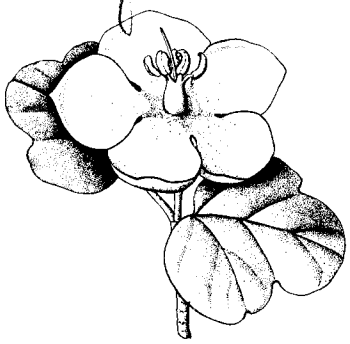
April 1982

# FREMONTIA

A Journal of the California Native Plant Society



## SPECIAL ISSUE: Water in California

# FREMONTIA

**Vol. 10 No. 1 April 1982**




Alice Q. Howard, Guest Editor
Margedant Hayakawa, Editor
Laurence J. Hyman, Art Director

**MATERIALS FOR PUBLICATION**

Members and others are invited to submit material for publication in *Fremontia* and the *Bulletin*. All time-value material should be addressed to the *Bulletin*. *Fremontia* is a journal for laymen about California plants. It hopes to be both readable and scientifically accurate. Technical botanical articles should be directed to other more scholarly journals. Please double-space copy, using wide margins and fresh typewriter ribbon, on 8½-by-11 paper, and include name, address, and phone number on the MS. As a general rule, in the interest of consistency, botanical nomenclature will conform to Munz, *A California Flora*. Please identify each plant referred to by its botanical name and, if there is one, by its common name. Photographs should be black-and-white glossy prints, preferably 8-by-10 size or accompanied by negatives.

**THE COVER:**

Verna R. Johnston's photograph of a Central Valley stream in something resembling its pristine state introduces an issue of *Fremontia* devoted entirely to water in California — its historical role in mining, agriculture, and other development; the vast aqueducts and drains that transport it; and the political and ecological issues centering around it.

# California Native Plant Society

## Dedicated to the Preservation of the California Native Flora

The California Native Plant Society is an organization of laymen and professionals united by an interest in the plants of California. It is open to all. Its principal aims are to preserve the native flora and to add to the knowledge of members and the public at large. It seeks to accomplish the former goal in a number of ways; by monitoring rare and endangered plants throughout the State; by acting to save endangered areas through publicity, persuasion, and, on occasion, legal action; by providing expert testimony to governmental bodies; and by supporting financially and otherwise the establishment of native plant preserves. Much of this work is done through CNPS Chapters throughout the State. The Society's educational work includes: publication of a quarterly journal, *Fremontia*, and a bi-monthly *Bulletin* which gives news and announcements of Society events and conservation issues. Chapters hold meetings, field trips, and plant sales. Non-members are welcome to attend.

The work of the Society is done by volunteers. Money is provided by the dues of members and by funds raised by chapter plant sales. Additional donations, bequests, and memorial gifts from friends of the Society can assist greatly in carrying forward the work of the Society.

**MEMBERSHIP**

Dues include subscriptions to *Fremontia* and the *Bulletin*.

| | | | |
|---|---|---|---|
| Individual | $ 12 | Groups | $ 18 |
| Couple | 18 | Supporting | 30 |
| Retired Person | 8 | Life Member: Individual | 350 |
| Student | 8 | Life Member: Couple | 400 |

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The Mokelumne River, near Clements. Photograph by Verna R. Johnston.

# THE VALUE OF RIPARIAN HABITAT

## by Anne Sands

"Riparian forest." The words cannot capture the delicate work of tent caterpillars on a button-willow branch or the flotilla of magnificent wood ducks sliding gracefully beneath an overhanging willow. And what about the raucous call of a yellow-billed cuckoo on a hot summer afternoon? Or the baby brown-headed cowbirds parasitizing the tiny Bell's vireo's nest? Were those the bushy, striped tail and huge eyes of the ring-tailed cat? See how the subtle veins of the Dutchman's pipevine flowers are highlighted by the sun as the pipevine swallowtail butterfly lays her eggs. And remember the taste of jams made from wild grapes, elderberries and blackberries!

Belatedly, Californians are becoming concerned about our rivers and forests associated with them. In 1977 a one-day conference on riparian forest ecosystems was held at the Davis campus of the University of California. From that small gathering grew legislation that resulted in a report by the State Department of Fish and Game on the condition of our remaining riparian resources. September 1981 found many of those who attended the earlier conference at another symposium on riparian systems, this time a three-day session presented to an audience of more than seven hundred people.

The many values of riparian systems are now being recognized, not only by resource managers, but also by the general public. Fishermen have become concerned as gravel beds where fish spawn have filled with sediment. Orchard owners watch with dismay as the river takes out five acres of valuable fruit trees in a single storm. Delta boaters wonder what has become of all the pleasant places to tie up for the night. The trees and their shady canopies are gone, replaced by rock-lined banks. The operator of the city sewage-treatment plant complains of overloading because of increasing volumes of water from storm drains.

All of these conditions are related to the changed balance among soil, water, and vegetation throughout the watersheds. Riparian forests are a vital part of the water-

## EDITOR'S NOTE

Only in recent years, when natural droughts have made us more aware of possible limitations upon supply, have most of us given much thought to water. Yet all life, our native flora included, depends in some way upon water. The welfare of native plants depends upon having suitable habitat. One of the factors making up suitable habitat is water — in appropriate amount, of an appropriate quality, and in an appropriate location.

Political decisions relating to water operate in an exceedingly complex arena. To understand them, as Mark Reisner said recently, "[O]ne should have a law degree and doctorates in most of the physical and social sciences, followed by several years spent in deepest isolated contemplation. The California doctrine of water law is enough to discourage almost anyone; it is unlike any other in the nation or the world, formed from a bizarre inheritance of codes and superstitions handed down from English common law, Mexican and Southern European traditions, and mining rules and customs."

Decisions relating to water are made every day by agencies to which we entrust the power to make decisions. Occasionally, as in the June and possibly the November primaries, the general citizenry can participate directly in the process.

This special issue of *Fremontia* attempts to heighten public understanding and awareness of the issues involved in these political decisions and to focus attention upon how these choices relate to survival of native plants. We are grateful to all our contributors for being willing to accept the challenge of distilling and condensing very involved subjects for a lay audience.

It was our intent to include considerations of the conflicts east of the Sierra concerning the Mono Basin and Owens Valley, with statements from both sides. Space limitations proved to be too severe, however, and because *Fremontia* has previously published material on these matters, further treatment has been postponed for a future issue.

Alice Q. Howard
*Guest Editor*

shed system. Without them the system collapses, and no amount of expensive engineering technology can rebuild it. Floodplains belong to the rivers. To take the floodplains away is to invite disaster. Recognition of this is the first step toward intelligent riparian resource management. We must examine existing policies and discard those that work against sensible floodplain management.

## The Floodplain

Riparian forests and the rivers they border are dynamic and interdependent. As a river overflows its banks, the water slows and deposits its load of sediment. Natural levees develop from these deposits, creating the terraces upon which vegetation establishes itself. Overflows also supply water to adjacent floodplains, which act as storage reservoirs for excess runoff. These ponding areas replenish the groundwater, which can be drawn upon during drier seasons. As a river erodes its channel on the outside of a bend and deposits sediment on the inside, the meander bend in time moves laterally and also down the valley.

Overflow, deposition, and meander are the natural processes that create the floodplain. The riparian forests respond by establishing successions of growth on newly deposited sand and gravel bars, beginning with sandbar willow (*Salix hindsiana*) and other low plant cover. As gravel-bar communities become more distant from the shifting river, they begin to become stabilized and are further colonized by tree saplings. Gradually, a new forest — dominated, here in California, by Fremont's cottonwood (*Populus fremontii*) — is established.

The natural balance between the river, its floodplain, and the riparian forest is easily upset by human interference. To straighten a channel is to invite erratic river meandering, severe bank erosion, and subsequent loss of vegetation, which in turn often result in further loss of stability in the riverbank, and further erosion.

Rather than tamper with the balance of the riparian system, we must recognize that floodplains must be allowed to function in their natural pattern. That is, we must not develop them with subdivisions, but rather leave them as open space for the river to overflow in. We must allow the natural succession of riparian forests to occur and we should encourage the growth of vegetation to control erosion. The results will be replenishment of rich alluvial soils, maintenance of wildlife resources, greater riverbank stability, and reduced losses of lives and property to flooding.

Though they are slender strips of vegetation closely confined to riverbanks, riparian forests are reminiscent of tropical jungles, especially in summer when vines of wild grape and clematis hang in profusion. The trees are often so crowded and the undergrowth of poison oak and blackberry vines so tangled that it is nearly impossible to pass through. Fremont's cottonwood (*Populus fremontii*) usually dominates the upperstory with California sycamore (*Platanus racemosa*) and valley oak (*Quercus lobata*) occurring on higher and drier ground. Mid-story trees include box elder (*Acer negundo*), ash (*Fraxinus latifolia*), black walnut (*Juglans hindsii*), and several species of willow (*Salix lasiolepis, S. goodingii, S. laevigata, S. lasiandra*). Understory vegetation often comprises elderberry (*Sambucus mexicana*), button-willow (*Cephalanthus occidentalis*), wild rose (*Rosa californica*) and wild blackberries (*Rubus* spp.). Vines such as poison oak (*Toxicodendron diversiloba*), clematis (*Clematis ligusticifolia*), and wild grape (*Vitis californica*) frequently provide abundant groundcover as well as dense curtains festooning the trees to heights of thirty meters.

These dense tangles of vegetation are cool retreats for wildlife and people during the long dry summer and provide abundant food and nesting sites for a great variety of animals. Perhaps the most important scientific reason to protect these habitats is their diversity of wildlife. More

*Hibiscus californicus*, a rare plant of riparian habitats. Photograph by N.H. (Dan) Cheatham.

kinds of birds breed in riverine forests than in any other habitat type in California (approximately seventy species), and over two hundred species of birds visit these forests for food and cover. In the Sacramento Valley alone, thirty-nine species of mammals, nineteen species of reptiles and amphibians, thirty-seven species of fish, seventeen species of butterflies, and numerous other invertebrates depend almost completely on these forests for survival. Fifteen uncommon, rare, and endangered wildlife species, including the California hibiscus (*Hibiscus californicus*), yellow-billed cuckoo, bald eagle, giant garter snake, and elderberry beetle (*Desmocerus californicus*) are found in California's riparian forests. These green ribbons of vegetation occur in every climatic zone in California from the Colorado River to the north coast. Although the plant species may vary, the structure and function of different riparian forests remain remarkably similar.

## Early History

Prior to 1814, the riparian woodlands of California were seldom visited by Europeans. Although settlements had been established in southern and northern California and along the coast, the central valleys with their extensive marshes and nearly impenetrable riverine forests were left to native Americans and the abundant wildlife. Among the first outsiders to explore the Sacramento Valley were fur trappers from Hudson's Bay Company. They were followed by a rapid succession of explorers, including Luis Arguello, Jedediah Smith, Sir Edward Belcher, and Lieutenant George H. Derby. Diaries, field notes, maps, and topographic surveys from their expeditions are the only records we have of the once-vast riparian jungles that flanked the bottomland rivers of California.

In 1840, Captain Belcher described the riparian forests of the Sacramento River below Red Bluff as follows:

> Its banks are well-wooded with oak, planes, ash, willow, walnut, poplar, and brushwood. Wild grapes in great abundance overhang the lower trees, clustering to the river, at times completely overpowering the trees on which they climbed, and producing beautiful varieties of tint. . . . Our course lay between banks for the most part belted with willow, ash, oak, or plane, which latter, of immense size, overhung the stream, without apparently a sufficient hold in the soil to support them, so much had the force of the stream denuded their roots. . . .

> Within, and at the very verge of the banks, oaks of immense size were plentiful. The two most remarkable measured respectively twenty-seven feet and nineteen feet in circumference, at three feet above ground. The latter rose perpendicularly at a height of sixty feet before expanding its branches and was truly a noble sight.

Most of the historical accounts do not indicate the depth of the forests, but some references suggest belts of trees averaging from two to four or more miles in width on both sides of the rivers; even tributaries had forests two or three miles wide.

## The Gold Rush

The Gold Rush of the 1850s caused many significant changes in riverine ecosystems of the Central Valley. Hydraulic mining destroyed miles of streamside vegetation, but the secondary effects of the Gold Rush — increased population and agricultural growth — were just as destructive. California's population soared. Rivers continued to be major transportation corridors and floodplain camps became cities, as people turned from gold mining to farming. Riparian trees were used for building materials and fuel, especially on the steam-powered paddle-wheelers that cruised the Sacramento-San Joaquin Delta carrying food, supplies, and passengers. Marshes were drained, levees cleared, and the rich alluvial soils planted to orchards and crops.

Conversion of riparian lands to agriculture was facilitated by the construction of dams, levees, reservoirs, by-passes, and canals, which controlled the flow of water and promised to reduce flooding while providing irrigation water when needed. Confident of this protection, farmers removed the trees and shrubs that had helped stabilize the banks and planted more orchards.

