribution

The federal Miller-Bradley law, new Delta water salinity standards and endangered fish protections will send more fresh water to the Bay. What would happen to Delta water in a dry year with and without new state and federal environmental protections:

Before new protections



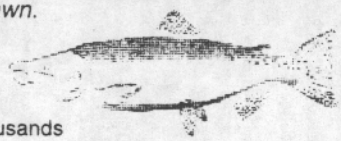
With new protections

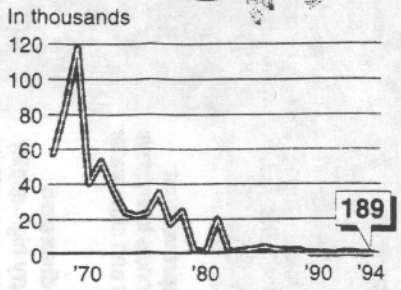


*million acre-feet (1 acre-foot= 325,900 gallons)
**Most of the water is exported by the pumps near Tracy

Winter-run chinook

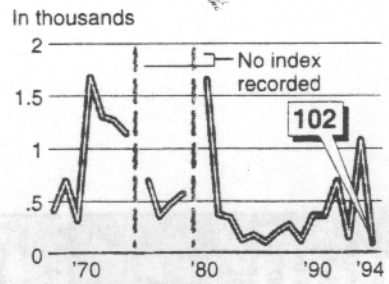
This salmon that spawns on the upper Sacramento River is a dramatic example of the decline. It is classified as endangered. Shown is the number of adult fish returning from the ocean to spawn.





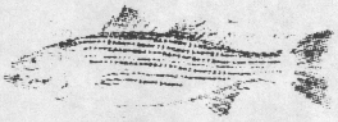
Delta smelt

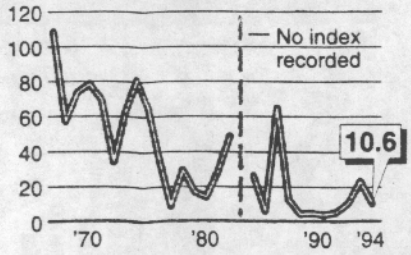
This tiny fish that lives in the Delta all year is listed as threatened. The index below shows the relative prevalence of baby smelt from year to year by netting samples at various Delta locations.



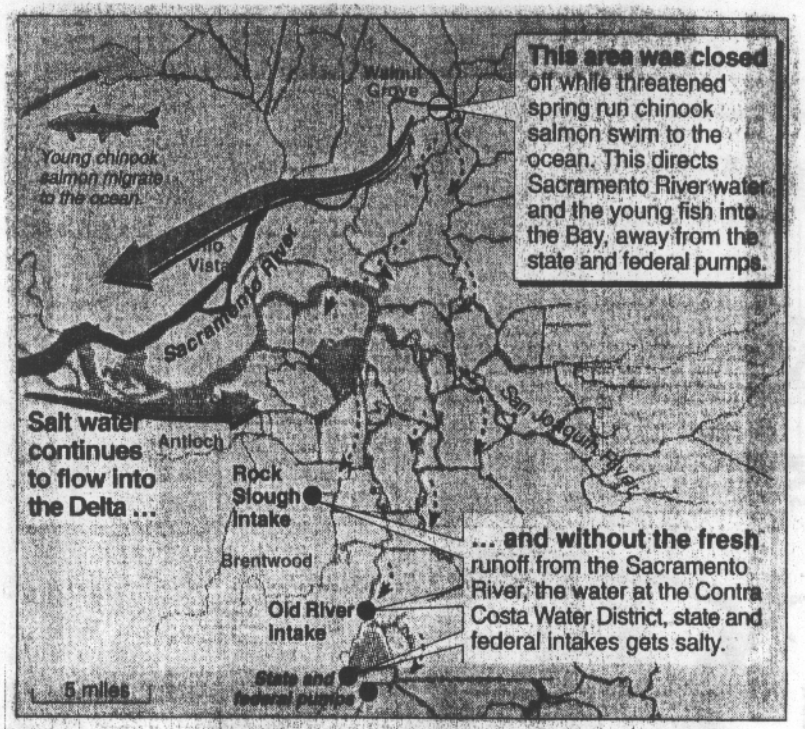
Striped bass

This popular imported sportfish spawns in the Delta and spends part of its life at sea. The index shows the relative prevalence of baby bass from year to year by netting samples at various Delta locations.

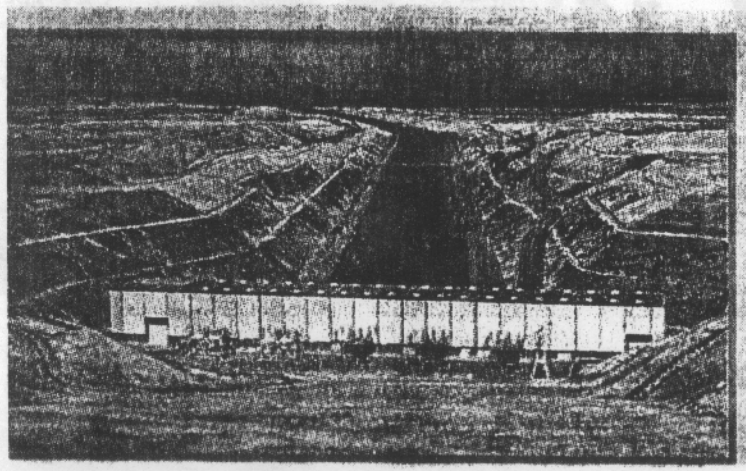




Sources: State Water Resources Control Board, U.S. Fish and Wildlife Service and the state Department of Fish and Game



Delta Management

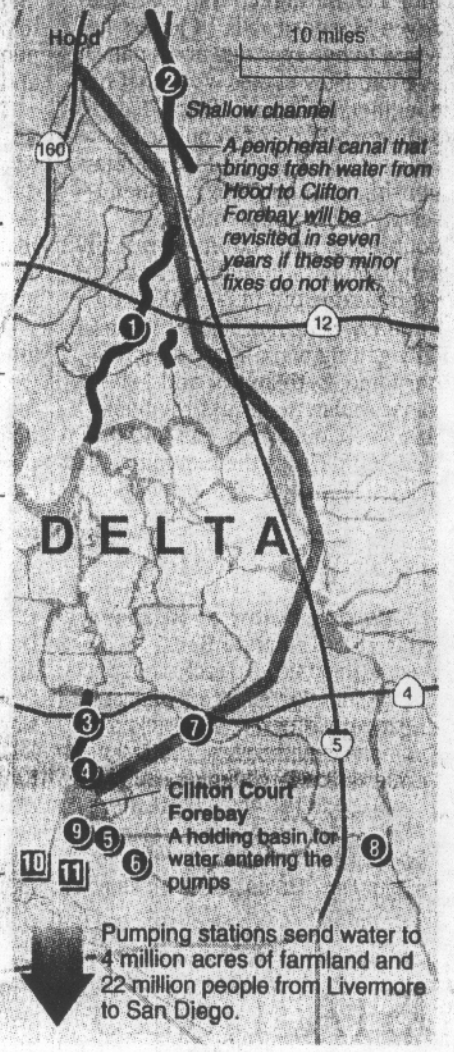


- Create environmental water account to buy and store water to help fish.
- Strengthen Delta island levees to reduce flood risks.
- Establish stricter rules on central and south Delta water quality.
- Spend $1 billion on water conservation and another $1 billion on water recycling.

1. **Habitat improvement** Widen channels to improve fish habitat and slow water flow.
2. **Screened diversion** It would carry high-quality water into the central Delta. CalFed will study the costs/benefits.
3. Enlarge channel that feeds state pump
4. Fish screen and pump station
5. Potential fish screen
6. Flow control barrier
7. Flow control barrier
8. Fish control barrier

Seasonal shutdowns would allow migrating fish to pass.

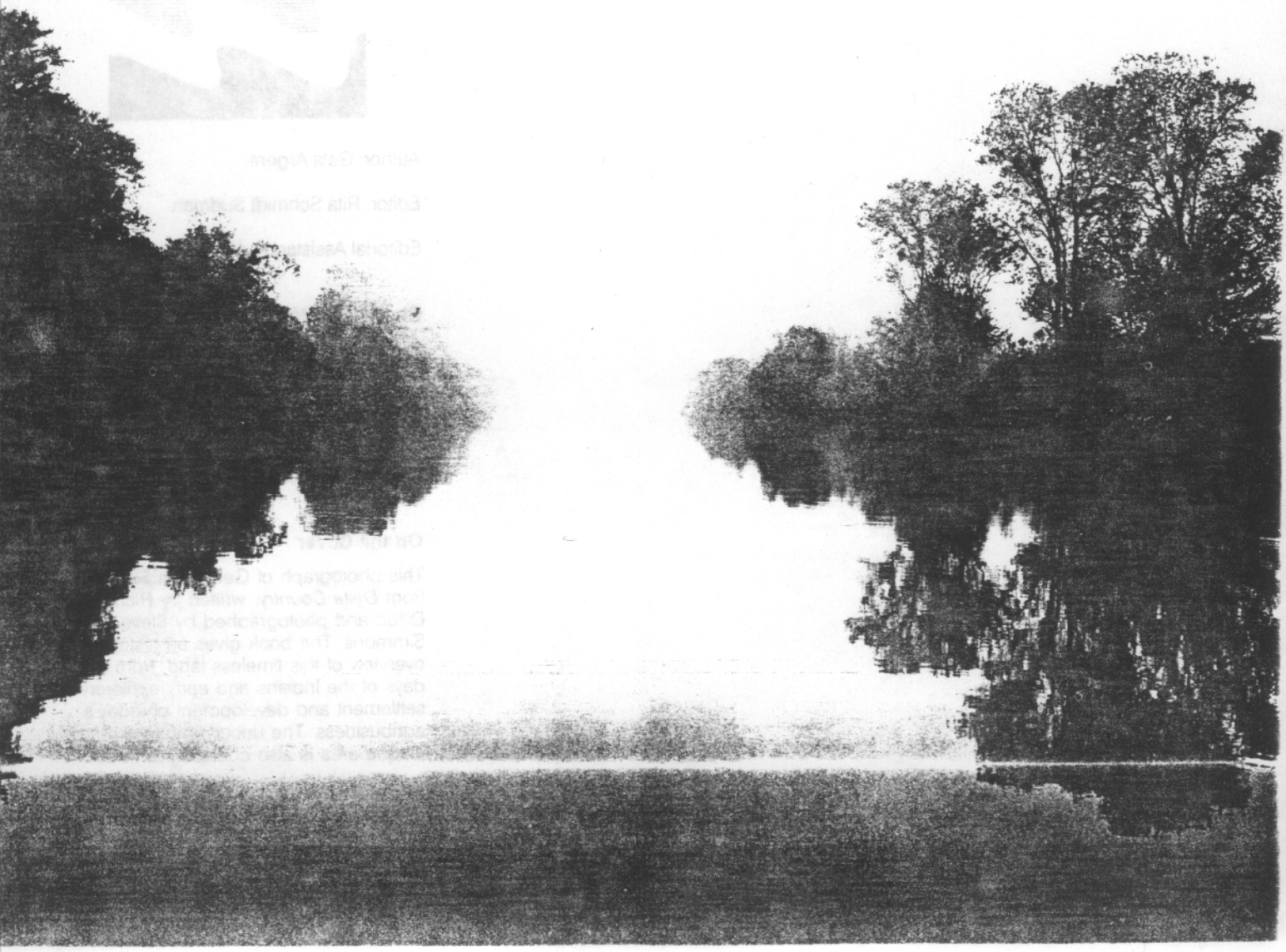
9. Intertie to link federal pumping plant to Forebay. This way, the pump doesn't take water straight from the river.
10. State pumping plant
11. Federal pumping plant



Source: CALFED

Layperson's Guide to the Delta

Prepared by the Water Education Foundation



Contents

The Layperson's Guide to California Water is prepared and distributed by the Water Education Foundation as a public information tool. It is part of a series of Layperson's Guides which explore pertinent water issues in an objective, easy-to-understand manner.

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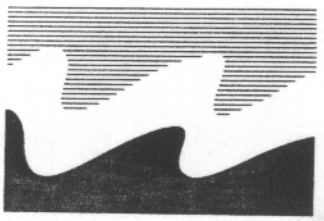

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U.S. Bureau of Reclamation

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California Department of Water Resources

On the Cover

This photograph of Georgiana Slough is from *Delta Country,* written by Richard Dillon and photographed by Steve Simmons. The book gives an historical overview of this timeless land, from the days of the Indians and early explorers to settlement and development of today's agribusiness. The uncertain future of this unique area is also considered.

1990

Introduction

Flowing south, fed by northern Sierra Nevada runoff, the Sacramento River meets the northbound San Joaquin River to form the Sacramento-San Joaquin Delta in the Central Valley. The two rivers mingle with smaller rivers to form a 700-mile maze of rivers and sloughs surrounding 57 islands, most of them now agricultural.

Their combined freshwater flows then roll on through the Carquinez Strait, a narrow break in the Coast Range, and on into San Francisco Bay's northern arm. Suisun Marsh and adjoining bays are the brackish transition between the fresh water flowing from the rivers and the salt water of the Bay.

The area has always been at the mercy of river flows and tides. Before humans changed the Delta environment, salty ocean water from San Francisco Bay crept up Delta channels during dry summers, when mountain runoff ebbed. Then, during the winter, heavy runoff from the mountains kept the sea water at bay. The early diaries of Spanish explorers indicate that the salt line moved according to the relative dryness of the year. A great flood in the 1860s resulted in a substantially freshwater Bay. Conversely, salt water reached as far as Sacramento in the 1930s. Today, upstream dams including Oroville and giant Shasta help control saltwater intrusion by releasing water into the Delta system during dry times.

The Delta, as we know it, is largely a human invention. Early explorers found a vast mosquito-infested tidal marshland covered with bullrushes called tules. Later, trappers took advantage of the abundant wildlife. They were followed by farmers, some of them unsuccessful gold-seekers, who discovered in the Delta wealth of another sort: fertile soil. Over a century ago, these farmers, using Chinese laborers, began building a network of levees to drain and "reclaim" this fertile soil. Progressively higher levees were built to keep the surrounding waters out, lands were pumped dry, and what once was uncontrolled marshland was transformed into productive farmland. By 1930 more than 1,000 miles of levees surrounded close to 500,000 acres of farmland.

No other single area is quite as crucial to the state's overall water picture as the Delta—it forms the cornerstone of California's two largest projects: the State Water Project (SWP) and federal Central Valley Project (CVP). Its existing channels are used to transport water to the federal and state pumps both in the western and southwestern Delta. From the Delta, water is channeled south and west through canals and aqueducts to the north and south Bay areas, Contra Costa County, agriculture-rich San Joaquin Valley and to over 16 million urban Californians, mostly in southern California.

Water that would otherwise flow into the Delta is also diverted upstream by local users and some exporters such as the East Bay Municipal Utility District on the Mokelumne River and San Francisco's Hetch Hetchy project on the Tuolumne River.

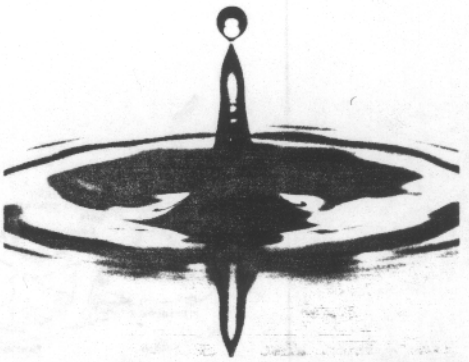
Water also flows west through the Delta and San Francisco Bay to the ocean, partially holding back the salt waters of the Bay and protecting water quality for urban uses, recreation, fish and wildlife and Delta agriculture. With brackish marshes and San Francisco Bay next door, the Delta forms part of an estuary and an important habitat for millions of migrating wildfowl, fish and other fauna and flora.

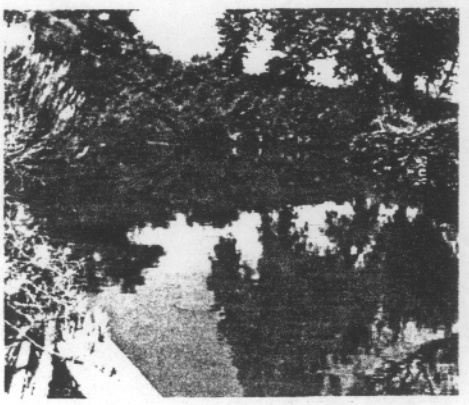
Yet above the picturesque waters of the estuary a decades-long tempest over the distribution of its waters has brewed. Comprising just one percent of California's total area, the Delta is at the heart of both the state's water supply system and water controversies, providing almost 55 percent of the state's water supply, including 40 percent of its drinking water.

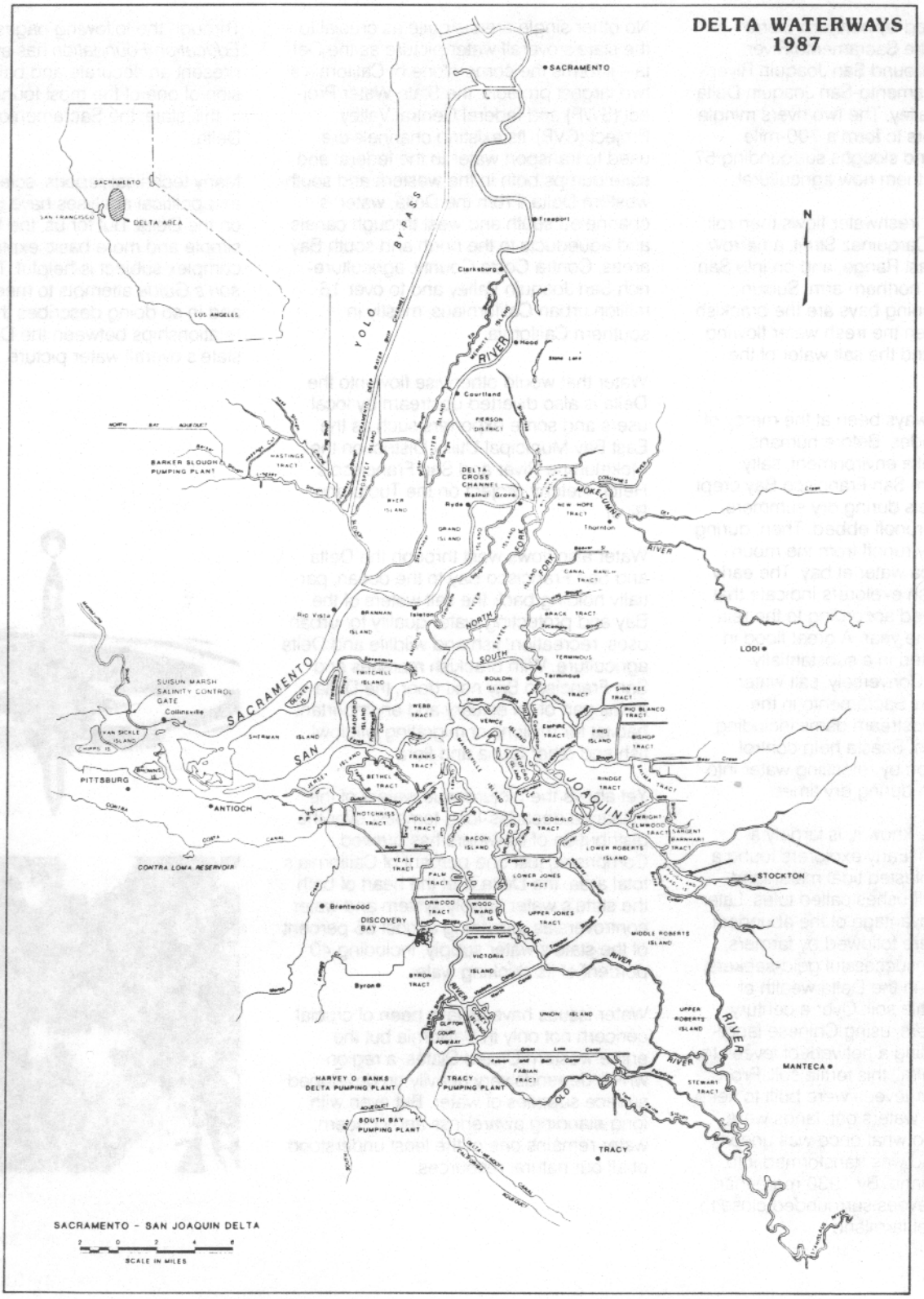
Water issues have always been of crucial concern not only in California but the entire western United States, a region which depends very heavily on developed surface supplies of water. But even with long-standing awareness and concern, water remains one of the least understood of all our natural resources.