It is estimated that there were still about 775,000 acres of riparian forests along the Sacramento River in the 1850s. By 1952, however, this figure had dropped to 27,000 and in 1972 there were less than 18,000 acres of riparian habitat remaining on the Sacramento River. Between 1972 and 1977 a further 20% reduction of riparian vegetation occurred between Redding and Colusa. Other California rivers have suffered similar impact. The California Department of Fish and Game estimates that less than 5% of the original riparian forests remain in the Central Valley. But no estimates have been attempted for the thousands of miles of foothill and coastal creeks that have been stripped of vegetation. Most Californians have forgotten, or have never known, that our rivers used to be flanked by magnificent jungles of vegetation, alive with song.

## Flood Control

The rivers, however, continued to meander and undercut their banks, as they had always done. Seepage through levees became serious in some areas and drainage, too, became a problem. When rivers meandered and levees failed, landowners and county supervisors appealed to the state and federal governments for a solution. Construction of federal flood-control and bank-protection projects in California began in the 1920s and continues today.

As suburban and rural lands are opened for development, the land is drained and leveled, and waterways are channelized, straightened, culverted, or simply erased by filling. The results are predictable. Surface water no longer flows into natural stream systems. Instead, run-off water moves over the new impervious surfaces and is collected in drains that send it rapidly elsewhere. Often the "elsewhere" is also an artificial watercourse. Little or no groundwater replenishment can occur under these conditions. Likewise, vegetation has a poor chance of survival. Wildlife habitats disappear, esthetic vistas are lost, water quality is degraded, and microclimates are altered.

As the floodplains of creeks are filled with houses and roads, the inevitable floods arrive. The watersheds continue to receive rain, but the drainage system has been so severely altered that it can no longer function. The amount of water entering the system may not have increased, but the creek channels overflow. Most communities react by further destroying the creeks and turning them into cement ditches, which may alleviate local flooding temporarily, but only pass the water downstream to become someone else's problem.

## Importance of Forests

But there are many other reasons besides flood control for preserving what remains of riparian forests. In many cases, they provide the only refuge for wildlife in an otherwise paved and developed landscape. Trees along a watercourse are essential for the health of the aquatic system itself. Fish use submerged roots and snags for cover. Insects dropping from overhanging vegetation are a source of food for fish. Trees provide shade that moderates water temperature, a critical factor for aquatic life.

Riparian forests shelter predators such as red-tailed hawks, coyotes, and gray foxes which feed on agricultural pests such as rodents and insects. Riparian bird

### IMPROVEMENT

The government tells us we need flood control and comes to straighten the creek in our pasture. The engineer on the job tells us the creek is now able to carry off more flood water, but in the process we have lost our old willows where the owl hooted on a winter night and under which the cows switched flies in the noon shade. We lost the little marshy spot where our fringed gentian bloomed.

Hydrologists have demonstrated that the meanderings of a creek are a necessary part of the hydrologic functioning. The floodplain belongs to the river. The ecologist sees clearly that for similar reasons we can get along with less channel improvement on Round River.

Aldo Leopold
*A Sand County Almanac*

Riparian habitat preserved at Howe Avenue access, American River Parkway, Sacramento. Photograph by Gary Rominger.

species feed exclusively on insects and thus provide free pest control to those who allow their riparian forest to remain.

Some of the qualities that attract animals, such as water and shade, are also attractive to people seeking recreation. Activities such as hunting, fishing, bird-watching, nature study, hiking, canoeing, and photography are made possible by riparian wildlife. Vegetation along the watercourses acts both as a visual screen and as a noise buffer to create a feeling of wilderness, even though a busy freeway may be just over the levee. In developing riparian forest lands for recreation, however, care must be taken not to clear away undergrowth, build restrooms, or open up trails to such an extent that the ecosystem can no longer support the variety and abundance of wildlife that made it attractive as a park.

## Water and Air Quality

Riparian forests filter nitrate-laden rainfall; other pollutants — zinc, copper, nickel, lead, manganese, some radioactive isotopes, and pesticides such as DDT — are removed by percolation through the soil. If the vegetation is disturbed or removed, however, the nutrient-holding capacity of the system is reduced; leaching follows and water-pollution results. Gases and particulates are also removed from the air. One acre of trees, for example, can remove 3.7 tons of sulfur dioxide and 12.9 tons of dust per year.

Riparian forests stabilize river banks and filter sediments from run-off. A disturbed watershed may have several thousand times the erosion rate of land covered with undisturbed forest.

Most of California's groundwater basins are in relatively arid valleys, while most of the precipitation occurs at high-mountain elevations. This means that the natural recharge of groundwater basins must occur mainly by percolation out from streams after they enter the permeable alluvial soils of the valleys. Riparian forests provide soils that absorb rainfall and percolation from streams, allowing them to replenish the groundwater more readily.

When riparian lands are unwisely developed, the functions performed by nature must be replaced with expensive, often fuel-consuming, technological substitutes. If a floodplain is subdivided for homes, then flood-control dams, channels, and storage basins must be constructed. When natural areas are destroyed, man-made parks must substitute for natural recreation areas. The unwise destruction of natural drainage and vegetation, and the additional facilities necessitated as a result, represent a huge and unnecessary expense to the taxpayers.

# WATER IN THE HISTORY OF CALIFORNIA

**by James King**

California's landscape is legendary for its variety. The forests of the rugged northwest are damp with perennial mists, while in the Mojave Desert in the southeast, years may pass without rain. There is equally dramatic variation in temperature, land forms, and altitude resulting in an unsurpassed diversity of ecosystems. In this exceptional land, modern man-made systems — like those of ancient civilizations — store, transport, and disperse water across vast distances.

Broadly speaking, the state has a wet-winter–dry-summer climate. A distinct wet season occurs from November through March, during which time most precipitation falls, as much as one hundred inches in areas on the northwest coast to less than five inches in the southeast interior. Summers are uniformly dry except in the far north and in the narrow zone of coastal influence where fog or low clouds predominate most of the time.

California's hydrologic features reflect the vast differences in its climates and the seasonality of its precipitation. Over half of the state's precipitation either seeps into underground storage-basins or is consumed through evaporation or through transpiration by vegetation. The remaining precipitation becomes the runoff that feeds the state's rivers. Seventy percent of the average annual runoff occurs in the northern third of the state, filling North Coast rivers and waterways of the Sacramento River Basin. Yet close to eighty percent of the state's water-use occurs in the southern two-thirds of the state. This disparity has resulted in the construction of the systems of canals and aqueducts that store and convey water from the north to the south and also in the extensive use of groundwater, especially in the San Joaquin Valley and Southern California. Groundwater comprises approximately fifty percent of the total water used in California.

Since rainfall in California tends to be irregular in amount and in occurrence, floods are of as great concern as drought, and consequently water is stored for flood-control purposes as well as for water supply. Throughout the state rivers have been dammed and a variety of facilities constructed in an effort to meet these dual purposes, resulting in considerable alteration of natural systems, particularly in the Central Valley.

## The Way It Was

The Central Valley as viewed by John Muir in the mid 19th century was a vast prairie interrupted by areas of lush riparian woodlands and tule marshes. Huge expanses of tule marshes were submerged by floods when the swollen rivers, fed by rainfall and melting snow from the mountains, inundated large areas of the flat valley floor. Over one hundred Indian tribes inhabited California for several thousand years prior to European colonization. For food they depended upon fish and game, seeds and fruits, and food from the ocean. Only a small percentage engaged in agriculture, those living in the Colorado River region.

The Spanish colonizers of the 18th century displaced the Indian societies and brought European agricultural practices to mission lands; but agriculture remained at a modest subsistence level. After the mission lands were secularized, huge land grants were made by the Mexican government, and economic life was focused on large cattle ranches for the export of tallow and hides. The Gold Rush brought new American settlers and dryland farming to the San Joaquin Valley, to be followed by vegetable farming on smaller parcels to feed a growing population. But drought and floods created serious problems for farmers, prompting the development of irrigation canals and levees. In the meantime, gold miners constructed flumes, aqueducts, and waterwheels throughout the Sierra foothills and initiated hydraulic mining. Hydraulic or "placer" mining washed away tons of earth, ravaged the mountain landscape, and wreaked havoc on the lowlands. Silt and debris clogged the major river systems and brought on disastrous floods. Water control and redistribution then became a universal concern in the economic development of the Central Valley.

## Irrigation Projects

The first irrigation projects in the Central Valley were achieved by individuals or small local agencies. Irrigation canals were first built in Yolo County in 1856. Larger projects were begun in the San Joaquin Valley and in Southern California. By the 1860s groups of landowners in flood-prone localities united to form reclamation districts and built levees for flood protection. However, the uncoordinated levee building merely diverted high water to other properties, increasing the danger and hardships for those unprotected. It is often said of this era that the tools of the flood-fighter were sandbags for his levees and dynamite for those of his neighbor across the river. Millions of dollars were wasted in the construction of levees while general conditions gradually grew worse.

Hydraulic mining debris not only reduced the flood-carrying and navigational capacity of river channels but lessened the depth of San Pablo and San Francisco bays. It has been estimated that over a billion cubic yards of debris are still located in the Sacramento River system, slowly emptying into the bays. In 1892 Congress created the California Debris Commission to seek solutions to the serious problems in California's rivers. (The same Federal Government had previously licensed hydraulic mining.) The Commission surveyed the Sacramento River flood

## MAJOR SURFACE-WATER DEVELOPMENTS

plain and recommended a flood control plan based upon the construction of levees, bypasses, and weirs that would carry floodwater out of the river channel, slow its velocity, and transport it around populated and intensely farmed areas.

## Flood Control and Water Storage

The Reclamation Board was created in 1911 by Governor Johnson and the Legislature to implement the Commission's plan. It remains the state agency responsible for flood management in the Central Valley. Since its inception a massive flood-control and water-storage system has been created, including 1500 miles of levees and nineteen multipurpose reservoirs. By means of levees and other diversion devices and dams located in the foothills, flood control projects divert the high flows of the Sacramento, San Joaquin, and most other significant Central Valley streams. In the Sacramento Valley huge expanses of land are used as bypasses for flood flows. Once the rivers reach a sufficiently high level a system of weirs and levees allow the controlled inundation of thousands of acres, providing relief to the main river channel. The same land is successfully farmed in the summer season.

Whereas the early Reclamation Board projects were chiefly intended to provide flood storage and water for local irrigation, the concept of long-distance transfer of water supplies developed not long after 1900. The City of Los Angeles began diverting water from the Owens River on the east side of the Sierra in 1916, a 240-mile conveyance. By 1934 the City of San Francisco had constructed its Hetch Hetchy Reservoir and a distribution system transporting Tuolumne River water 150 miles westward. A similar project was later to bring water from the Mokelumne River ninety-four miles by way of the East Bay Aqueduct to Oakland and neighboring cities. These and later long-distance aqueducts made possible California's phenomenal urban growth.

## State Water Plan

In the early 1930s the Division of Water Resources cataloged the state's water reserves, the potential for irrigation, and remaining flood control needs in a document called the State Water Plan. From this plan emerged the Central Valley Project, one of the world's most extensive water transport systems. Suffering from the depression, the state was unable to finance the project so instead it was built and operated by the Federal Bureau of Reclamation. The key to the system is Shasta Dam and Reservoir on the upper Sacramento River. Its waters flow south in the natural channel of the Sacramento River, augmented by additional supplies brought through a tunnel from the west-draining Trinity River and from reservoirs behind Folsom and Nimbus Dams on the American River. About thirty miles south of Sacramento, the Delta Cross Channel provides for the regulated passage of Sacramento River water through the Delta channel to the Tracy Pumping Plant. During the passage through the Delta, part of the water is used to prevent the inflow of salt water into the Delta from the west. An additional portion is pumped into the Contra Costa Canal for municipal use in Contra Costa County. On the south side of the Delta the Tracy Pumping Plant lifts the water 197 feet above sea level and into the Delta-Mendota Canal for a 117-mile southward conveyance to the Mendota Pool on the San Joaquin River. Here northern water replaces the natural flow of the San Joaquin River, which is impounded at Friant Dam in the Sierra Nevada foothills northeast of Fresno. The waters behind Friant Dam flow through the Friant-Kern Canal 153 miles south to the southern part of the San Joaquin Valley.

## Southern California Projects

A major water storage and conveyance system was constructed by the Metropolitan Water District (MWD) in Southern California beginning in the late 1930s. MWD planned, financed, and built the 242-mile Colorado River Aqueduct and its key storage facility, Parker Dam. The aqueduct carries water across the Mojave Desert from Parker Dam to Lake Mathews near Riverside. Included in the system are five pumping plants, 92 miles of tunnels, seven distribution reservoirs in the coastal mountains, and over 460 miles of distribution lines ranging from San Diego in the south to Ventura in the north. The development of local reservoirs on Southern California mountain streams has also been extensive, though reserves are undependable because of frequent dry years. Other major Southern California developments are the federally sponsored Coachella and All American canals, which bring lower Colorado River water, stored in Imperial Reservoir, to the Coachella and Imperial valleys, and the two-pronged San Diego Aqueduct, which branches from the Colorado River Aqueduct near San Jacinto and supplies Colorado River water to San Vicente and Lower Otay reservoirs in San Diego County.