Through the following pages, the *Water Education Foundation* has attempted to present an accurate and balanced discussion of one of the most fought-over areas in this state, the Sacramento-San Joaquin Delta.

Many technical reports, scientific studies and political analyses have been prepared on the Delta. But for us, the laypeople, a simple and more basic explanation of this complex subject is helpful. This *Layperson's Guide* attempts to meet that need and in so doing describes the important relationships between the Delta and the state's overall water picture.






DELTA WATERWAYS
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DELTA AREA
SAN FRANCISCO
LOS ANGELES
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YOLO BYPASS
RIVER
Freeport
Clarksburg
Hood
Courtland
PIERSON DISTRICT
DELTA CROSS CHANNEL
Walnut Grove
Ryde
RIVER ISLAND
GRAND ISLAND
NORTH FORK
SOUTH FORK
MOKELUMNE RIVER
NEW HOPE TRACT
Thornton
CANAL RANCH TRACT
BRACK TRACT
LODI
TERMINOUS
BOULDIN ISLAND
SHIN KEE TRACT
RIO BLANCO TRACT
KING ISLAND
BISHOP TRACT
VENICE ISLAND
EMPIRE TRACT
Rio Vista
BRANNAN ISLAND
Isleton
TWITCHELL ISLAND
SUISUN MARSH SALINITY CONTROL GATE
Collinsville
SACRAMENTO
SAN JOAQUIN
WEBB TRACT
FRANKS TRACT
BETHEL TRACT
VAN SICKLE ISLAND
SHERMAN ISLAND
PITTSBURG
ANTIOCH
HOTCHKISS TRACT
HOLLAND TRACT
MANDEVILLE ISLAND
MC DONALD TRACT
RINDGE TRACT
WRIGHT ELMWOOD TRACT
NARGENT RANNAHAN TRACT
LOWER ROBERTS ISLAND
BACON ISLAND
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PALM TRACT
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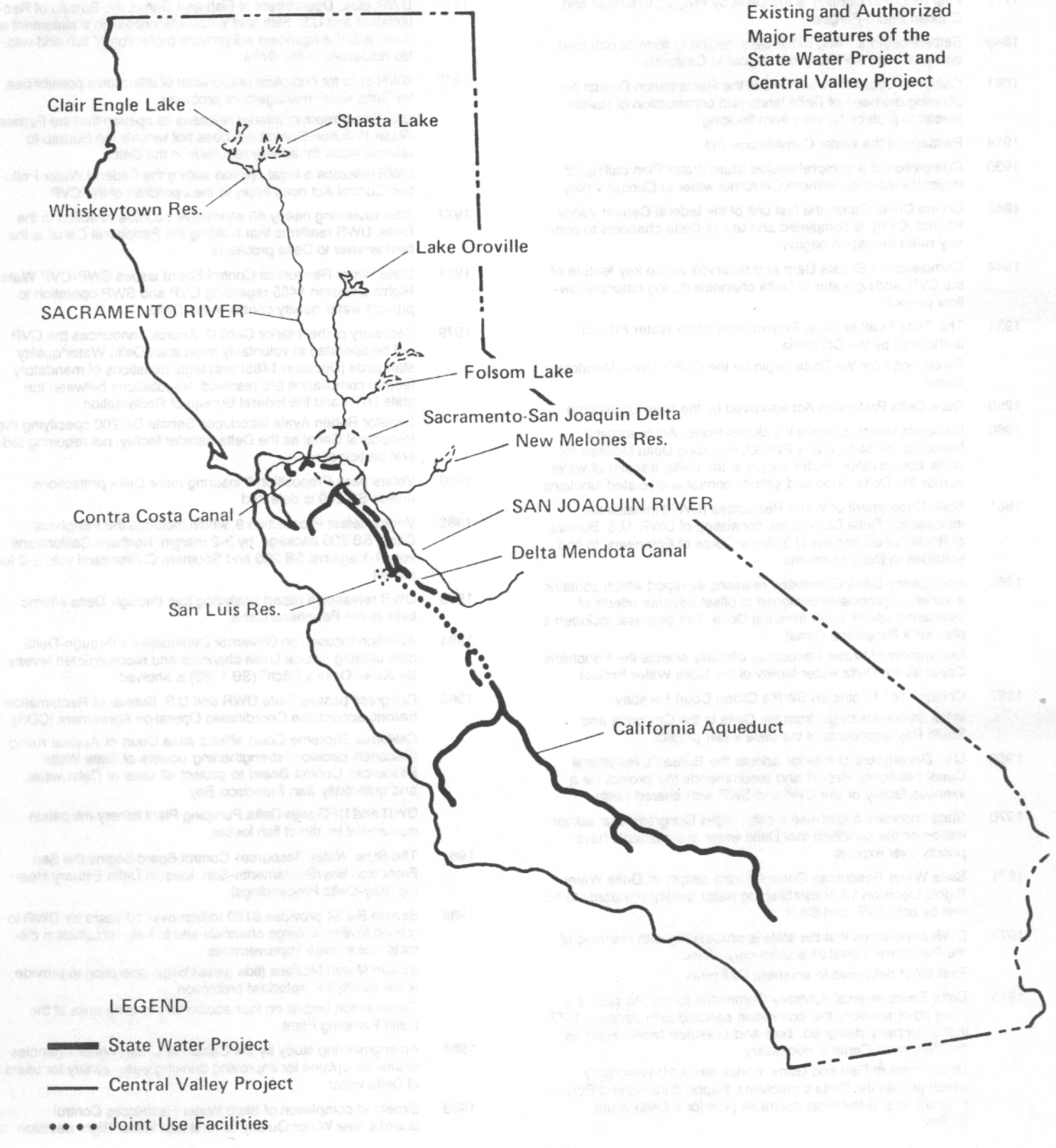
MIDDLE ROBERTS ISLAND
VICTORIA ISLAND
Byron
BYRON TRACT
MIDDLE RIVER
OLD RIVER
UNION ISLAND
UPPER ROBERTS ISLAND
CLIFTON COURT FOREBAY
HARVEY O. BANKS DELTA PUMPING PLANT
TRACY PUMPING PLANT
FABIAN TRACT
STEWART TRACT
MANTECA
SOUTH BAY PUMPING PLANT
TRACY
BARKER SLOUGH PUMPING PLANT
HASTINGS TRACT
SACRAMENTO - SAN JOAQUIN DELTA
SCALE IN MILES

Existing and Authorized Major Features of the State Water Project and Central Valley Project



Chronology

1772 First recorded sighting of the Delta by Fray Juan Crespi and Captain Pedro Farges

1849 Settlers begin arriving in the Delta region to farm its rich land, one year after the discovery of gold in California

1861 California Legislature authorizes the Reclamation District Act allowing drainage of Delta lands and construction of sturdier levees to protect the area from flooding

1914 Passage of the Water Commission Act

1930 Completion of a comprehensive State Water Plan calling for major transfers of northern California water to Central Valley

1940 Contra Costa Canal, the first unit of the federal Central Valley Project (CVP), is completed and use of Delta channels to convey water for export begins

1944 Completion of Shasta Dam and reservoir as the key feature of the CVP, adding water to Delta channels during naturally low-flow periods

1951 The State Feather River Project (now State Water Project) authorized by the California

Diversions from the Delta begin for the CVP's Delta-Mendota Canal

1959 State Delta Protection Act approved by the state Legislature

1960 California voters approve the Burns-Porter Act to assist in financing the State Water Project, including Delta facilities for water conservation, water supply in the Delta, transfer of water across the Delta, flood and salinity control and related functions

1961 State Department of Water Resources (DWR) initiates the Interagency Delta Committee, consisting of DWR, U.S. Bureau of Reclamation and the U.S. Army Corps of Engineers, to find solutions to Delta problems

1965 Interagency Delta Committee releases its report which contains a variety of proposals designed to offset adverse effects of increasing use of water from the Delta. The proposal included a plan for a Peripheral Canal

Department of Water Resources officially selects the Peripheral Canal as the Delta water facility of the State Water Project

1967 Construction begins on SWP's Clifton Court Forebay

Initial diversions begin from the Delta to the California and South Bay aqueducts of the state water project

1969 U.S. Department of Interior adopts the Bureau's Peripheral Canal Feasibility Report and recommends the project be a joint-use facility of the CVP and SWP with shared costs

1970 State endorses a joint-use facility, urges Congressional authorization on the condition that Delta water requirements have priority over exports

1971 State Water Resources Control Board adopts its Delta Water Rights Decision 1379 establishing water quality standards to be met by both CVP and SWP

1972 DWR announces that the state is proceeding with planning of the Peripheral Canal as a state-only project

First SWP deliveries to southern California

1973 Delta Environmental Advisory Committee forms. As part of a three-point solution, the committee concludes in January 1977 that a properly designed, built and operated facility such as the Peripheral Canal is necessary

Department of Fish and Game concludes a 10-year study which probes the Delta's problems. Report concludes a Peripheral Canal is the most desirable plan for a Delta water facilitiy

1974 DWR, state Department of Fish and Game, the Bureau of Reclamation and U.S. Fish and Wildlife Service sign a statement of intent that the agencies will provide protection of fish and wildlife resources in the Delta

1975 DWR calls for complete reappraisal of alternative possibilities for Delta water management problems

U.S. Department of Interior releases its opinion that the Federal Water Pollution Control Act does not require the Bureau to release water for salinity repulsion in the Delta

DWR releases a legal opinion stating the Federal Water Pollution Control Act does apply to the operation of the CVP

1977 After reviewing nearly 40 alternative courses of action in the Delta, DWR reaffirms that building the Peripheral Canal is the best answer to Delta problems

1978 State Water Resources Control Board issues SWP-CVP Water Rights Decision 1485 regarding CVP and SWP operation to provide water quality control in the Delta

1979 Secretary of the Interior Cecil D. Andrus announces the CVP will be operated to voluntarily meet state Delta Water quality standards (Decision 1485) until legal questions of mandatory federal compliance are resolved. Negotiations between the state DWR and the federal Bureau of Reclamation

Senator Ruben Ayala introduces Senate Bill 200 specifying the Peripheral Canal as the Delta transfer facility, not requiring federal participation

1980 Voters pass Proposition 8 insuring more Delta protections unless SB 200 is defeated

1982 Voters defeat Proposition 9, which includes the Peripheral Canal SB 200 package, by 3-2 margin. Northern Californians vote 9-1 against SB 200 and Southern Californians vote 3-2 for the bill

1983 DWR releases a report analyzing four through-Delta alternatives to the Peripheral Canal

1984 Attention focuses on Governor Deukmejian's through-Delta plan utilizing natural Delta channels and reconstructed levees. By June "Duke's Ditch" (SB 1369) is shelved

1986 Congress passes State DWR and U.S. Bureau of Reclamation historic accord, the Coordinated Operation Agreement (COA)

California Supreme Court affirms state Court of Appeal ruling (Racanelli decision) strengthening powers of State Water Resources Control Board to protect all uses of Delta water, and potentially San Francisco Bay

DWR and DFG sign Delta Pumping Plant fishery mitigation agreement for direct fish losses

1987 The State Water Resources Control Board begins the San Francisco Bay/Sacramento-San Joaquin Delta Estuary Hearing (Bay-Delta Proceedings)

1988 Senate Bill 34 provides $120 million over 10 years for DWR to rebuild levees, enlarge channels and to help reclamation districts make levée improvements

Suisun Marsh facilities (tide gates) begin operation to provide water quality for waterfowl protection

Construction begins on four additional pumping units at the Delta Pumping Plant

1988 An engineering study by the California Urban Water Agencies examines options for improving drinking water quality for users of Delta water

1993 Expected completion of State Water Resources Control Board's new Water Quality Control and Water Right decision

Background

California is a land of great diversity. Within its boundaries lie vast mountain ranges, sprawling deserts, miles of picturesque coastlines and major urban areas. This state is the world's leading agricultural producer and simultaneously is home to more than 28 million residents, making it the most populous state in the nation.

No other single resource has been more important to the development of California than its water. California's natural water picture is also a study in contrasts. Two-thirds of the state's water originates north of Sacramento, while 70 percent of its users live south of the Capitol City. Most of the state's rainfall occurs in winter and spring while peak demand occurs in the hot summer months. This is the setting for California's water story. As *Time* magazine once noted, "California has everything - usually in the wrong place."

Adjusting water distribution in time and place is at the heart of California's water development program. Winter and spring flows are stored in reservoirs for use during the summer growing season, and the excess runoff of wet years is captured for use during drought periods. Large amounts of runoff are stored in ground water basins which serve as a mechanism for balancing irregularities in water supply.

To regulate the distribution of water, major water storage and transportation facilities have been built in California. The Delta is at the heart of the two major projects in California, the State Water Project (SWP) and the federal Central Valley Project (CVP).

The Sacramento-San Joaquin Delta lies at the center of almost all discussions of California's future water supply. What could possibly be so important about the Delta? Why should such a small area, 700,000 acres in total, be embroiled in such controversy and have such an effect on the state's future?

The Delta lies in that area where the Sacramento and San Joaquin Rivers converge to discharge over 40 percent of the state's total runoff into San Francisco Bay. In addition, it is the low point of the Sacramento-San Joaquin Valley through which water flows before going to the ocean. Consequently, whatever affects the Delta affects large portions of northern, central and southern California.

Problems, whether environmental, political or engineering in nature, are nothing new to the Delta region. Since the first settlers arrived in the area, the Delta has simultaneously offered a fertile, rich environment and seemingly insurmountable problems.

Legend has it that the first explorers to set eyes on the vast tidal marshland now known as the Sacramento-San Joaquin Delta were two soldiers from the party of the explorer Hernando Cortez in 1520. Mosquito-infested and tule-covered, the Delta was a rare sight to these early day conquistadors.

In 1771, Pedro Farges first recorded sighting the Delta. In 1776, Juan Bautista de Anza gazed upon the immense expanse of waterways and tules from the foothills overlooking the Carquinez Strait.

Farges and de Anza were the first to provide written accounts of the abundance of wildlife in the Delta region. Later, in 1827, American adventurer Jedediah Smith provided detailed accounts of trapping and hunting in the area. Smith trapped beaver, otter and mink on the periphery of the giant marsh and blazed a trail north to Fort Vancouver, where his tales of the wealth of animal pelts yielded by the Delta were heard with keen interest by the Hudson Bay Company.

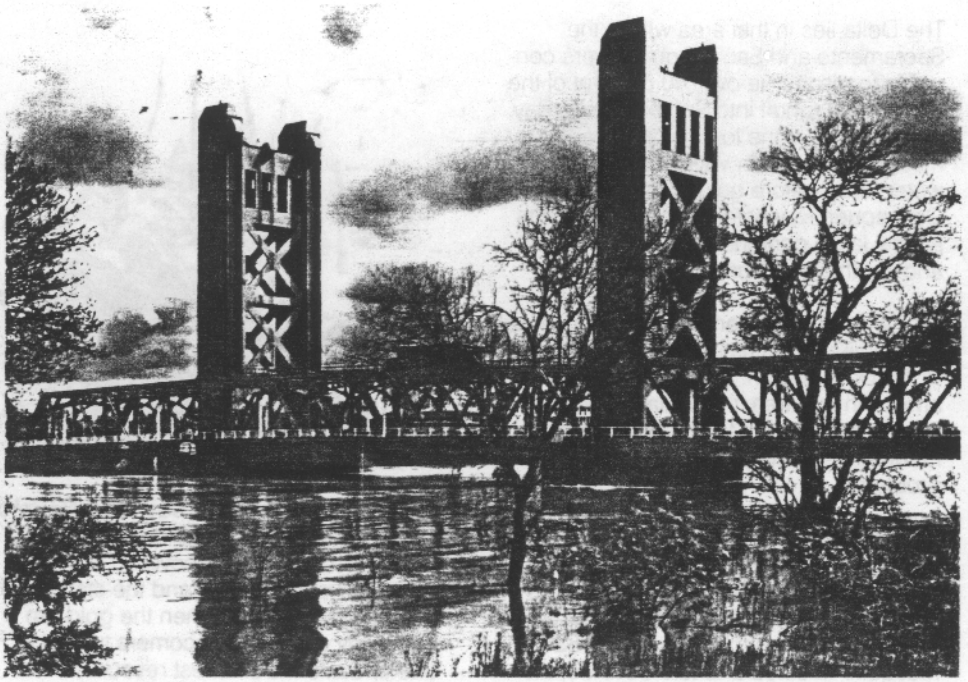
During the next 15 years, trappers were a familiar sight in the Delta. Seagoing ships navigated the Sacramento and San Joaquin rivers to bring in supplies and to take out tallow and an ever increasing number of animal skins.

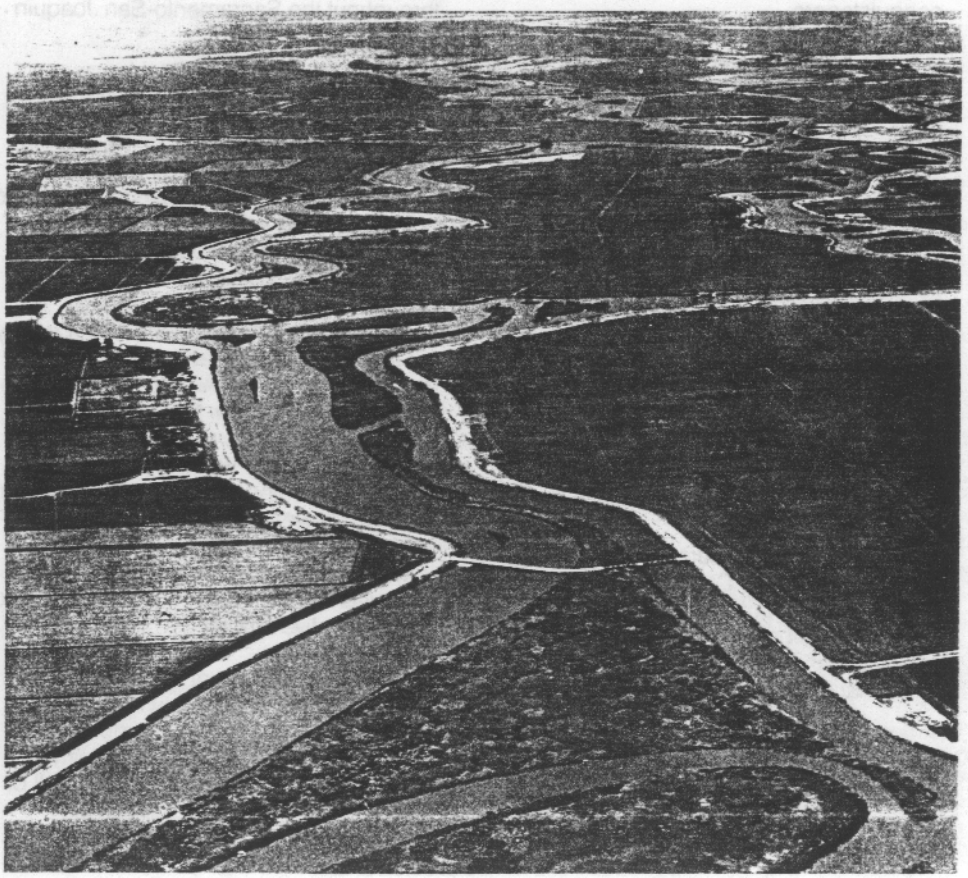
Growth during this time was characterized as steady and slow, but in 1848 the trend changed. Gold was discovered in the Sierra Nevada foothills, and the stampede to California was on. When the gold ran thin many of these newcomers turned to one of California's richest resources - its fertile soil. They settled in large numbers throughout the Sacramento-San Joaquin Valley region.

But farming in the Delta wasn't without serious perils. The land was constantly threatened by flooding. Farmers and Chinese laborers began building series of small levees - called shoestring levees - to hold back flood water. Their efforts were mostly futile, as the levees were able to hold back little more than a high tide.

During the second half of the 19th century great strides were taken to convert the marshlands of the Delta into primarily an agricultural area. New techniques were tried as part of these reclamation efforts. Mechanical power was applied to dredging, levee building, ditching and land clearing. Pumps were introduced in 1876 to control water levels on reclaimed land. Levee-building projects ultimately turned what was once an uncontrolled marshland into productive farmland.

By 1880, the amount of reclaimed area rose to 100,000 acres; by 1900, it had reached 250,000 acres. And during the next 30 years, the amount of reclaimed land grew to almost 450,000 acres, all of this accomplished by local interests.





At the same time successful farming was burgeoning in the Delta, new species of fish and game were introduced into the area. Striped bass, American shad and white catfish were brought to the Delta. Game birds, imported varieties of orchard and field crops and new breeds of livestock also were introduced.

Ironically, though, man's attempts to harness the natural resources of California were causing problems of equal significance to his accomplishments. Starting in the 1860s, the Delta suffered enormous damage from the vast amounts of sediment and debris swept downstream from hydraulic mining in the mountains far up the Sacramento and San Joaquin rivers. Even after an 1884 federal court injunction halted these mining operations, silt continued to settle in the Delta, altering the navigable channels and greatly hindering shipping activity.