By the late 1950s with the state's population approaching twenty million and continued expansion in the agricultural sector, the State Water Plan was again revised and further development recommended. Voters authorized the sale of bonds enabling the State Department of Water Resources to build and operate the State Water Project, another massive water storage and distribution system. The State Water Project stores Feather River water behind Oroville Dam and releases it into the natural channels of the Feather and Sacramento rivers. It flows through the Delta to the Clifton Court Forebay where some enters the South Bay Aqueduct for delivery to the Santa Clara Valley. The greater portion is lifted 244 feet into the California Aqueduct for delivery to the southern San Joaquin Valley and further lifted over the Tehachapi Mountains into Southern California.

Numerous additional developments have occurred in recent years in various parts of the State. Most significant of these is the joint State-Federal San Luis Reservoir west of Los Banos where California Aqueduct water is

stored for distribution to points south. Reservoir storage has been further augmented with new dams in the coastal mountains of Northern and Southern California and in the Sierra Nevada. Additional distribution canals have been constructed throughout the State.

## Environmental Concerns

As in the case of Egypt and Rome, California's development of its water resources has been at the center of its prosperity; nevertheless its massive water programs have always generated controversy. From the 1800s into the early part of this century, violence and legal battles raged on until court rulings and legislation brought a sense of order to events. While water rights continue to be an issue in localities around the state, the larger question today concerns the maintenance of environmental qualities. It is now widely recognized that in the flurry of growth and development of the past one hundred years considerable damage has been inflicted upon the environment. Plant and animal species have perished and major ecosystems have shrunk drastically in number and species composition. We have now begun to take heed and to prevent needless deterioration.

The Department of Water Resources has developed a new perspective in its resource-management responsibilities in recent years. Its present management plan balances engineering solutions with a more comprehensive approach that combines many elements including the use of ground and surface water, water conservation, reclamation and reuse of municipal, industrial, and agricultural wastewater and brackish groundwater. The severe drought of 1976 and 1977 gave further impetus to the new approach. In flood management non-structural alternatives for flood control are used; for example, natural floodways have been designated and development in them is prohibited. Today's more comprehensive approach to water management holds promise for creative environmentally sensitive solutions to our water needs.

# GROUNDWATER: CALIFORNIA'S HIDDEN RESOURCE

The plane circled toward the runway at Sacramento Metropolitan Airport as the sun was breaking through the clouds after the storm. The passenger turned to his seatmate, "I've been hearing about groundwater but I've never seen it before. Look at all of it out there." Below was an expanse of water ponded on farmland lying idle between crops.

In case our readers, too, think groundwater is water lying on the surface of the ground, we define groundwater as underground water, and more specifically, water in the Zone of Saturation, the top of which is called the water table.

Groundwater occurs everywhere in California. But some kinds of geologic materials have such small pores that they can store only small quantities of water and it can move through the deposit only with great difficulty. Water wells are not practical in this kind of material. Other kinds of materials, such as sandy and gravelly deposits laid down by rivers, marine sediments, or deposits of volcanic origin, have relatively large pores and are good suppliers of water in usable quantities and rates. Deposits of this kind are called aquifers and underlie about forty percent of California. The regions in which they occur are called groundwater basins.

The total storage capacity of groundwater basins in California is about 1.3 billion acre-feet, some four times the amount of water stored in the state in reservoirs. On the average, approximately 15 million acre-feet are withdrawn each year from these aquifers and about 13 million acre-feet are returned to them by natural precipitation, by percolation of water used in irrigation, and by artificial recharge. Thus there is an annual overdraft of two million acre-feet. Continued overdraft of groundwater supplies is sometimes called "mining" water, since it draws on supplies that have been stored up over geologic time.

Continued overdraft has a number of serious possible effects. The water table falls and wells may have to be deepened to continue in use. More energy is needed to raise the water a greater distance to the surface, increasing the cost of the water. The surface of the ground may sink as subsurface deposits compress. Salt water may invade coastal regions that sink below sea level. Poorer quality water, again including salt water in coastal areas, may invade the aquifer as fresh water is no longer present to keep it out. Springs may cease flowing, marshy areas may dry up, and natural surface vegetation may die if it no longer can reach the groundwater upon which it depends.

## Subsidence

Numerous examples of such effects exist in California. Widespread subsidence in the San Joaquin Valley has reached as much as thirty feet in places and has required modification of canals to maintain the slope necessary to transport water. Near San Jose, levees have been raised many times to hold back waters of San Francisco Bay. Saline water has entered depleted fresh-water aquifers in Orange County, the coastal plain of Los Angeles, near Oxnard in Ventura County, in the Salinas Valley, in the Pajaro-Santa Cruz area, and in Napa and Sonoma valleys at the north end of San Francisco Bay. Injection of fresh water to form an underground hydraulic barrier has solved this problem in the first two locations.

According to the Department of Water Resources, indications of overdraft exist in forty-two of the 394 groundwater basins identified in California. Eleven of these are considered in critical condition of overdraft. Eight of these are in the San Joaquin Valley, which has experienced overdraft for decades. The others are the Santa Cruz-Pajaro Basin, the Cuyama Valley Basin, and the Ventura Basin. Additional basins with special problems that have been identified are Surprise Valley in eastern Modoc County, Long and Sierra valleys in eastern Plumas and Sierra counties, and Owens Valley in Inyo County.

Storage of water in groundwater basins has some great advantages over surface storage in reservoirs. There are no losses to evaporation. There is no flooding of large regions. There is no impact upon fisheries dependent upon free-flowing rivers (although there may be diversions from such rivers to flood artificial recharge basins). Capitalizing upon these advantages and taking a cue from nature in noting that natural recharge takes place by percolation from stream channels and in fields where rainfall ponds, water managers have created artificial recharge basins, sometimes called spreading basins. There are many of these in the San Joaquin Valley. A hazard in utilization of groundwater is possible contamination by agricultural, industrial, or urban pollutants. This, too, has occurred in parts of California.

When surface water is scarce, as in a drought, groundwater may be substituted to meet needs. A problem in rational use of groundwater is that what one individual does on his or her own property alters the availability of water on neighboring property and eventually even throughout the entire basin. This is so because the underground aquifers do not observe property lines or political boundaries on the surface. Groundwater constitutes a "commons" and is subject to the abuse of resources held in common discussed by Garrett Hardin in his seminal essay "Tragedy of the Commons." No individual, Hardin would argue, is likely to hold back on pumping from the common pool for the sake of future benefits, because if he does so his "share" will most likely be used by someone else and he will be at an economic disadvantage. As long as pumped groundwater is cheaper than surface water and its use is unregulated, overdraft is likely to continue. But, except for a few local endeavors, there is at present no effective overall management of groundwater in the state.

A.Q.H.

*With the technical assistance of Helen J. Peters*

*Cordylanthus palmatus* is a very rare dweller of the Central Valley that has been driven to the brink of extinction by a combination of development — primarily for agriculture — and falling water tables due to groundwater pumping. By 1973, its last known natural population, in Fresno County, had disappeared. In 1978, however, a new population was discovered by Beecher Crampton near the Woodland city dump in Yolo County. Ways are being sought to preserve the habitat at this new site. Photograph by Lawrence Heckard.

Photograph by Mary DeDecker.

## OVERDRAFT VICTIM

*Sidalcea covillei,* the Owens Valley mallow, is a perennial relative of the hollyhock and is endemic to moist alkaline meadows in Owens Valley east of the Sierra. One of its major stands, appearing to the monographer of the genus like "a meadow full of shooting stars," is now under Haiwee Reservoir, part of Los Angeles Department of Water and Power's aqueduct system conveying Owens Valley water to the City of Los Angeles. The drying of Owens Valley, rapidly accelerated by the pumping of groundwater since the second aqueduct was built in 1970, has destroyed most of its moist meadows. The loss of previously known populations led to the fear that the species had been totally extirpated by 1978. Since that time, however, remnant populations have been discovered in some previously unknown localities. But this does little to lessen concern for the survival of the species because all populations of any significance are on land owned by the DWP. That agency has shown little understanding of the requirements of the species and no sincere interest in providing a reliable water source. A population southeast of Independence on pasture land east of the aqueduct received no water in 1981 despite strong assurance that it would "always" be watered. The clayey soil was brick-hard in midsummer and the plants showed extreme stress. The intrusion of rabbitbrush on the Horton Creek site as seen in the photograph indicates a drying meadow, all too typical of the plant's deteriorating habitats.

Mary DeDecker

# CALIFORNIA WATER RIGHTS LAW: THE NEED FOR CHANGE

by Harrison C. Dunning

The year 1982 appears to be a rare crucial juncture in popular decision-making on California water policy. On three previous occasions in this century Californians have voted on fundamental questions of water policy — in 1914, the people approved regulation of previously unappropriated surface water; in 1928, the people approved a constitutional amendment limiting all water rights to reasonable and beneficial use; and in 1960, the people narrowly approved the first phase of the State Water Project.

In 1982, one and possibly two decisions of comparable importance will be on the ballot: in June, the people will decide on a second phase of the State Water Project, including the highly controversial Peripheral Canal; and in November, the people may be asked to approve the Water Resources Conservation and Efficiency Act, an initiative measure for which signatures are now being collected.

The State Water Project, like all water projects, operates under California water rights law. I aim here to review the characteristics of the principal water rights recognized in California, to review the public-interest limitations placed on water rights by the voters of 1914 and 1928, and to discuss the need for some important reforms in current California water rights law.

## Appropriative Water Rights

When Gold Rush fever brought thousands of prospectors to California's foothills in the late 1840s, they treated their water as they treated their gold: "first in time, first in right." This principle, known later as the system of "prior appropriation," was quickly accepted by the California courts and later was copied throughout the western United States.

Under the appropriative water right thus recognized, water is an independent natural resource allocated separately from land. Land ownership does not confer water rights, nor is land ownership technically needed to perfect an appropriative water right. A consequence of this notion is that water once appropriated may be used where needed, not necessarily along the stream nor even within the watershed of origin. Gold miners often sent appropriated water many miles to the place of need; later, coastal cities brought water from the mountains. Beneficial use rather than land ownership came to be the central requirement for the appropriative water right in the western United States.

In recent years an important controversy has raged whether "diversion," i.e., some form of physical control of the water, is a necessary part of an appropriative water right. In the past appropriators *have* diverted the water by canals or by construction of dams. But neither California statutes nor the California Supreme Court explicitly requires such physical control. In two recent test cases, organizations interested in fisheries have sought so-called "instream appropriations" to insure minimum flows in particular streams. In both cases the State Water Resources Control Board (SWRCB) refused to process the applications, taking the position that California law requires "control akin to possession" for an appropriative water right. The Court of Appeal agreed with the SWRCB in both instances.

## Riparian Water Rights

Although the riparian water right of the Anglo-American common law prevails in the eastern and midwestern United States, many western states, but not California, repudiated it as unsuited to semi-arid conditions, since it is thought to provide little security of investment. In most respects, this right is entirely different from the appropriative right. It depends on land ownership — one must have riparian land — but does not require use — an unexercised right has the same status as an exercised right, although the California legislature has placed some limitation upon that principle.

The riparian water right must be used on a riparian parcel within the watershed, apparently on the principle that land and water go together and that water used within the watershed will be returned, at least in part, to the stream for which it was diverted.

## Groundwater Rights

According to the common law, groundwater was allocated according to ownership of the land above the groundwater reservoir. But there was no protection against a neighbor's pumping and drawing away one's groundwater, and the California courts in 1903 adopted a series of rules that are sometimes called the "doctrine of correlative rights." This provides that the paramount groundwater right goes to an overlying owner using the water on land overlying the groundwater basin in question. Another early case established that the land must be owned by the pumper. Thus, a city pumping groundwater to irrigate its municipal golf course is exercising an overlying right, but a city pumping water from the same basin and delivering it to property owners is not. The riparian principle is followed in case of dispute among the overlyers — each is entitled to a reasonable share, and overlyers have rights whether these are exercised or not.

The courts have also decided that surplus groundwater is available for appropriation, and that the "first in time, first in right" principle of allocation applies. Thus the basic legal framework for groundwater closely parallels the California surface water regime.

It is questionable how practical these rules for groundwater allocation are. Most of the major adjudications of groundwater basins that have occurred in California have utilized a different principle, that of "mutual prescription," which serves in practice to make legitimate the status quo. But a recent decision of the California Supreme Court raises doubt that the doctrine of mutual prescription will again be imposed in a groundwater adjudication, so earlier solutions are relevant but seem to present serious difficulties for complex basins, for example in sorting out overlying uses from appropriative uses or determining priorities for the latter. In many cases of surface water use, diversion occurred early and the pattern of use has remained relatively constant. This is not so for groundwater, where pumps are added occasionally and the amounts being pumped vary with availability of surface water.

Moreover, owners of parcels over groundwater basins are linked in that when one of them pumps from the aquifer, all are affected to some extent. Those who pump will receive all the benefit of the use of water, but both those who pump and those who do not pump will suffer any detriments, such as subsidence of the surface, intrusion of sea water, or increased energy costs for a longer pumping lift. This imbalance of benefits and burdens provides a strong incentive to each overlying user — and, if there is a surplus, to any potential appropriator — to exploit the resource; there is every likelihood that overexploitation will occur.