Deposited silt also reduces the Delta channels' carrying capacity, increasing the dangers of flooding when the rivers rise. Over the years, these channels were dredged to improve navigability and reduce flooding. (Today, silt deposits, sometimes accelerated by human activities, are still a problem.) By the turn of the century, because of low Delta outflows in dry years, saltwater intrusion into the Delta from the ocean became an increasing problem. In contrast, high water levels during the winter season and occasional high tides caused many of the Delta islands to flood.

High flood waters on the Sacramento River also caused problems, and in 1880 the State Engineer devised an integrated flood control plan which eventually came to include a system of levees and bypasses transporting floodwaters past protected areas. After a series of flood years in the Sacramento Valley, Congressional authority for the Sacramento Flood Control Project by the U.S. Army Corps of Engineers was finally granted in 1917, and the project was completed in 1960.

In 1921, the state legislature authorized an extensive investigation by the State Engineer to develop a comprehensive water plan for California. For the next 15 years, federal, state and local interests wrangled over how to best supply California with a dependable source of water and reduce salinity intrusion into the Delta. The state Central Valley Project Act, passed and approved by voters in 1933, authorized building reservoirs to supply water and provide a hydraulic barrier to repel seawater intrusion, but could not be financed by the state during the depression. In 1937, the Department of the Interior was authorized by the Rivers and Harbors Act to construct a federal Central Valley Project.

The use of the Delta channels as conduits for transporting water began in 1940 with completion of the Contra Costa Canal, the first unit of the CVP. With the completion in 1951 of the Delta-Mendota Canal—part of the CVP, which begins at Trinity Dam and ends in the lower San Joaquin Valley—the Delta became part of a vast water export system. Also in 1951, the Delta Cross Channel was constructed near Walnut Grove in the North Delta to facilitate favorable flow patterns for water transfer across the Delta by the CVP.

Also in 1951, the state authorized the Feather River Project and Delta Diversions Projects, later known as the State Water Project (SWP), and in 1960 the Burns-Porter Act defined and funded the facilities of the SWP.

In 1967, the state also began pumping water from the Delta into its California Aqueduct, part of the SWP which today serves the north and south Bay area and the San Joaquin Valley, as well as much of the densely populated Southland.

By 1975, the combined deliveries of the SWP and CVP, both north and south of the Delta, had grown to about 4.8 million acre-feet; by 1988, the total reached around 10.6 million acre-feet. Prior to the CVP and SWP, many of the state's ground water basins were overdrafted; the projects helped alleviate this problem by substituting surface water for ground water mining.

The Delta Today

By definition, an estuary is an interconnected area where tidal and river currents meet, and where salinity (saltiness) is between the extremes of ocean and fresh waters. The Delta, Suisun Bay, San Pablo Bay and south and central San Francisco Bay form such an estuary.

The estuary is hydrologically complex. The Sacramento and San Joaquin rivers are the major source of freshwater inflow to the estuary, with the Sacramento River the largest contributor. The area where river flows and tidal flows interact most intensively, known as the "entrapment zone," is of ecological significance to many plants and animals residing in or migrating through the estuary. The location of the entrapment zone moves back and forth from the Delta to near San Pablo Bay depending on Delta outflow and the ocean tides.

Downstream of Suisun Bay, the estuary is more subject to daily tidal forces, although moderate to high seasonal freshwater flows and prevailing wind patterns still affect circulation patterns.

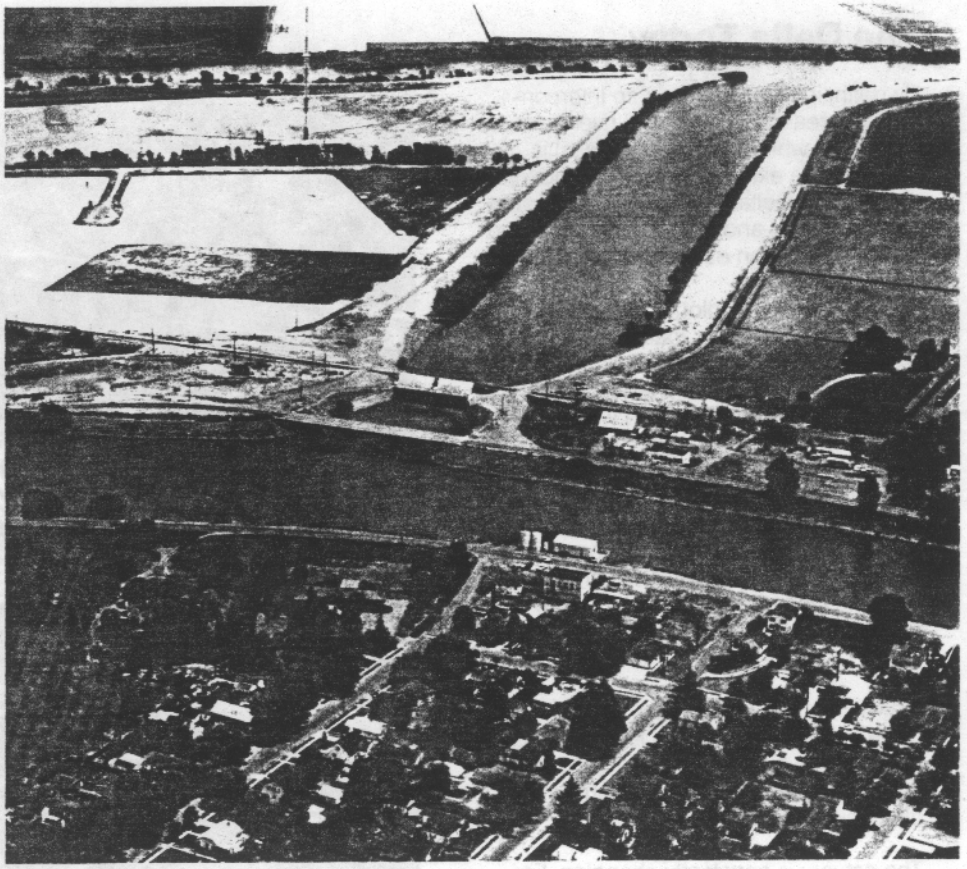
The estuary is constantly changing. For instance, according to the Bay Conservation and Development Commission, San Francisco Bay has shrunk since 1850 from 780 to 550 square miles due to the construction of dikes and the filling of low-lying areas. Also, the South Bay was plagued with fish kills and algal blooms in years prior to the passage of the federal Clean Water Act in 1972. Since the passage of the act, investments in the treatment and disposal of municipal sewage have greatly reduced these problems.

Today, the estuary is connected not only ecologically, but also through the various uses made of it. The Delta contains numerous below-sea-level islands protected by levees. The surrounding levees and channels, and the islands themselves, serve as passageways for migrating fish and provide valuable habitat for a wide variety of fish and wildlife. The leveed islands are also productive agricultural lands, generating an average gross crop value of $375 million, according to the Department of Water Resources (DWR) *Sacramento-San Joaquin Delta Atlas*.

The Delta also supports over 8.5 million user-days of recreation annually, from boating and waterskiing to sport fishing, which contribute to the area's economy.

Perhaps one of the biggest obstacles to resolution of the Delta's myriad problems is the enormous complexity of the issues and the way in which each fits tightly with the other. Each of the Delta's problems, be it preserving the fisheries, maintaining water quality levels, managing Delta levees or making sure enough water is present for meeting agricultural and urban needs within the state, brings with it opposing points of view, special interest groups and new conflicts. For the most part, past studies and programs have taken a piecemeal approach to exploring and managing the Delta's—and the estuary's—problems. It is only recently that studies and programs, discussed later in this Guide, have begun to address the estuary as a whole rather than its component areas.

Delta Issues



The CVP Delta-Cross Channel regulates water passage in the Delta.

The "Tule Theory"

Although human modification of the Bay-Delta estuary began in the mid-1890's—relatively recently in the estuary's overall timespan—accurate measurements of the amounts of water flowing from the Delta through the Bay are only available beginning in the early-1900's.

Today there is interest in just how much water flowed through marshes in the early days because of testimony brought up in the State Water Resources Control Board's Bay-Delta Proceedings concerning historic freshwater flows. Many arguments in favor of requiring more freshwater inflow to the Bay cited estimates of as much as a 60 percent reduction in "historic" flows to the Bay due to increased land use and export diversions.

But testimony offered by consultants to the State Water Contractors (a group of 28 of the 30 agencies that buy water from the State Water Project) in the Proceedings stated that as much water actually reaches the Bay today because California has been experiencing an overall period of increasing precipitation. Also, they stated that in frontier times vast acres of tule marsh and riparian forest in Central Valley consumed much of the water that would have flowed into the Bay.

The "tule theory" pointed out that the estimates that water project diversions allow only a fraction of historic flows into the Bay had not included the amounts formerly consumed by Central Valley vegetation, much of which used more water per acre than any of the currently cultivated crops.

As the Bay-Delta Proceedings continue, there remains a question of how much fresh water actually flowed into the Bay and how much was absorbed and transpired through marshlands in the Delta and in the entire Central Valley. Nevertheless, the State Board is left with the amount of water that is available today and in the future to allocate to urban, agricultural and environmental needs.

Water Distribution

The Delta, because of its geographical location, is the historical collection point for much of the runoff and resulting water supplies of California. And it is through Delta channels that this water must pass in order to satisfy the demands within the Delta itself, the agricultural lands of the San Joaquin Valley, the San Francisco Bay Area and the state's densely populated Southland.

Many who have studied the Delta believe that some of its environmental problems have been aggravated by the development of the state and federal water projects. The Bay-Delta region has played a key role in meeting the water supply needs of much of California's population. In the past, rapid growth and development were accommodated, to a large extent, by increased annual upstream and export diversions of some waters that would otherwise flow toward San Francisco Bay.

No one disagrees that there will be new demands for water in the state. By the year 2010, California's population is projected to rise from 28 to 36 million. Net water use throughout the state is expected to grow, too, by about 1.4 million acre-feet per year by 2010, according to DWR. Since the amount of water passing through the Delta for export is limited by the size of Delta channels, the SWP cannot maintain a reliable future water supply for the state without building an improved Delta water transfer system and constructing more storage, according to DWR.