Thus some form of collective or public decision making is needed. In California, two approaches have been utilized. In a few areas, such as Orange County and the Santa Clara Valley, water districts have been established and given powers to manage the basin for the common good. In other areas there has been adjudication. In Southern California more than half a dozen water basins have been adjudicated and now are managed by water masters acting under the jurisdiction of the court. This allows a lid to be placed on total pumping from the basin in particular years in order to avoid harmful impacts on all users.

Cooperation among interested parties is necessary if the aquifer is to be managed like a subsurface reservoir. In recent years interest in such management, generally known as "conjunctive use," has increased. Conjunctive use means that the surface reservoirs and natural underground reservoirs are operated in tandem, so that in dry years more is taken from subsurface sources and in wet years more is taken from surface sources. To many, conjunctive use suggests that full groundwater basins should be pumped down to some extent to create storage space for surplus waters in wet years.

## Public Interest Limitations on Water Rights

Early decisions established that riparian rights are recognized in California and that in most cases they are paramount to appropriative rights. By definition, the "reasonable share" concept of riparian law means riparians are limited by a standard of reasonableness. Appropriators, on the other hand, are entitled to a given amount of water in accordance with their respective priorities. In disputes between a riparian and an appropriator, the courts early in this century determined that the riparian was limited neither by a standard of reasonableness nor to a quantified amount. This conclusion caused considerable difficulty for appropriators and in some instances appeared to permit waste in a most dramatic fashion. This led to a constitutional amendment intended to add a reasonableness standard to riparian rights but the provision was written as a general prohibition of waste. The most pertinent language is as follows:

> 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 method of use or unreasonable method of diversion of water.

Although this clearly states what has become a central tenet of California water rights law, that all use of water must be reasonable and beneficial, there is little guidance as to the meaning of these terms. The courts have been very lenient in determining that a use is "beneficial" and but slightly more stringent with regard to what is "reasonable." In general they have merely stated that reasonableness determinations must be made on a case-by-case basis and do not respond to any general formulas.

## The Permit and License System

Another limitation on water rights is the permit and license system operated by the State for appropriation of surface water from 1914 on. Control of such appropriations was recommended by the Conservation Commission in its report of 1912, was initiated by the Water Commission Act of 1913, and was approved by the people in a referendum held in 1914. The Conservation Commission noted the need to regulate groundwater, but, in the absence of sufficient study, did not recommend a statute.

A major concern of the Conservation Commission was to make effective the beneficial-use limit already existing for appropriative rights. There was no agency with information as to who the appropriators were, what their rights were, or whether the rights were being properly exercised. All this has changed since 1914, when administrative control, now exercised by the SWRCB, began. The Board reviews applications to appropriate water and examines whether the vested rights of others will be adversely affected. Permits are issued to divert water and, when construction of facilities is completed, a license is issued. Generally conditions limiting the exercise of water rights are placed in both permits and licenses, some of them merely repetitions of statutory and constitutional requirements, others tailor-made to fit a particular situation. Violation of any of the provisions could lead to revocation of a right.

Administrative controls are tightest at the time when the application is being processed. Subsequently, there appears to be little review by the SWRCB, barring a complaint.

Limitations in permits are much less easy to enforce if the permit is held by a federal agency. The key recent test case has involved the New Melones Dam on the Stanislaus River. The authority of the State to impose terms and conditions on the permits issued to a federal agency for operation of the dam was challenged. The federal government clearly has the constitutional right to ignore any terms and conditions imposed by a state, but in Section 8 of the Reclamation Act of 1902 Congress directed that state law be observed in certain respects in reclamation projects. The United States Supreme Court, apparently modifying its views on Section 8, recently concluded that California may impose terms and conditions not inconsistent with a clear Congressional directive. Thus terms and conditions may be imposed on federal permittees, but for each one the question may be asked (and is now being asked regarding New Melones) whether the provision conflicts with a clear Congressional directive.

## The Possibility for Reform

Given the political realities of both federal and State water projects, of powerful local and regional water agencies, and of the different values and objectives of the public and private entities holding water rights, a single statewide water management program is out of the question. There are, however, three areas where progress may occur.

*Groundwater Management.* California is unlike most western states in failing to regulate groundwater. Surface streams are to some extent protected against overdrafting because applications to appropriate water may be denied to protect beneficial instream uses. But protection against overdrafting of groundwater basins is provided only sporadically. The Governor's Commission to Review California Water Rights Law drew attention to this problem in 1978 and recommended adoption of a state policy aimed at eventual elimination of overdraft in most situations. Local governments were to be primarily responsible for achieving this goal, but with review by state government. The topic is controversial among farmers, many of whom oppose any interference with their present freedom in most parts of California to pump unlimited quantities of groundwater. The solution to continued overdrafting of groundwater basins, they say, is more surface supply through more dams on the northern rivers, including those now protected by the Wild and Scenic Rivers Act.

The Water Resources Conservation and Efficiency initiative deals with groundwater management more narrowly than did the Governor's Commission to Review California Water Rights Law. This measure — available in full from the California Water Protection Council, 401 San Miguel Way, Sacramento 95819 (telephone 916/453-0443) — adopts groundwater management as state policy to avoid conditions of long-term overdraft, land subsidence, water quality degradation, and other significant environmental harm. It states that local economies shall be predicated on reliable, long-term water supplies and not upon long-term overdraft. But implementation is confined to the eleven groundwater basins identified by the Department of Water Resources as currently critically overdrafted. For these basins, local entities must establish a groundwater management authority, which in turn must develop a groundwater management program to be approved by the SWRCB. No provision is made for the state to manage the groundwater resources of these basins if local entities fail to act. The initiative measure does state, however, that if no groundwater management program is approved by the Board by one year after the effective date of the legislation, no land within the given overdraft area shall be irrigated unless it has a recent irrigation history. Thus at least matters cannot be made worse by irrigating land not recently irrigated.

*Instream Flows.* The SWRCB now has considerable authority to protect instream flows for purposes such as recreation and fishing. It may, however, lack authority to develop an adequate comprehensive regulatory scheme for a particular stream to preserve instream flows, and it also apparently lacks authority to grant appropriative water rights for instream uses involving "control akin to possession." The Governor's Commission to Review California Water Rights Law felt it inadvisable to grant the latter authority as a permanent matter because the interests being protected are diffuse and essentially public. The Commission recommended that authority to develop comprehensive instream flow regulations be explicitly granted by the legislature to the SWRCB, but so far this hasn't happened.

On the question of instream flow protection, the Water Resources Conservation and Efficiency initiative departs somewhat from the approach of the Governor's Commission to Review California Water Rights Law. The initiative gives the SWRCB clear authority to establish instream flow protection standards. But it also provides for the permanent appropriation of water for instream uses without the necessity for physical control of the water if the SWRCB finds this to be in the public interest and not in violation of law. Furthermore, it requires that where conventional appropriations adversely affect fish and wildlife dependent on instream flows, conditions to mitigate those impacts be imposed upon permittees.

Under the general heading of instream-flow protection, the Water Resources Conservation and Efficiency initiative also addresses filling the reservoir created by New Melones Dam on the Stanislaus River. This dam, one of the most controversial ever to be built in California, is federal so that any limitations imposed by state law involve delicate questions of state-federal relations. Insofar as the initiative measure would affect federal agencies, the provisions generally correspond to those imposed by the SWRCB. But it also imposes limitations on water contractors, including subdivisions of the state such as water districts. These subdivisions may not contract for New Melones Project water unless (1) the contracts are conditional upon 75% of the firm yield of the project being contracted for and (2) the contracts use a pricing formula that eliminates a large part of the massive subsidy characteristic of federal water projects.

*Water Conservation.* Water conservation is of increasing concern. The constitutional amendment of 1928 lays

down a broad antiwaste standard with considerable potential for development by the courts. But the water rights system works against conservation in some ways, for example, by requiring continued beneficial use for maintenance of a water right. It has also been suggested that new water should not be available to importing areas until they have demonstrated an adequate commitment to water conservation. Again, however, the legislature has been unreceptive to such urgings.

The Water Resources Conservation and Efficiency initiative imposes requirements for conservation only where there are interbasin transfers of water of more than 20,000 acre-feet of water per year. Water suppliers or contractors engaged in such interbasin transfers would be required by the initiative measure to prepare a water conservation program and submit it to the SWRCB by January 1, 1985. Furthermore, after the effective date of the legislation, no new or increased interbasin transfer would be permitted until the Board had determined that an adequate water conservation program had been prepared and was being implemented.

California water rights law to date has generally been more concerned with water development than with water conservation and efficiency in use. Similarly, the "water industry" — those companies, cities, and water districts charged with day-to-day water-supply responsibilities — have been more concerned with expanding capacity through building new water projects than with conservation. But times are changing. For example, some electric utilities, which ten years ago were busy promoting the use of more electricity, have now taken the lead in promoting energy conservation. It seems inevitable that at some point the water industry will make a commitment to conservation as thorough-going as its present commitment to development. Reform of California water rights law to introduce a conservation ethic should help this transition take place.

# WATER USE — ARE GREATER EFFICIENCIES POSSIBLE?

## by David F. Abelson

The year 1982 is a critical one for California water policies and the state's water future. A referendum on the Peripheral Canal will be held in June, a Water Conservation Initiative drive is well under way for the November ballot, the 1902 Reclamation Act is being debated and restructured by Congress, and major judicial opinions affecting Mono Lake and the Stanislaus River-New Melones Dam controversy are expected this year. In the midst of all these issues are the citizens of California, whose decisions will play a critical role in determining the state's water policy for at least the next generation.

Whereas land is traditionally measured in acres and road trips in miles, water is measured by the "acre-foot." An acre-foot is the amount of water it would take to cover one entire acre of land to the depth of one foot. One acre-foot of water is equivalent to 326,000 gallons of water. It is enough water to provide for all the domestic needs (*e.g.*, showers, gardens, toilets, sinks, cooking, etc.) of a family of five for an entire year.

On the average, California receives approximately 200 million acre-feet (hereinafter "maf") of fresh water each year from rain, fog, and snowfall. However, much of this water is not recoverable for human uses because approximately 130 maf either evaporates or is transpired by natural vegetation, or runs off into tiny streams unsuitable for damming.

Nevertheless, a tremendous renewable water resource (*i.e.*, 70 maf) is available for human uses in the state each year. Of that 70 maf, approximately 36 maf has already been "developed" and is employed for such diverse purposes as agriculture, hydroelectric generation, industrial processing, and domestic needs. The remaining developable water resources continue to function as natural systems, recharging groundwater basins, providing for the needs of fish and wildlife, carrying mountain sediments to sea and thereby restoring beaches eroded by wave action, purging our rivers, estuaries, and bays of man-made pollutants, and providing recreation and inspiration for millions of people throughout the state.

One point needs to be emphasized. Because California has an annual developed water supply of approximately 36 maf, there is *absolutely no way* to run short of supplies for domestic needs such as drinking, washing, etc. Thirty-six maf is enough water to provide for all of the domestic needs of 180 million people (*i.e.*, three-fourths of all the people living in the United States today). State law has long provided that the highest and best use of developed water is for domestic purposes. While it is true that much of our developed supply is now being used for other purposes, anyone who says your taps may run dry if we don't develop more water is either ignorant of the facts and the law or is attempting to mislead you.

Our 36 maf of developed water comes from four principal sources. The first source is water pumped from huge *groundwater basins* scattered throughout the state. These basins hold several hundred maf of water in vast underground lakes and channels, but at present only about *16 maf a year* are extracted, owing largely to the tremendous energy costs of pumping water from ever greater depths to the surface.

The second major source of developed water comes from the large *state and federally owned water project dams* located within the state. These projects (Trinity Dam, Shasta Dam, Oroville Dam, Folsom Dam, New Melones Dam, Kings River Dam, etc.) produce about *10 maf* of water per year, storing water during the winter and spring runoffs and then transporting it up to 600 miles or more for use at some later time.

A third source of water is the *Colorado River,* which traverses seven states before entering Mexico. California is now receiving about *5 maf* of water annually from this source.

Finally, there are the myriad projects of various *local governments* (*e.g.*, San Francisco's Hetch Hetchy Dam, Los Angeles's Owens Valley and Mono Basin ground and surface diversions, etc.), which yield approximately another *5 maf* to the average annual pool.

In summary then, California has developed about half of its recoverable water supplies (*i.e.*, 36 maf). Groundwater provides roughly 16 maf; state and federal dams within the state provide about 10 maf; the Colorado River provides approximately 5 maf; and local projects provide about another 5 maf.

## Existing Uses

Existing uses of California's developed water supplies can be divided into two major categories: municipal-industrial and agriculture.

*Municipal-industrial* (M&I) needs currently consume *about 5 maf per year* of our water supplies, or about fifteen percent of the 36 maf that have been developed. M&I uses include domestic needs (*e.g.*, showers, toilets, cooking, gardens, etc.), municipal activities such as sewage treatment, street cleaning, and golf-course watering, and industrial processing such as steam generation for heating, electricity, and the production process (*e.g.*, canning fruits and vegetables).

However, by far the greatest use of our developed water supplies is for California's irrigated *agricultural production.* This sector utilizes approximately eighty-five percent, or *about 31 maf annually* of the state's developed water supplies. In turn, it produces about $10 to $15 billion a year of California's $100 billion or more economy.