Present and past state administrations believe development of additional water for the state project is crucial. But environmental groups and others oppose increased development of Delta water on the grounds that more diversions may further harm the estuary's ecosystem. Indeed, some groups argue for reduced Delta diversions to allow more fresh water to flow through the estuary, especially during the spring when some anadromous fish migrate upstream to spawn, and others migrate out to the ocean. They contend new demands can be met by more efficient use or reallocation of already developed supplies from agricultural to urban uses.

Because an estimated 80 percent of California's developed water is used by agriculture, some of it either used upstream or imported through the Delta, those with interests in this $14.5 billion annual industry are understandably concerned about the continued availability of Delta waters.

Water districts in Kern County, for instance, serve 1.5 million acres of California's most productive farmland, with an estimated crop value of $1.6 billion in 1986. Decreases in the amount of water to farming, the agricultural community argues, could damage the state's agricultural economy, with serious social and economic effects on many farming communities. Various proposals to increase the Delta's water transfer ability have been proposed over the years.

Salinity and Agricultural Drainage

Salinity, either intruding from the sea or accumulating as minerals from the state's agriculture and discharged into the Delta's tributaries, has long been a Delta issue.

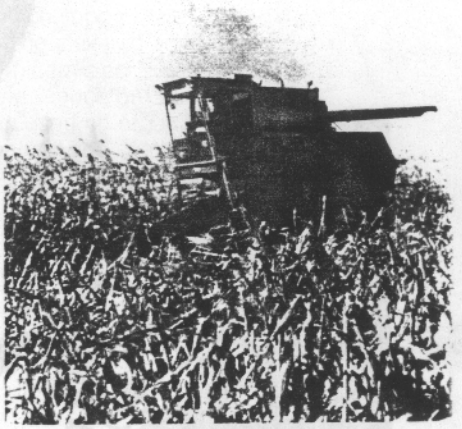
Freshwater outflow repels the intrusion of sea water into the Delta, helps to provide necessary levels of nutrients for the estuary's many flora and fauna, and mixes with heavier salt water to create a dynamic circulation process that helps disperse pollutants and maintain adequate water quality. During dry years, or dry parts of the year—late summer and early fall—the state and federal reservoir projects help to control salinity by releasing water held in reservoirs. But after a prolonged drought, there often isn't enough water left for salinity repulsion. And during the spring when reservoirs are being filled, Delta salt concentrations can go up, creating salt intrusion problems for Delta farmers and municipal and industrial users.

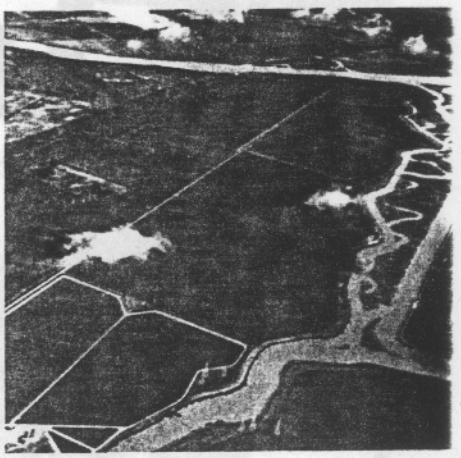
Compared to other Delta areas, the western Delta suffers periodically from higher saltwater content and its possible adverse effect on drinking water supplies of more than one-third million residents of eastern Contra Costa County. The more fresh water flowing from the Delta to San Francisco Bay, the better the water quality in the western Delta.

Over the years, four basic types of facilities were studied to solve salinity intrusion and other problems in the Delta. They are: 1) hydraulic barriers—the provision of sufficient Delta outflow to repulse ocean salinity, basically the method used today and an integral part of the remaining types of facilities; 2) physical barriers—actual low-level dams separating fresh water from saline water with passageways for navigation and fish migration; 3) waterway control—alterations and facilities in existing channels to improve flow patterns; and 4) isolated channels—new channels to isolate export water from Delta waters and provide for releases to the Delta. Plans that were combinations of these concepts were also studied.

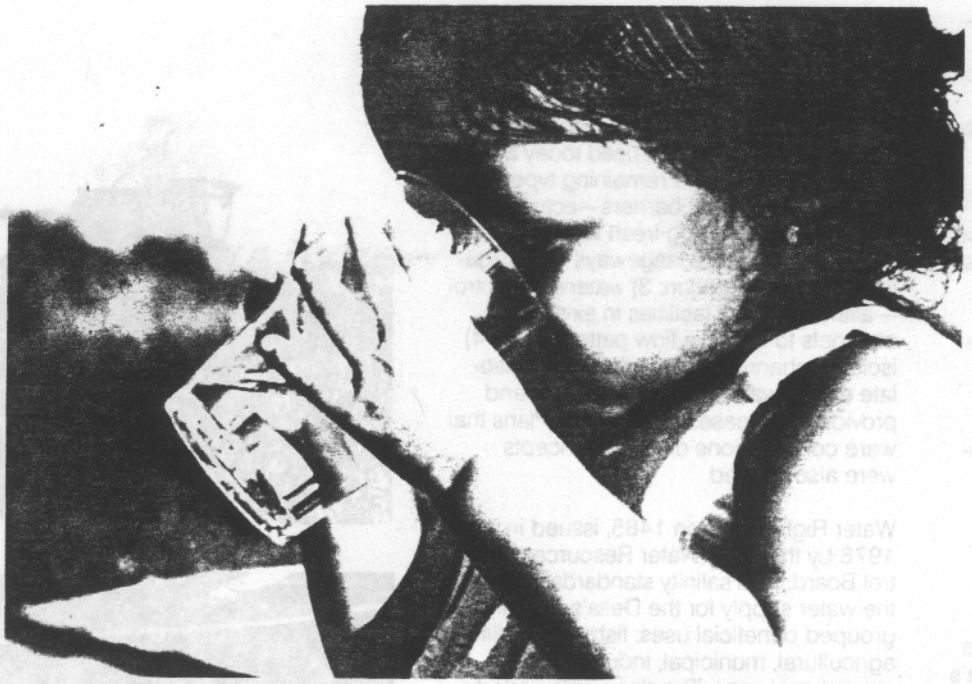
Water Right Decision 1485, issued in 1978 by the State Water Resources Control Board, sets salinity standards to protect the water supply for the Delta's broadly grouped beneficial uses: fish and wildlife, agricultural, municipal, industrial and recreational uses. The decision's underlying premise is that Delta water quality should be at least as good as the levels available had the state and federal projects not been constructed, with adjustments built in to accommodate changes in hydrologic conditions under different types of water years. A monitoring program is required to gauge compliance. Revisions of this decision are now under consideration; the "Bay Delta Proceedings" began in early 1987, and enactment is expected in 1992 or 1993. (See page 17: Bay-Delta Proceedings.)

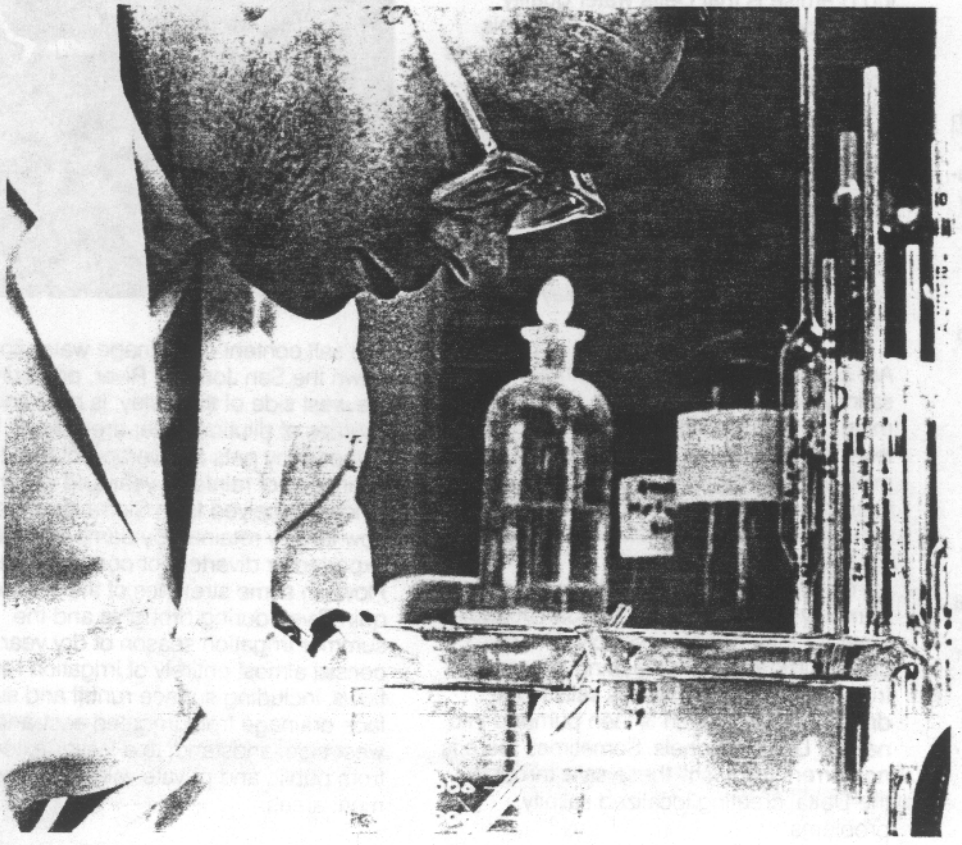
Agricultural drainage also contributes to salinity problems in the Delta. Because most of the Delta islands are below sea level, the area is beset by seepage-related problems. Farmers must constantly pump water from their lands to permit crops to grow. However, farmers must also add controlled amounts of water for productive agriculture. In the South Delta farmers rely primarily on the waters of the San Joaquin River for their irrigation supply. The process of irrigation and leaching minerals from the soils concentrates salts in the drainage water which is then pumped into nearby Delta channels. Sometimes there is no current to "flush" these salts through the Delta, creating localized salinity problems.





The salt content of drainage water flowing down the San Joaquin River, primarily fror the west side of the valley, is high and sources of dilution water are limited. Most of the valley gets an average of less than 10 inches of rainfall a year and water historically received from Sierra streams is now largely retained by dams and either exported or diverted for consumptive use: Flows in some stretches of the San Joaquin River, during droughts and the summer irrigation season of dry years, consist almost entirely of irrigation return flows, including surface runoff and subsur face drainage from irrigated east-and west-side lands and, to a lesser extent, from public and private wildlife management areas.





Drinking Water Quality

Drinking water quality is an issue of growing concern to domestic water users and water agencies which supply water from the Delta source. The elevated concentrations of salts and minerals continue to be of concern; however, much greater public attention is now focused on organic contamination from natural and synthetic organic chemicals and their reactions with chemicals used in the water treatment process.