It is estimated that California has potentially thirty to forty million acres of arable land. However, at present only about nine million acres are being irrigated and some additional land is dry-land farmed with reliance only on natural rainfall for moisture. Since the average irrigated farm in California uses about three acre-feet per acre annually, it is apparent that there will never be enough fresh water to irrigate *all* of the state's potential farmland, even if every stream and lake were totally utilized in an effort to do so. Therefore, it is important that our existing agricultural water supplies be used as efficiently and productively as possible. Unfortunately, that does not appear to be the practice at the present time.

Of the 31 maf used in farming, approximately 16 to 18 maf are devoted to the production of forage crops (*i.e.*, cattle food such as irrigated pasture, alfalfa, sorghum, etc.). This is a questionable use of our existing water supplies for several reasons. First, forage crops are among the most water-intensive crops grown in California, consuming four to five acre-feet of water per acre of production per year. Second, forage is an extremely low-value crop, yielding only about thirty percent of farm revenues while consuming fifty-five to sixty percent of farm water resources. Third, forage is grown, in part, to fatten cattle that originate as calves in Texas, then are trucked to California for fattening, from there to the Midwest for slaughter, and finally back to California for consumption. This wasteful energy triangle is particularly difficult to justify in view of the vast acreage of naturally irrigated forage land lying fallow in the Midwest owing to a lack of economic demand for the product. Finally, it must be recognized that cattle and forage are *not* exported, *i.e.*, they are not used to "feed the hungry world," nor do they help keep our import-export trade in balance.

Other major California crops with similar shortcomings are cotton and rice, the relocation of which to California has displaced much of the economy of the southern states. More readily understood is California's production of crops such as fruits and vegetables, which often consume less water than forage and, in some cases, do provide food to those abroad, while helping with our international balance of trade. Yet these crops receive only a relatively small percentage of California's agricultural water supplies. Whether we wish to continue the present inefficient use of much of the state's agricultural water resources is a major policy issue that must be understood and dealt with in the water-policy decisions of 1982. As will be noted below, elimination of water subsidies will help to promote the economic decisions that are likely to reduce much of the current waste in California's agricultural use of water. This, in turn, can help to ensure that our future water needs are met in an efficient, equitable, and environmentally sound manner.

## Future Needs

While there is substantial debate concerning the means for meeting California's future water needs, there is relatively little disagreement about what those needs are.

First and foremost, we must reduce or eliminate the 2.2 maf *groundwater overdraft* that exists in certain portions of the state, principally in the San Joaquin Valley. This overdraft is the result of pumping more water from the ground than is annually recharged by rain, runoff, etc.

A second need is to compensate for the loss to California of about 600,000 acre-feet of *Colorado River* supplies when the Central Arizona Project (CAP) is completed, sometime in the late 1980s. In 1964 the U.S. Supreme Court rendered a final opinion regarding Arizona's and California's rights to Colorado River water. That opinion will enable Arizona, once the CAP is completed, to take about 600,000 acre-feet of water at present used in California.

Finally, there is the issue of *population growth* in California. While there is no legal duty for the state to continue to develop water to accommodate additional population growth, it is prudent to assume that the political pressures for continued growth will require that adequate water be made available to meet that growth. If we assume that approximately ten million more people will live in California in the next generation, they will require approximately 2.0 maf of water to meet their needs. (Recall that one acre-foot will meet the domestic needs of a family of five at current consumption levels.)

Delta irrigation. Photograph by Verna R. Johnston.

In summary, approximately 4.7 to 5.0 maf of water is needed to meet California's needs in the next generation: (1) 2.2 maf for eliminating groundwater overdraft; (2) 600,000 acre-feet to replace Colorado River water taken by Arizona; and (3) 2.0 maf for future population growth.

At present there are two principal options for meeting California's future water needs. The first is to continue past practices and includes development of additional large water storage and diversion projects, as embodied in the June 1982 referendum on SB 200. The alternative is to increase efficiency in use of existing water supplies; it is contained in proposals such as the Water Resources Initiative, now seeking signatures to qualify for the November 1982 ballot. The following sections will discuss briefly these alternatives to aid in the choices we will soon be asked to make on this subject.

## SB 200 and the Peripheral Canal

In 1980, after four years of debate, the State Legislature passed SB 200 (the Peripheral Canal Bill) and it was signed into law by the Governor. Never in the history of California politics had so much money been spent to lobby a bill through the Legislature. However, opponents of the bill quickly rallied and in record-breaking time qualified the proposal for a referendum by the people in June of 1982.

In essence, SB 200 proposes to meet the state's future water needs by building a forty-three mile channel around the Sacramento-San Joaquin Delta near Sacramento. The channel will be wider than twenty lanes of freeway and deep enough to float a supertanker. Winter and spring runoff flows from the Sacramento River, which currently renew fish and wildlife habitat in the Delta and flush San Francisco Bay of pollutants, will be diverted into several large storage reservoirs, authorized by the legislation. The total additional water from the package is estimated at between 1.6 and 2.6 maf, plus a 750,000 acre-foot "goal" of *urban* conservation and reclamation. There are no provisions for agricultural conservation. At best, the project will produce 3.3 maf of California's estimated future water needs of about 4.7 maf.

Today the cost of the project is said to be about $5 to $7 billion, but a more realistic figure has been set forth by the State Department of Water Resources, which estimated that the State Water Project (SWP) would cost between $10 and $23 billion before completion in the early part of the next century. The SB 200 package will also have the effect of *doubling the electrical demand* of the State Water Project because power is needed to move the

water from north to south. Since the existing SWP is already the single largest consumer of electricity in the state, impacts on the state's energy from this proposal are serious.

The SB 200 package is seriously flawed on a number of levels including: (1) its failure fully to meet projected state water needs; (2) its extremely high cost and total lack of cost comparisons; (3) its failure to deal with California's groundwater overdraft problems; (4) its failure to eliminate wasteful subsidies in the existing SWP; (5) its high demand on the state's electrical resources; and (6) its potentially devastating effect on the environment of the San Francisco Bay-Delta system and the North Coast rivers.

## The Water Resources Initiative

The Water Resources Initiative now gathering signatures for the November 1982 ballot seeks to meet California's future water needs in an entirely different manner from that of SB 200.

It is well established that without any radical change in lifestyle fifteen percent, or about 0.75 maf of *urban water uses can be conserved* through techniques such as low-flow shower heads and toilets with smaller flush tanks. This type of savings can also save energy by reducing hot water bills. In addition, two major *urban wastewater reclamation* studies were recently completed, revealing that up to 1.0 maf of treated wastewater now discharged into the sea can be reused for purposes such as watering golf courses, freeway landscaping, etc.

In the *agricultural* sector *conservation* figures vary from five to fifty percent. Assuming a ten percent savings through techniques such as drip irrigation, laser leveling of fields, lining of irrigation ditches, etc., *over 3 maf* could be conserved annually. For example, recently it was confirmed that about 1 maf of the state's Colorado River water supply is lost to the Salton Sea each year through unlined ditches and excessive irrigation in the Imperial Valley. *Agricultural wastewater reclamation* may yield an additional 0.5 to 1.0 maf of water for salt-tolerant plants. Genetic advances make this area more promising each year. In short, *at least 5 maf* of existing supplies can be used more efficiently, thereby more than meeting our future water needs of 4.7 to 5.0 maf.

The Water Resources Initiative in essence does three things to promote this outcome. First, it requires that any major importer of water from another water basin prepare and implement a water conservation plan to ensure *that all cost-effective conservation and reclamation alternatives are being implemented before importing more of California's undeveloped water supplies*. Second, in the state's eleven critically overdrafted groundwater basins, *groundwater management plans* must be created to reduce or eliminate the overdraft before more new water supplies can be imported to those basins. Finally, authority is provided to ensure that, where the public interest is served, *adequate water remains in our streams and lakes* to protect the natural flora and fauna and the recreation and esthetic values of these waters.

The Water Resources Initiative does *not* foreclose future water development but it does attempt to put such development on a rational economic and environmental basis, which has been and still is lacking under existing state water policy.

# FACING THE ISSUES OF THE PERIPHERAL CANAL

### by Michael H. Remy

When the public votes on the SB 200 referendum this June it must decide between varying visions of California's future without having been given a blueprint of what either vote, "yea" or "nay," really means. The respective campaigns to gain the voters' allegiance are being waged on pseudo-issues. California water politics are based on non-decisions. For example, because of the failure of leadership and the paralysis of the legislative process, it is today the policy of California to allow the groundwater table to drop. Equally it is the policy of California to allow the water quality, fisheries, and wildlife of the Delta to decline. In short, it is the political policy of California to do nothing, despite serious problems.

The political process that brought us to this condition can be described as one that fosters diverse and unlikely alliances and results in political stalemate. The SB 200 referendum represents one of the greatest opportunities in the history of California water politics to break the mold. Unfortunately, however, another stalemate is likely, and the meaning of the vote on the referendum is likely to be misinterpreted no matter what it is.

The proponents of the Peripheral Canal maintain that this facility will solve the Delta problems associated with saline intrusion while filling their — the proponents' — primary purpose of moving the water south. The Canal is an unlined ditch, forty-three miles long, four hundred feet wide, and thirty feet deep, with a capacity of 16.3 million acre-feet per year — enough to carry over seventy percent of the average flow of the Sacramento River. The facility skirts the east side of the Delta, pumping water from the Sacramento River near Hood and transporting it to Clifton Court Forebay for further pumping into the aqueduct. Along the way, it would have twelve gates from which water could be released into Delta channels to create a westward flow and prevent saline intrusion. Having participated in the preparation of environmental impact reports on the Peripheral Canal, both from the inside in 1973-1974 and the outside in 1979-1980, I am

convinced that the Peripheral Canal represents the best engineering solution to various environmental problems of the Delta if increased export of water to the south is inevitable. Environmentalists argue that increases are avoidable and undesirable. How the canal would be operated in times of environmental or political stress has them legitimately concerned.

## The Cross-Delta Canal

An alternative to the Peripheral Canal currently receiving renewed attention is the Cross-Delta Canal, so called because it proposes to transport water directly through existing channels. Such a system has always been favored by agricultural interests and could be implemented rapidly at allegedly lower costs. It is generally recognized, however, that this alternative would cause further decline of fish and wildlife resources in the Delta and the Suisun Marsh. Furthermore, it does not provide the same range of operational possibilities as does the Peripheral Canal. Environmentalists fear that the Peripheral Canal will be operated to the detriment of the environment in stress situations — such as drought — while agriculture fears that environmental restraints may deprive them of needed water under such circumstances. Both sides feel themselves at the mercy of an unpredictable future. The fact that the Cross-Delta facility removes much of the ability to vary the operations is thus one of the reasons that it is favored by agricultural interests.

The Peripheral Canal cannot, however, solve all the problems associated with the Delta and does not create the additional water supply needed to meet the projected export demand for 7.5 million acre-feet by the year 2000. It includes off-stream water storage components north and south of the Delta and additional facilities in the Delta. The real question is whether water management measures, policies, and legal safeguards will be adequate to control adverse effects of increased withdrawals from the Sacramento-Bay-Delta system. In voting for the Peripheral Canal, the public is delegating decision-making to future administrations that will be subject to unknown political pressures to respond to environmental and economic needs not yet appreciated or clearly understood. Furthermore, the facilities in SB 200 additional to the Peripheral Canal have not been adequately studied for their engineering, environmental, and economic feasibility. Approval of the Peripheral Canal at this stage is likely to discourage badly needed study, thought, and the search for reform. The answer to the need for environmental protection, economic efficiency, and safeguards for water supply lies in our learning to use more wisely those water resources we already have. The question before the voters is whether we shouldn't reform the state's water law, policies, and practices before further expanding the supply. The rational, as opposed to a pragmatic, answer to that question is an emphatic yes. It is a question of enlightened long-term self-interest as opposed to the short-term gratification of merely enlarging the plumbing system. Whether or not the Peripheral Canal is built, however, we need to reform our laws, policies, and practices.

## Divergent Views

Environmentalist opponents of the Peripheral Canal hope not only to defeat SB 200 but also to focus attention on the need to reform California water law. But their unusual alliance with farming interests as Californians for a Fair Water Policy does not appear to be producing the desired educational campaign to foster reform. The Coalition for the referendum is focusing on the environmental impacts of the Peripheral Canal for the northern vote and on its economic impacts for the southern vote. As a matter of fact, literature soliciting support for the Coalition implicitly advocates the Cross-Delta alternative as the most practical and least costly proposal and states that using the existing natural waterways across the Delta would cost 80% less than the proposed SB 200 package. Most environmentalists believe that the Cross-Delta alternative is less capable of addressing their concerns and thus clearly less desirable than the Peripheral Canal. The danger is that a vote against SB 200 will be viewed as a vote for the cheaper Cross-Delta alternative, thus inviting its implementation. The controversy over SB 200 in the Legislature centered on the Peripheral Canal even though environmental organizations attempted to incorporate broader concerns for water-policy reforms in the measure. A similar focusing of the controversy on the Peripheral Canal during the referendum campaign will not create public understanding of the need for reforms.

## November Ballot Measure

Recognizing this dilemma a coalition of environmental, consumer, sport-fishing, and other interests, as well as many experts in water law and management, formed the California Water Protection Council. This organization takes no position on the Peripheral Canal (SB 200 referendum) but rather has put into one package a number of water-policy reforms needed no matter what the outcome of the referendum this June. This measure will be presented to the voters this November.

The California Farm Bureau and the Cattlemen's Association have withdrawn their support for SB 200 supposedly because of Proposition 8, which was passed along with SB 200 to provide further protection for North Coast rivers and Delta water quality. These two organizations hold the hope that a less protection-oriented and cheaper Cross-Delta facility will follow after a negative vote on the Peripheral Canal, which would eliminate both SB 200 and Proposition 8. These organizations are not interested in providing a platform from which to advance water policy reform.

The issue should not be just whether the Peripheral Canal is the best physical facility to increase the export of water. Rather it should be what authorization of the Peripheral Canal will mean to the water-policy future of California. Whether we build the Peripheral Canal or not, management of our scarce water resources needs attention that it may not get if the voters do not understand what is at stake.

# OTHER ELEMENTS IN THE PERIPHERAL CANAL PACKAGE

It is not commonly realized that SB 200 involves several facilities besides the Peripheral Canal. Some of these are considered alternatives with the choices left to some future director of the Department of Water Resources. Several are of particular interest because of possible environmental impact, including on the native flora.

Los Vaqueros, a pumped-storage reservoir of about 5000 acres drawing water from the Delta, would be built in eastern Contra Costa County in a region with eighteen known earthquake faults, some recently active and capable of considerable movement. The region is habitat for several rare or uncommon animals, including the San Joaquin kit fox, golden eagle, prairie falcon, ringtail cat, red-legged frog, and Alameda striped racer. Sandy deposits inhabited by coast horned lizards and desert-related plants are discussed elsewhere in this issue. They may be part of the story of how the desert-related ecosystem at the Antioch Dunes (*Fremontia,* October 1980) got there. There are also significant archeological values at Los Vaqueros and real concern that all might be threatened, if not directly by construction activities, indirectly by fostering related development nearby.

Los Banos Grandes, another pumped-storage reservoir of about 14,000 acres, is considered an alternative to Los Vaqueros. It would lie in the eastern foothills of the South Coast Ranges between the present San Luis and Los Banos reservoirs in western Merced County and would store water from the California Aqueduct. Apparently only very preliminary biological investigations have been conducted there, but it is considered a very interesting area, a likely habitat for blunt-nosed leopard lizards, the San Joaquin kit fox, and Fresno kangaroo rats, all animals of concern.

Fishing on Joice Island. BCDC photograph.

This complex comprises several reservoirs, the largest of which are Newville and Rancheria, together with connecting canals and several pumping-generating plants, all primarily to store water pumped several hundred feet up from the Sacramento River. The major adjacent reservoirs would cover about 62,000 acres, about twice as much as Shasta Lake, the largest existing reservoir in the state. The site is in the foothills of the North Coast Ranges from Paskenta on Thomes Creek in the north southward along the valley of Stony Creek almost to East Park Reservoir. Northerners are not reassured to know that across the mountains to the west is Round Valley, the site of the proposed Dos Rios dam and reservoir of a few years ago that would have tapped the headwaters of the Eel River and diverted its waters into the Sacramento via a tunnel. Southerners have several times admitted to long-term designs on North Coast rivers as sources of additional water.

Though the terrain consists of large tracts of grassland and blue-oak woodland, botanists have found populations of several rare plants in or near the area of inundation: *Antirrhinum subcordatum, Eriastrum brandegeae, Fritillaria pluriflora, Collinsia greenei, Euphorbia ocellata* var. *rattanii, Nemacladus montanus, Amsinckia lunaris, Allium craterícola,* and *Navarretia jepsonii.* The surrounding serpentine chaparral is largely unexplored botanically.

The Colusa Reservoir–River Diversion would occupy 30,000 acres and is considered a partial alternative to the Glenn Reservoir complex. It also would be a pumped-storage facility drawing upon Sacramento River water. Here, too, apparently only preliminary biological investigations have been conducted.

Unspecified protective facilities for the Suisun Marsh are authorized in SB 200. The marsh comprises about 85,000 acres of tidal marsh, managed wetlands, and waterways in southern Solano County downstream from the Delta. The largest remaining wetland of San Francisco Bay, whose marshes had been about 95% destroyed by the early 1960s, it constitutes about ten percent of the wetlands remaining in the state and thus is very important for waterfowl of the Pacific Flyway. Its estuarine location enables it to support a diversity of plant communities. Rare plants there include *Aster chilensis* var. *lentus, Cicuta bolanderi, Cordylanthus mollis* subsp. *mollis, Cirsium hydrophilum* var. *hydrophilum, Lathryus jepsonii,* and *Lilaeopsis masonii.* Rare animals include the giant garter snake, salt marsh harvest mouse, Aleutian Canada goose, bald eagle, peregrine falcon, California black rail, and yellow-billed cuckoo. The sloughs in the marsh are major habitat for striped bass and the *Neomysis* shrimp that is their primary food. Most of the marsh is managed

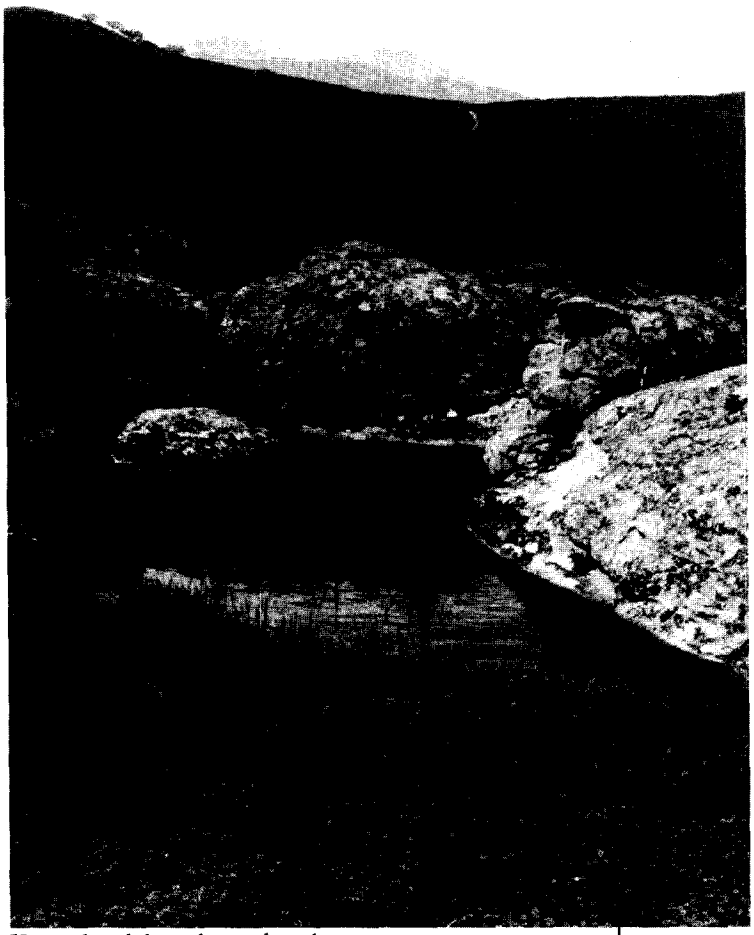
## DESERT OUTPOST AT LOS VAQUEROS

The Los Vaqueros Reservoir, if constructed as provided in SB 200, would lie in what appears to be a typical Coast Range valley of grasslands and oak woodlands. A closer look shows it as special. Great sandstone monoliths to the south have basins where water from seasonal rains accumulates, then slowly evaporates. These basins are vernal pools, but ones reminiscent of the temporary rock pools of desert regions called "tanks" rather than the usual California ones. Their plants, too, are different. *Lilaea scilloides* forms a lawn on the bottoms of the basins, growing with *Isoetes* and *Callitriche* spp. But the familiar downingias and navarretias of lowland pools are absent. The invertebrate fauna, too, is different and includes species thought to be undescribed. As a California ecosystem, these pools have apparently never before been described.

Riparian vegetation lines the streams and arroyos and the surrounding grassy hills are punctuated with patches of sage scrub and chaparral, the latter becoming continuous on the higher, steeper slopes to the west. Occasionally golden-flowered *Fremontodendron californicum,* as well as *Arctostaphylos auriculata* dominate.

But the greatest botanical surprise of Los Vaqueros comes at the crest of an unspectacular hill covered with grass and sage-scrub not far from the sandstone monoliths and their vernal pools. A thicket of gnarled, spiny-leaved shrubs proves to be *Quercus dunnii,* an oak of southern California whose nearest location north of the Transverse Ranges is in San Benito County. At Los Vaqueros it had been hidden from botanists behind the locked gates of cattle ranches.

Over the hills to the east of Los Vaqueros lie, in the few areas left unplowed, fields with the more usual kind of vernal pools, including one with fully seven species of *Lasthenia,* including the endangered *L. conjugens.* Tidy-tips, *Layia* spp., turn the surroundings gold in spring. Some of the pools have bottoms so salty that only salt-tolerant plants like *Frankenia grandifolia* and *Cressa truxillensis* grow there. At nearby Byron Hot Springs on a much larger salt flat grows the most northerly stand of iodine bush, *Allenrolfea occidentalis,* in cismontane California. Here, within a short drive of the San Francisco metropolitan area, is an outpost of San Joaquin desert flora.



Unusual rock-bound vernal pools.
Photograph by Dale Sanders.

If Los Vaqueros Reservoir must be built, concerted attention should be directed at preserving the rare natural communities nearby and preventing secondary impacts on fauna and archeological qualities.

Glen Holstein

wetlands artificially flooded and cultivated by the California Department of Fish and Game and private duck clubs to enhance production of preferred waterfowl plants.

The protective facilities referred to in SB 200 will strive to provide fresh water to the managed wetlands to maintain the brackish salinity levels needed by the preferred waterfowl food plants in the light of diminished outflows from the Delta as increased amounts of water are diverted southward. At present the facilities of choice are tidal gates at the eastern end of the major slough winding through the marsh to maintain east-to-west flow. But the slough is an important striped-bass spawning area and fisheries experts fear adverse impact upon reproduction as a result.

As sea water intrudes farther toward the Delta with increased diversions of fresh water, salinity levels are likely to rise in the unmanaged parts of the marsh and to affect the plants growing there. Damage to less salt-tolerant plants during the 1976-1977 drought showed that changes in species composition may be expected with changing salinities, but no studies seem to have been made either to locate rare plants in the marsh or to predict the impact of increased diversions upon them.

A.Q.H.

# THE CHANGING FACE OF THE SAN JOAQUIN VALLEY

**by Felix E. Smith**

The San Joaquin Valley discovered by early settlers was a vast grassland dotted with oaks, with riparian woodlands along the perennial rivers and extensive wetlands. In less than one hundred years conversion of the San Joaquin Valley to agricultural uses was nearly complete.

Today almost the entire valley floor is in some kind of agricultural, urban, or industrial use. About 5,350,000 acres are under irrigation and another 150,000 are dry-farmed. Most remaining irrigable land is used for grazing. A variety of crops is grown.

Overgrazing and introduction of plants from foreign countries have altered the species and character of what is left of the once vast native grasslands, the remnants of which are most easily recognized as the almost treeless ring bordering the cultivated valley floor. The once extensive riparian forests are now narrow bands or pockets of trees along the rivers. The managed wetlands of the Grasslands Water District and adjacent areas in Merced County, the Department of Fish and Game's Wildlife Management Areas, and the Fish and Wildlife Service's National Wildlife Refuges contain most of what is left of the once vast valley wetlands.

The pronghorns are gone, incompatible with fences and intensive agriculture. Tiny remnant herds of tule elk are confined to reserves. The flights of geese and ducks are greatly diminished. The once common valley quail are much reduced. The kit fox now seeks to exist on the valley's edges. The golden beaver is condemned as a

Drawing by Charles Allen. Courtesy Great Valley Museum.

threat to the levee systems. Chinook salmon, their migration to historical spawning grounds made difficult or impossible by dams, water diversion structures, pollution, and loss of water to irrigation, are gone from streams or reduced to only remnant populations. The blunt-nosed leopard lizard, Fresno and giant kangaroo rats, San Joaquin antelope squirrel, and other plants and animals are now rare or endangered. Few vernal pool ecosystems remain unleveled by the plow.

What does the future hold?

- Urban-suburban sprawl. The 190,000 acres of urbanized land in the valley in 1972 are expected to grow by an additional 400,000 acres by the year 2000.

Found in the 1930s in several localities in vernal pools of Central Valley grasslands along the lowest Sierra Nevada foothills from Fresno to Stanislaus counties, *Orthocarpus campestris* var. *succulentus* is rarely found today. Agricultural development has eliminated many former sites. Most recently it was found north of Fresno on property earmarked for urban development. Photograph by Lawrence Heckard.

• Economic pressures. Sale of land for urbanization will provide capital to convert more land to more profitable intensive agriculture.

• Flood control, drainage, and channelization activities will continue to put extreme pressure on remaining riparian zones, seasonal wetlands, stream channels, and associated ecosystems.