Tastes and odors can also be a problem in treated water supplies from the Delta. Taste and odor are due mainly to organic compounds but are also occasionally due to high mineral content.

A clear indication of the increasing concern of California citizens about the quality of their drinking water is the growing use of bottled water and home treatment devices, even though the tap water meets all state and federal drinking water standards. The people who use Delta water are the highest bottled water users in the state.

When water from the Sierra rivers flows into and through the Delta, additional naturally-occurring organic materials (mainly derived from vegetation) are added to those already in the water as it contacts the Delta's peat soils. Organic material is also added by agricultural drainage from Delta farms. These organic compounds are precursors to the formation of disinfection by-products. The best known of these by-products are the trihalomethanes (THMs).

THMs formed upon chlorination of the precursor-rich Delta water supplies are of concern because THMs are an animal and suspected human carcinogen. This problem is exacerbated at certain times of the year when the powerful state and federal pumps in the south Delta draw water from the western Delta that includes ocean-derived bromides which produce other forms of THMs.

The THM problem could cost urban water purveyors billions of dollars over the years in additional treatment costs to meet anticipated higher EPA drinking water standards for THMs and other disinfection by-products.

Increasing evidence of Delta drinking water quality problems created interest in studying ways to operate existing water systems diverting water from the Delta in ways that will minimize contamination. Research by water agencies has shown that only with the installation of advanced and expensive water treatment will Delta water be able to meet anticipated drinking water standards for THMs and other disinfection by-products.

Such concerns led the California Urban Water Agencies (CUWA), a coalition of the state's largest drinking water supply agencies, to commission a study of Delta drinking water quality. The study, completed in 1989, investigated both operational and physical means of improving the existing water supply systems in order to improve drinking water quality.

The results of this Delta drinking water study show that the urban water agencies will have to use costly treatment techniques to meet anticipated tougher drinking water standards. However, less treatment will be required for drinking water diverted upstream of the Delta because those areas are less developed and the upstream waters contain lower amounts of contaminants.

The CUWA study reported several alternatives that could help improve the quality of Delta-source drinking water and concluded that alternatives that would take water upstream of the Delta would provide higher quality drinking water and would reduce overall costs to urban water users. The study did not attempt to analyze the many environmental, institutional and other impacts of the alternatives it presented, and stressed that much more study and assessments of these factors are needed.

Fish and Wildlife

The fish and wildlife that call the Bay-Delta Estuary a permanent or temporary home come in all shapes and sizes, from ducks and cranes to salmon and sturgeon. Millions of traveling birds exit the "Pacific Flyway," a major north-south migration route, to fuel up and rest at the 55,000-acre Suisun Marsh and other brackish marshes and freshwater wetlands around the Bay and Delta.

Delta fisheries have had their problems. Striped bass, an introduced species, feed in the Bay and ocean directly beyond the Golden Gate, migrating to the fresh water of the Delta to spawn. Once responsible for a $7.5 million sportfishing industry, from the mid-1960s the adult striped bass population declined from about 3.5 million fish to about 1 million today. Also, because of mercury in excess of health standards, an advisory was issued to consumers on limiting their intake of striped bass.

Increased exposure to toxics, introduction of new species, changes in food supply, loss of habitat and water diversions are all implicated in the decline of the striped bass fishery, but there is debate as to whether water withdrawal has caused or exacerbated the problems.

According to the state Department of Fish and Game, more than three-quarters of the state's multimillion-dollar commercial salmon catch depends upon the habitats of the Bay, Delta and tributary rivers. And natural spawning chinook salmon populations, too, are declining, although hatchery production has kept their overall numbers relatively stable. In 1989, however, the Sacramento River's winter-run salmon population, one of four California sub-species, reached a low of 500, down from 117,000 in 1969, causin the state Fish and Game Commission to list the run as endangered.

Another major problem in the Delta is tha of reverse flows, which occur at certain times of the year when export water on its way to pumps flows down the Sacrament River into the western Delta and then bac upstream in the lower San Joaquin River. Reverse flow problems have been implicated in the decline of migrating salmon and young striped bass which ar either sucked into the pumps and killed thrown off their spawning pilgrimage by this change of flow pattern.

Many believe that the fluctuating entrapment zone, where fresh and salt waters mingle, is very important to the fo chain of the region. This area of circulati currents provides a particularly good habitat for the tiny plankton upon which larger organisms feed. Although the location of the entrapment zone fluctuate under natural conditions, diverting water upstream and out of the Delta also alters the location of the meeting place of fres and salt waters, and some contend this adversely affects, at the most fundament level, the food supply of the Bay-Delta estuary.

The timing of the fresh water influx may be more important than the total annual amount, with late spring and early summer diversions reducing the outflow that would otherwise occur as the Sierra snowpack melts and runs off. According to fishery biologists, this "spring flow" cycle is needed for the creation of the conditions favorable to migration and spawning for fish such as striped bass and salmon.

Spring, however, is the harvest season for water. Once the need for flood control stops in the spring, water managers need to place as much of this "spring flow" water as possible in storage to use throughout California's long, dry summers.

As brought up in the Bay-Delta Proceedings, there is no consensus on either the problems of fish and wildlife within the estuary or the solutions to those problems. Some argue that until direct, cause-and-effect relationships for fishery declines are found, current standards should not be changed. Furthermore, they argue that physical measures—such as fish screens at the pumps, improved water transfer facilities and upstream habitat enhancement—and, in the short term, increased hatchery production, should be used to protect the fishery or to offset losses in preference to augmenting flows.

Others hold that the amount of water discharged into the estuarine system is correlated to fish catches and that adequate freshwater flow is necessary to maintain habitat for fish and wildlife. They see short-term solutions such as hatcheries and screens as temporary, and at best only partial solutions, secondary to the issue of getting more fresh water through the Delta and out the Golden Gate. One thing is certain: isolating the variable(s) responsible for, and solutions to, fishery declines remains a difficult challenge yet to be met.

Delta Levee Issues

A well-maintained levee system is needed to protect the supply of fresh water moving through the Delta, fish and wildlife living in the Delta, recreation on Delta waterways, roads on levees and island floors, and farmlands and towns in the Delta. When levees fail, water rushes into the lower-than-sea-level islands and salt water can be drawn up from further downstream.

According to DWR, the collapse of Delta levees would create widespread flooding because most of the Delta islands are below sea level and would fill with water. In a summer situation with low freshwater flows to counter the pressure of the sea water, salt water would intrude farther into the Delta and into water that is used by millions for their agricultural and drinking supplies.

Much of the soil used to reclaim the Delta is now destroying it. On two-thirds of Delta lands, the local soil, composed of organic matter from the original marshlands, sinks or erodes at the rate of about three inches per year.

Today, most of the Delta is below the surrounding water level and many islands are 25 feet or more below sea level. Continually higher levees are necessary to hold back Delta waters, but some levee foundations are made of the stringy peat soil that oxidizes and compacts, or blows away. This compaction, known as subsidence, is a critical problem because the process puts stress on levees and makes island flooding more probable.

A major aspect of flood control in the Sacramento-San Joaquin Delta and along the rivers is stability of its levees, many of which are vulnerable to failure in high water situations.

Responsibility for federal project levee maintenance travels through three levels. After the U.S. Army Corps of Engineers completes a Congressionally-approved levee construction project in the Central Valley, the legal responsibility for the project is transferred to the State Reclamation Board, which then turns levee maintenance over to DWR or local public agencies. Outside the Central Valley, other levees are transferred directly from the Corps to local flood control districts, cities or counties.

About 65 percent of Delta levees are "nonproject" - they were constructed and are maintained by island landowners through local levee and reclamation districts, to varying and generally less stringent standards than those for project levees, according to DWR. Many are in very poor condition. A part of Senate Bill 34, the "Delta Flood Control Protection Act of 1988," will increase the financial assistance to reclamation and levee districts maintaining nonproject levees throughout the Delta, and provide funds for special flood control projects in the northern and western Delta.

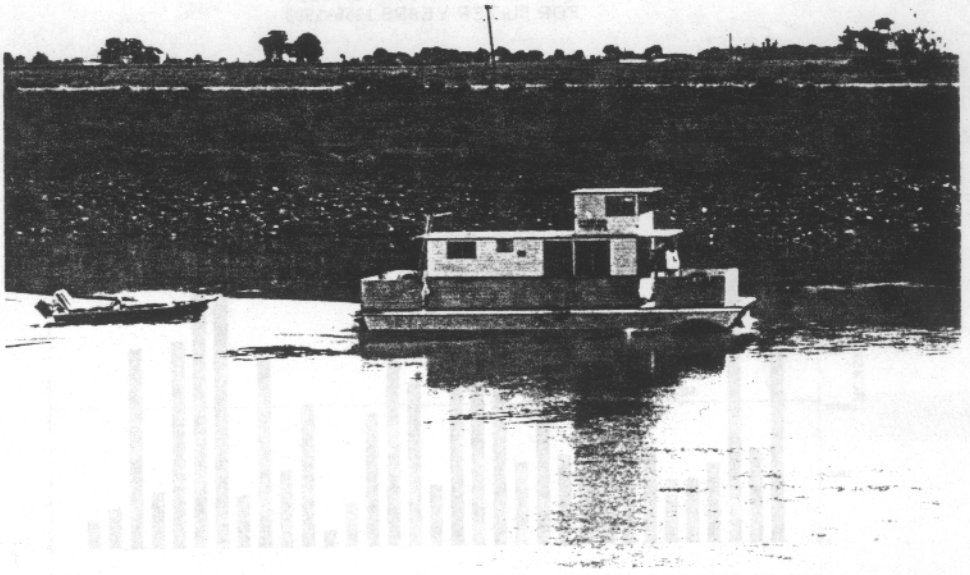
DWR is considering several improvements to the Delta to help alleviate its flood problems, including dredging, levee setbacks, channel improvements, and land use changes which would also provide water quality, fishery, wildlife, and water supply benefits.

Senate Bill 34 provides $120 million over 10 years for DWR to rebuild levees, improve channels and help local reclamation districts improve and maintain levees.

Another potential danger to levee stability is a major northern California seismic event. If an earthquake caused the Sacramento-San Joaquin Delta's fragile levee system to collapse, millions of individuals from the San Francisco Bay area to southern California could be left without adequate drinking water.