• Corporate farms characteristic of the Tulare Basin have the financial resources to practice very intensive agriculture. Native vegetation in field corners and along ditches tends to be lost, along with remnant habitat for wildlife.

• In expectation of additional imported water, clearing and development of land is occurring, particularly on the west side of the Tulare Basin. About an additional 3.4 million acres in the San Joaquin Valley could be irrigated.

• Between 1972 and 1980, 262,000 more acres in the Tulare Basin were brought under irrigation utilizing diminishing groundwater supplies. In the absence of effective groundwater management, there is widespread and severe groundwater overdraft throughout much of the San Joaquin Valley. Valley water interests blame not lack of a groundwater management program but an inadequate supply of supplemental surface water.

• Drainage problems and accumulation of salt in soils of the valley are growing with continuing and increasing irrigation. Plans for a master drain to draw off waters laden with salts, nutrients, and pesticides could very well cause problems at the eventual point of discharge.

The impact of providing additional water to the San Joaquin Valley cannot be viewed in isolation. Development of additional water supplies that reduce the salmon stocks of Central Valley rivers increases pressure on the fish resources of North Coast rivers and those elsewhere on the Pacific Coast. Agricultural wastewater from the San Joaquin Valley drain could have severe impacts on the fish resources and aquatic ecosystem of the San Francisco Bay estuary and the Delta. The demand for high-quality water by San Joaquin interests may affect present upstream users in the Sacramento Valley as well as lead to pressures to harness North Coast rivers.

Water is not a simple commodity to be bought and sold,

but a complex, life-supporting, public resource that is the basic determinant of overall land use. The Governor's Commission to Review California Water Rights Law recommended groundwater management and laws to support such a program. The next step would be a conjunctive water-management program adapted to the capabilities and limits of the lands involved and aiming to prevent waste and degradation of water. The public interest compels management of our land and water resources in an ecologically sound manner that will maintain the long-term welfare of water, soil, vegetation, fisheries, and wildlife.

San Luis Island. Photograph by Tom Bonnicksen.

## SAN LUIS ISLAND

The vast herds of deer and elk, the grasslands and fields of wildflowers that once existed in the Central Valley are things of the past now, because of the conversion of land to agricultural uses. The Central Valley, of all California's landscape provinces, is the least represented in state public land preserves. In 1969, to correct this situation, plans were made for a state grasslands park of up to 21,000 acres, including San Luis Island, a relatively pristine riverine bottomland "island" lying between the San Joaquin River and Salt Slough in Merced County. (*Fremontia,* April 1979, April 1981). Since then little more than two thousand acres have been acquired, and much of the grasslands, marshes, and riparian forests has been lost to the plow.

When the Parks Department recently announced intent to acquire 3700 acres westward toward Kesterson National Wildlife Refuge (*Fremontia,* July 1981) criticism from agricultural interests and local politicians caused the Parks Department to suspend all plans. The great grassland park envisioned earlier is stalled at 2,800 acres, perhaps forever. This park, to flourish as a sustainable natural unit, at the very least needs additional semi-protected acreage around it to serve as a buffer against intensive agriculture. Joseph L. Medeiros

# WATER DEVELOPMENT AND THE SAN FRANCISCO ESTUARY

Estuaries — those meeting grounds where riverine fresh-water flows gradually intermingle with saline oceanic waters — are among the most biologically productive areas on earth. The San Francisco Bay and Delta system, where waters of the Sacramento and San Joaquin rivers mix with those of the Pacific Ocean, is such an area, the largest on the Pacific Coast. It has been the nursery for about half the state's anadromous fish — those that live in the ocean but migrate to fresh water to spawn, including salmon, steelhead, striped bass, shad, and sturgeon in the case of San Francisco Bay.

But the hand of man has lain heavily upon the health and hydrological regime of San Francisco Bay over the past century and a half. Tremendous amounts of debris were washed into it by hydraulic mining in the days of the Gold Rush. Growing cities brought polluting waste discharges and upstream water diversions to develop reliable supplies. These relatively modest diversions have given way in the last thirty years to massive diversions directly from the Delta by the competing federal Central Valley Project (CVP) and State Water Project (SWP), primarily for agricultural purposes. Fresh-water inflow from the Sacramento and San Joaquin rivers has already been diminished to half or less of what it was and with present proposals for further diversions will by the year 2000 be only five to ten percent of the average of pre-development flows. Remaining inflows will be burdened additionally by the need to dilute massive discharges of the proposed San Joaquin Valley master agricultural drain.

All these projects have been or are being proposed for construction with little or no information on the nature or functioning of the San Francisco estuarine system. That it was indeed an estuary has been clearly perceived only recently. The decision in the late 1930s to build Shasta Dam, the key unit of the CVP, was made without any studies of the likely impact upon fisheries. The report of a 1945 conference on water development in California treated effects on the bay's fisheries in less than two pages. A systematic approach to collection of basic hydrological data was not begun until the late 1960s. Collection of basic information as to the fresh-water needs of the fisheries is only now underway with completion due in 1986, but decisions on further diversions are being asked for now, prior to availability of the results of the study.

In the meantime, the oyster industry, once major, disappeared by the late 1930s but may be restorable with improving water quality. Salmon runs are only twenty percent of what they once were and are virtually gone from the San Joaquin. Striped bass are about ten percent of their peak and about half of what remain suffer lesions and deformities or are heavily parasitized. The Dungeness crab industry has collapsed in the past twenty years to ten percent of previous average catches. Dramatic fish kills from obscure causes occur.

Rozengurt and Herz, writing in *Oceans* for September 1981, cite evidence from estuaries around the world of disastrous effects on fisheries and other estuarine resources stemming from fresh-water diversions. Evidence suggests a limit of about thirty percent on acceptable diversions. Anything greater causes detrimental and eventually irreversible damage to deltas, estuaries, and the coastal zone. Yet water developers the world over consider fresh-water flows "wasted" if allowed to pass into the ocean. Enough is enough, say Rozengurt and Herz. Fisheries, too, are a vital part of global food resources.

A.Q.H.

# WHO USES STATE WATER? WHO PAYS?

## by Dorothy Green

The Metropolitan Water District of Southern California (MWD) and the Kern County Water Agency (KCWA) together *contract* for 75% of all water delivered by the State Water Project (SWP). MWD accounts for 48% and KCWA for 27%. Actual usage, however is quite different. MWD *uses* only 24% of SWP water. KCWA *uses* about 54%, twice its contract amount, and gets half of it at bargain-basement prices that do not reflect true cost. The remaining 25% of SWP water goes to twenty-nine separate contractors.

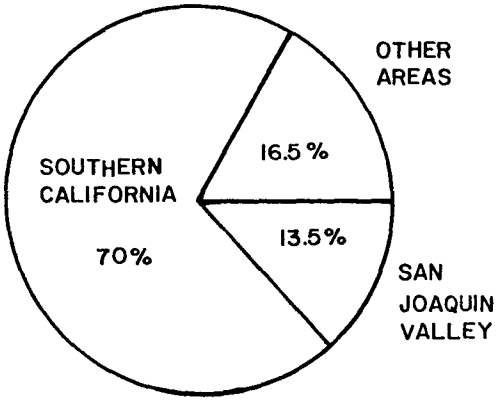
The San Joaquin District receives most SWP water, some 62% of it going to five water districts on the West Side, with groundwater of quality too poor to use for irrigation. One of these is KCWA. Fifty-nine percent of the land in these five districts is owned by a handful of tax-shelter and agribusiness corporations like Chevron USA, Getty Oil, Shell Oil, Tenneco West, Southern Pacific Land Co., and the Tejon Ranch Co., which is twenty-five percent owned by the publisher of the Los Angeles Times. With the availability of cheap imported water, land values here have risen as much as 1400%. Vast tracts planted to specialty crops may exercise control over market conditions to the detriment of small farmers. Profits are to be made in land development, too: The Tejon Ranch Co. recently announced plans to develop about 40% of its land, mostly in the Tehachapis, into a number of new communities. And more land lies ready to be brought into cultivation. All such plans depend upon a

supply of imported water. Thus powerful economic incentives relying on subsidized water prices exist to press for greater supplies of state water.

MWD serves more than twelve million people living on the coastal plain of Southern California, with the exception of the City of Los Angeles, which has its own Department of Water and Power (DWP). MWD supplies water imported from the Colorado River and from Northern California via the SWP. An overriding fear throughout Southern California is what will happen when the surplus water MWD now obtains from the Colorado River, amounting to about 500,000 acre-feet, is no longer available beginning in the mid-1980s as a result of a court decision and the fact that Arizona will be able to use its full entitlement.

MWD predicts a shortage of eleven to fourteen percent of anticipated demand for water by the year 2000, amounting to 400,000 to 500,000 acre-feet. However, it bases its figures on a per capita use the same as in 1970 and makes little allowance for diminishing amounts of land that will dictate changing life styles with shrinking gardens. Nor does it make any allowance for efforts to conserve in response to rising prices for water.

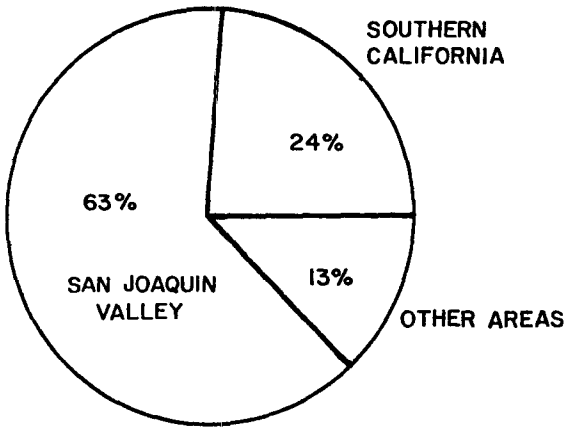
The State Department of Water Resources (DWR), on the other hand, predicts cutbacks in use within the MWD service area of fifteen percent by the year 2000 as a result




Cumulative SWP payments through December 31, 1979, by service area.

of various measures to conserve water not dependent upon conscious action by anyone, and of an additional ten percent in response to rising prices. Even the California Council on Environmental and Economic Balance, a business- and labor-supported group supporting the Peripheral Canal to bring more water south, projects residential conservation of 25% in response to doubling of costs.

Will costs rise? The SWP is now the state's biggest single user of electrical energy, which is required to push the water it delivers uphill from the Delta through the length of the San Joaquin Valley and over the Tehachapis to Southern California. (MWD itself is the second largest user.) Contracts for this energy were signed in the 1960s when oil cost $2 a barrel. They expire in 1983 and DWR expects state water to increase in price by five to eight times by the year 2000 as a result of renegotiated con-




Cumulative SWP deliveries through December 31, 1980, by service area.

tracts. Thus it would seem clear that expectable conservation efforts alone, without any rationing or other coercive policies, will guarantee a continuing supply of surplus water in Southern California far into the future.

Contractors for state water are supposed to pay true costs, including construction, operation, and maintenance. Remember that MWD contracts for forty-eight percent of SWP water but uses only about twenty-four percent. It must pay full price for the forty-eight percent; the half it cannot use is declared "surplus" and is sold instead to KCWA for only the cost of energy to deliver it, about ten percent of what KCWA pays for its own entitlement water. MWD's customers pay both user-fees and property taxes in support of the agency. Residents of the City of Los Angeles, too, support MWD through property taxes, paying out, in fact, thirty percent of all property taxes collected by MWD even though the city gets its waer from its own Department of Water and Power (DWP). DWP's water comes eighty percent from the Mono Basin and Owens Valley, sixteen percent from local groundwater, and only four percent from MWD. Though entitled to up to one-third of MWD's supply of water, Los Angeles has purchased only 3.6% over the years. Overall, Southern Californians through MWD have paid seventy percent of SWP revenues in exchange for only twenty-four percent of the water. San Joaquin Valley users, on the other hand, have paid only 13.5% of the revenues while getting sixty-three percent of the water.

The most recent figures published by DWR as to the cost of the facilities in the Peripheral Canal package through the year 2000 amount to $5.4 billion dollars, without interest. However, construction is planned to the year 2035. The most recent DWR figures to project costs to that year show a total of $23.3 billion. With interest at 4.6% and operating and maintenance costs included, the total reaches over $61 billion.

Such extraordinary financial commitment in these very difficult times demands close investigation of the validity of projected water needs and of possibly less costly ways to meet them. To date there has been no cost-benefit study of the project. And, although it is clear that the need for an agricultural drain will be exacerbated by further importations of water, the costs of the drain are not included in the package.

# WATER COSTS AND WATER CONSERVATION

by E. Phillip LeVeen

It has been almost a decade since the first round of oil price increases that began the "energy crisis." In the interim we have all seen certain aspects of our daily lives fundamentally changed as higher prices have caused us to drive smaller and lighter cars, to insulate our houses, and to purchase energy-saving appliances, to mention only a few of the ways we have accommodated.

What we have learned about the possibilities for energy conservation must now be applied to water, for over the next ten years, water prices are going to rise at least as rapidly as did energy prices, especially for agricultural users. For example, the Department of Water Resources (DWR) estimates that costs of water from the State Water Project (SWP) will rise almost four-fold between now and 1990, in real 1980 dollars (if inflation is included, the rise will be more than six-fold). During the same period, real water costs in Los Angeles are expected to increase by two and a half times, more with inflation.