The state Legislature has required, through AB 955, the Department of Water Resources to devise an emergency plan that would allow the CVP, SWP, East Bay Municipal Utility District (EBMUD) and Contra Costa Water District to "continue or quickly resume exporting or delivering usable water (from the Delta) in the event of the failure of one or more levees in the Delta."

The emergency response plan as outlined by DWR would entail stopping the SWP and CVP pumps in the south Delta, filling Clifton Court Forebay for a reserve, waiting for the Delta to stabilize, and increasing releases from Folsom, Shasta, and Oroville reservoirs to fill up the Delta with fresh rather than salt water. Once stabilized, work to patch up the levees and block salinity intrusion could begin.



But many argue that massive Delta levee failure could not be so easily repaired -that the Delta is essentially a "weak link" in the state's water transportation system. Studies done for EBMUD concluded that long reaches of Delta levees built over sand pockets could liquefy under severe seismic loads and cause failure. (Liquefaction occurs when the earth shakes and saturated sand start to flow like liquid. Quicksand is an example of liquefaction).

Researchers are continuing to look at the effects of an earthquake on the Delta.

D-1485 and The Delta Plan

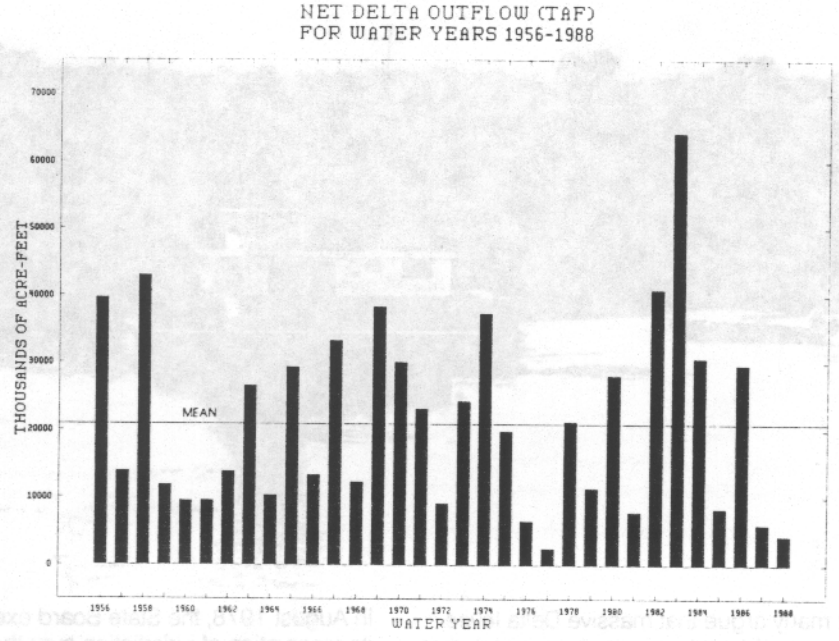
Over the years, the State Board issued numerous conditional water right decisions and permits—to the U.S. Bureau of Reclamation (Bureau) for its Central Valley Project and to DWR for its State Water Project—for the operation of water projects in the Delta.

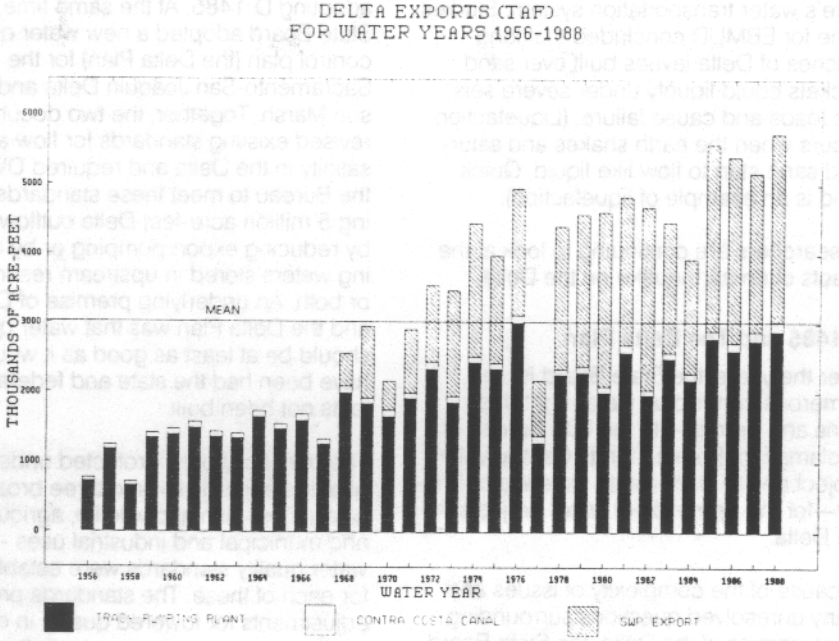
Because of the complexity of issues and many unresolved questions surrounding the dynamics of the Delta, the State Board (and its predecessor, the State Water Rights Board) "reserved jurisdiction" when it issued permits to DWR and the Bureau for operations in the Delta. The purpose of this reservation of jurisdiction was to allow the State Board an opportunity to revise standards pertaining to salinity control, fish and wildlife protection and coordination of the state and federal projects as more information was developed.

In August 1978, the State Board exercised its reservation of jurisdiction over the water right permits of DWR and the Bureau by adopting D-1485. At the same time, the State Board adopted a new water quality control plan (the Delta Plan) for the Sacramento-San Joaquin Delta and Suisun Marsh. Together, the two documents revised existing standards for flow and salinity in the Delta and required DWR and the Bureau to meet these standards (allowing 5 million acre-feet Delta outflow), either by reducing export pumping or by releasing waters stored in upstream reservoirs—or both. An underlying premise of D-1485 and the Delta Plan was that water quality should be at least as good as it would have been had the state and federal projects not been built.

The beneficial uses protected under these quality standards fall into three broad categories - fish and wildlife, agriculture, and municipal and industrial uses - and water quality standards were established for each of these. The standards provide adjustments for lowered quality in critical or dry years, when less water is flowing into the Delta from the rivers which feed it.

Delta Decisions





At the time D-1485 and the Delta Plan were issued, the State Board stated it believed the level or protection afforded was "reasonable." However, because it recognized that there was continuing "uncertainty associated with possible future project facilities and the need for additional information," it stated that it would review the Delta Plan in ten years. It also called for additional fisheries and water quality studies and sampling and monitoring programs in an attempt to gain a better knowledge of the ecosystem and water quality needs for Delta agriculture, and to find answers to some of the persistent questions. For the first time the State Board mandated studies of the projects' impacts on San Francisco Bay.

Both the Delta Plan and D-1485 stated the State Board's intent to reopen the matter in order to review this additional information and to reassess the standards.

In mid-1987, as the next step in this evolutionary process, the State Board began an extensive hearing procedure, the Bay-Delta Hearing (later called the Bay-Delta Proceedings), aimed at developing new water quality objectives for the Bay-Delta estuary and the means for implementing them. During the first six months of this multi-year process, its members heard testimony on a number of issues. Over the coming months and years, this evidence will be assessed, and a salinity control plan and pollutant policy document prepared.

Ultimately, the 1978 Water Quality Control Plan and Water Right Decision 1485 (D-1485), which together set water quality and flow standards for the Delta, will be revised and possibly expanded to include San Francisco Bay. (See page 17: Bay Delta Proceedings.)

Racanelli Decision

In 1986 an historic decision of the state Court of Appeal (known as the Racanelli decision) concluded that the State Board in issuing D-1485 had improperly narrowed its scope of its water quality planning to the protection of water rights (instead of the protection of all beneficial uses of Delta waters) and to the impacts on water quality of the state and federal projects (instead of the impacts of all factors and water users affecting water quality in the Delta).

This ruling, allowed to stand by the California Supreme court, instructs the State Board, when establishing water quality objectives for the Delta, to take into consideration all factors - not just the operation of the state and federal projects -which have a bearing on Delta water quality. The decision also said the State Board had improperly based its previous salinity objectives on levels which are needed to protect existing water rights, rather than determining what flows and salinity are needed to protect the various uses of Delta water.

The ruling distinguished the State Board's water rights and water quality planning authorities. In doing so, the court paved the way for more comprehensive water quality objectives and a broader program of implementation to obtain those objectives, including the regulation of non-project water rights and the recommendation of other non-regulatory measures.

The Public Trust

A 1983 California Supreme Court decision focusing on the Los Angeles Department of Water and Power's diversion of water from the streams that feed Mono Lake overlaid the California water rights system with the age-old English Law doctrine of "Public Trust," through which a state is required to hold in trust for future generations the values associated with certain resources.

The decision essentially charged the courts and state agencies, including the State Board, with the obligation to act as guardian or "trustee" for the beneficial uses dependent upon the public's water resources. The court noted its previous expansion of the concept of the public trust doctrine to include not only the traditional uses of navigation, commerce, and fishing but also "changing public needs of ecological preservation, open space maintenance and scenic and wildlife preservation." Additionally, the court held that the public trust doctrine applies to diversions from streams tributary to navigable waters when such diversions may harm public trust uses of the downstream navigable waters.

In its presently developed form, the public trust doctrine requires the courts and the State Board to perform a balancing test to weigh the value to society of a proposed or existing water diversion against protection of the public trust uses of water. Public trust issues and values associated with the Delta are figuring more prominently in the current Bay-Delta Proceedings than in past Delta decisions.

Interagency Agreements:

Coordinated Operation Agreement

In 1986, DWR and the Bureau replaced 26 years of year-to-year agreements regarding the responsibilites of each project in the Delta with a Coordinated Operation Agreement (COA).

The agreement gave additional safeguards to the fragile Delta by committing the Bureau to a share of the responsibility for sustaining flows in the Delta during dry periods.

A major hurdle in reaching agreement was the federal government's reluctance to set a precedent by accepting the state's authority to prescribe water quality requirements for the Delta to be met by the CVP. The concern was resolved by a provision in the COA which authorizes the Secretary of the Interior to determine if operating the CVP to meet new state Delta standards would be inconsistent with Congressional directives. If the Secretary were to make this determination, the U.S. would be required to bring a legal action to decide whether the state standards for the Delta apply to the federal CVP.

Cooordinated operation is vital for both projects to make the best use of their facilities, but had long been controversial. In times of drought prior to its implementation, the SWP may have been forced to sacrifice the needs of some of its customers to meet State Board Delta flow and water quality standards, if the Bureau did not voluntarily agree to contribute water to meet those standards. Under the COA, the federal government is committed to share with the state the responsibility to meet most of the water quality and flow standards established in D-1485, as well as future Bay-Delta standards, subject to provision in the agreement.