These increases will largely be due to the energy crisis. The SWP is the largest single user of electricity in California, for it must pump uphill most of the water it delivers to its main users in Kern County and in Southern California. This task requires roughly 5 billion kilowatt-hours of energy per year. In 1980, the SWP charged water users 0.46 cents per kilowatt-hour for water it pumped. In contrast, commercial rates are from ten to twenty times higher than this. The SWP has been able to charge this low rate because of beneficial contracts it negotiated in 1963 with commercial power companies and because of the predominance of hydro-electric power-generating facilities in its system, which produce electricity much more cheaply than other methods. However, the beneficial contracts will terminate in 1983, requiring higher charges for energy.

In addition, if the SWP is to deliver the additional water supplies for which the facilities authorized by SB 200 are intended, it must double its consumption of energy. This additional energy must be purchased at much higher prices. As a result, the DWR projects that its energy costs will rise ten-fold over the next ten years. These projections appear somewhat optimistic, since even with these projected increases, the SWP still plans to charge its contractors only about one-third the rates that commercial power companies expect to charge in 1990.

The second reason for rising water costs is the high price of new projects. For example, the Peripheral Canal, which is only one component of all the facilities envisioned by SB 200, would cost about $1 billion. At current interest rates, this expenditure implies an annual interest cost of more than $100 million. The Peripheral Canal will yield between 700,000 and a million acre-feet of new water supplies. Thus, it will cost more than $100 per acre-foot. To deliver this water to Kern County will cost in excess of $140 per acre-foot and to Los Angeles in excess of $350 per acre-foot, including energy. Compare these costs with the $25 per acre-foot and the $115 per acre-foot prices now paid in Kern County and Los Angeles, respectively, and the much higher costs of new water are readily apparent.

The Peripheral Canal is probably the cheapest major water project on the drawing board. The other components of SB 200 will produce additional water at costs in excess of $200 per acre-foot, while development of North Coast rivers could cost upwards of $400 per acre-foot. Similar cost estimates prevail for Bureau of Reclamation projects, such as the proposed Auburn Dam, which the General Accounting Office estimates will produce water at about $200 per acre-foot. There is no such thing as a cheap water project.

Agricultural water users have the option of using groundwater, but excessive pumping of this has caused declining water tables, hence much higher pumping costs. Should growers try to avoid higher surface water costs by substituting groundwater, they will find themselves needing more energy; since they must buy this energy from commercial suppliers who do not offer subsidized rates, groundwater costs will increase at least as rapidly as surface water costs.

## Conservation Measures

But, this is not to imply that no additional water supplies can be had for less than $100 per acre-foot. Conservation measures could release additional supplies of water for less than the cost of new projects. For example, "conjunctive water-management programs" would integrate surface and groundwater supplies to increase water availability. During wet years the excess flows in the Sacramento–San Joaquin river systems could be diverted and stored in underground aquifers in Kern County. Similar possibilities exist for storing excess Colorado River water in desert aquifers. During dry years, these underground supplies can supplement scarce surface supplies. Costs of such programs are low because they use existing canals and because the underground reservoirs are essentially free. Moreover, if groundwater supplies are restored, water tables are raised, thus reducing the energy needed for pumping.

The potential of such programs to increase water supplies has long been recognized by water planners, and SB 200 pays them lip-service by authorizing groundwater storage programs to provide 400,000 acre-feet per year by 1995. Unfortunately, SB 200 provides no mechanism to effect conjunctive use of surface and groundwater supplies and even the DWR admits in its latest analysis of SB 200 that Kern County has refused to cooperate in developing groundwater management plans. There are, however, effective groundwater-surface management

programs in place throughout Southern California, where political support is greater (and water scarcity is a much larger problem).

There are, of course, many other ways in which water could be used with greater efficiency, both in and out of agriculture. Since agriculture uses 85% of developed water supplies, conservation measures affecting irrigation use should have the largest impacts. One of the commonly cited alternatives available to growers is changing to irrigation technologies that reduce evaporation of the water before it reaches the root zone of the plant, such as is possible with sprinklers and drip systems. Flood irrigation can be improved by leveling fields with extreme accuracy by the use of lasers.

Evaporation or seepage from canals can be eliminated by lining and covering them. Enclosing the All-American and Coachella Canals in the desert regions of Southern California could reduce losses by more than 500,000 acre-feet per year at less cost than the Peripheral Canal or other new projects.

"Demand scheduling" of irrigation deliveries, whereby water is made available only when needed, rather than on a particular date, would allow greater flexibility in the timing of application, with beneficial results in both water savings and crop yields. There is an interesting parallel here with recent advances in pest control, where careful monitoring of pest populations by trained field workers has allowed more strategic applications of smaller amounts of pesticides with lower costs to growers and no loss of yields.

In addition to technological approaches to agricultural water conservation, water use can be influenced by the choice of crops. If grain crops, such as wheat, are grown in place of alfalfa or irrigated pasture, overall water consumption will decline, since wheat requires less than a third as much water. This explains why wheat was California's first important crop, before the coming of widespread irrigation. This example is of additional relevance because it appears that California will produce more wheat as world demand for it grows, and less forage crops as demand for them falls in response to the continued shift of cattle feeding to the midwest.

Finally, another form of water conservation in agriculture involves the trading of water rights. If new water costs in excess of $100 per acre-foot, it is likely that some holders of existing water supplies will have incentives to sell their water for this price, rather than use it to produce crops. Very few agricultural water uses can economically justify a price of $100 per acre-foot; therefore, some water-right holders could improve their incomes by reducing their consumption of water and selling it to others willing to pay this sum. In this way, water is conserved in an economic sense; that is, it is transferred from lower to higher valued uses.

The potential for conservation in urban areas is better understood, given the experience of the drought of 1976-1977. Recycled water for lawn watering, car washing, and industrial uses can be lower in cost than water from new water projects. Since much of household consumption is for lawn and garden use, conservation is possible through changing application technologies or by shifting to plants better adapted to long, dry summers. Swimming pool covers can help to reduce evaporation.

Many other possibilities for conservation exist. Critics of this approach argue that potential is very limited, especially in agriculture, but until appropriate incentives are provided, predictions cannot be made. Certainly we could not have accurately predicted in 1970 the magnitude of the reactions to higher energy prices. The limited evidence available suggests a substantial conservation potential in agriculture and elsewhere. Developing this potential is a far more economically rational and fiscally sound way to increase water resources than are massive new construction projects.

If new projects are to be so costly, why is there a debate about conservation versus development? Will not all water users increasingly be forced by higher prices to conserve? Yes, natural economic forces will have this effect, but built into our current water institutions are severe obstacles that blunt these forces. These obstacles must be removed if we are to exploit the most cost-effective means of satisfying our growing demands for water.

The most important of these obstacles are various administrative devices that blunt the impact of rising water prices. In particular, much of the surface water supplied by both the SWP and the various Bureau of Reclamation projects is sold at much less than its real cost to agricultural users. In the SWP, an ingenious pricing mechanism requires Southern California property owners to subsidize the price of water charged to growers in Kern County. In Reclamation projects, even larger subsidies exist. In many instances, irrigators pay a flat rate for water. In others, water prices vary according to the crops produced. Alfalfa growers, who cannot pay as much as cotton growers, are charged lower prices. Such practices discourage conservation by making surface water artificially cheap to irrigators. Conservation measures are generally more costly, since they are not equivalently subsidized.

This asymmetry helps to account for the continuing political demands for new projects from agricultural users. It is clear that growers in Kern County would lose interest in SB 200 if required to pay the full costs to be incurred on their behalf. However, as long as a substantial portion of these costs is borne by property-tax payers in Southern California and in Kern County, too, who receive very little of the water from the project, growers may be able to insulate themselves from current economic realities and postpone the day of having to pay serious attention to conservation.

It is also very possible that growers in Kern County may be unable to afford even the subsidized water prices that are projected over the next ten years when farmers may well pay in excess of $100 per acre-foot, especially if SB 200 is approved and the new facilities are built. At such prices, most of the crops now grown cannot produce a profit and changes will be forced. In this case, the Kern County Water Agency will find it difficult to sell the additional water it now claims it needs, and will have to face a difficult decision of how it will honor its contractual commitments to pay for the SWP. Since the agency can impose new property taxes (it is exempt from the condi-

tions of Proposition 13), in all likelihood the property owners of Kern County will be forced to pay much higher taxes. Ironically, the more growers conserve, the greater will be the threat of such taxes. In short, if SB 200 is authorized, neither the Kern County Water Agency nor the Department of Water Resources will want to encourage conservation for fear of undermining the entire financial basis of the SWP.

In addition to the obstacles of subsidized water, there are important legal barriers to more rational water resource development. Groundwater overdraft arises because of inadequate laws defining ownership and use of this resource. At present, a landowner has the right to use water under his property as long as he meets the vaguely-defined "beneficial use" requirements of California water law. Individuals are not prevented from pumping out more water than flows into underground aquifers. Moreover, if an individual reduces pumping to conserve the resource, he will benefit other landowners pumping from the same source but not himself. They will reap the short-term benefits of pumping more water at less cost and this overrides their interest in long-term benefits of conservation that may be reaped only by posterity.

If ownership were assigned so that each individual landowner's share of the groundwater supply were consistent with long-term sustainable yields, the problem of overdraft could be eliminated. Such legal reform would be a prerequisite to any comprehensive use of groundwater aquifers for storing excess wet-year water supplies in order to supplement dry-year surface-water deliveries. Such reform would be in the long-term interest of landowners, but in the short-run restrictions on groundwater pumping would be likely and so reform is vigorously resisted.

The strategy of growers in the San Joaquin Valley over the past four decades has been to deplete groundwater supplies and then, using the threat of lost agricultural production, seek subsidized surface-water supplies from either the state or federal government. As long as subsidized surface water is available to agriculture in ever increasing supplies, there will be no support for more rational use of groundwater and effective integration of both surface and groundwater resources.

A second legal obstacle to conservation is the impact that the "beneficial use" doctrine, which is the basis for assigning water rights, has on water transfers. While beneficial use has many definitions, the most important of these is the "use it, or lose it" doctrine. If a water-rights holder does not exercise his rights, he loses them. If an individual conserves water, he reduces his use and thus may lose his right to the conserved water. The rationale is if an individual finds a way to conserve water, he must not have been using the water "beneficially" in the first place.

It should be obvious that the "use it, or lose it" doctrine constitutes a major disincentive to water conservation, especially in the context of water transfers. For example, a water-rights holder is discouraged from conserving water and selling the unused portion of his allocation to someone else for profit, since the conserved water is not his to sell. Similarly, since beneficial use doctrine does not recognize the sale of water as a "beneficial use," no water-rights holder will risk selling his water for fear of losing his rights. Thus, without legal reform, water will continue being applied to very low-valued uses, while much higher-valued uses are left unfulfilled.

The need for reform of water rights law has long been recognized in California, but organized agricultural interests have opposed changes and generally reject the concept of water transfers. The reasons for such opposition are varied. Some growers so distrust the government that they see any effort to change water rights as a disguised effort to steal their water. Others, especially those who receive highly subsidized water, see water transfers as a threat to the regime of cheap water. Water markets would introduce a new element of competition for water

## CONSERVATION AT HOME

Since agriculture uses 85% of California's developed water, only conservation in agriculture will make a real dent in solving problems of water supply. But the public-spirited city-dweller can help, too, and can make adjustments that will help when the next drought comes. Here are some references that will assist:

*Growing California Native Plants*. Marjorie G. Schmidt. University of California Press.

*Plants for California Landscapes*. Bulletin 209, Department of Water Resources, P.O. Box 388, Sacramento 95802.

*How to Have a Green Garden in a Dry State*. Metropolitan Water District, Los Angeles.

*California Native Trees and Shrubs for Garden and Environmental Use in Southern California and Adjacent Areas*. L.W. Lenz and J. Dourley. Rancho Santa Ana Botanic Garden, 1500 N. College Ave., Claremont 91711.

*Trees and Shrubs for Dry California Landscapes, Plants for Water Conservation*. Bob Perry. Land Design Publishing. P.O. Box 857, San Dimas, CA 91773.

*Sunset* Magazine: October 1976 (list of drought-tolerant plants), April 1977 (more drought-tolerant plants and advice for using "grey water").

*Grey Water Use in the Home Garden*. Farallones Institute, Berkeley.

*Captured Rainfall*. Bulletin 213, Department of Water Resources, P.O. Box 388, Sacramento 95802.

Guidelines for eligibility for tax credits for rainwater cisterns and grey-water systems are available from the Department of Water Resources.

*North Marin's Little Compendium of Water Saving Ideas*. North Marin County Water District, Box 146, Novato 94947.

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that would certainly drive up the price of water in agriculture and at the same time, would provide an alternative source of supply to regions that now claim to have unmet "needs." In such an environment, agricultural interests would have greater difficulty in arguing for new, subsidized supplies from the state.

In summary, there are important economic and legal barriers to rational water resource development in California that must be reformed. Without reforms, the cost-inefficiencies already endemic in California's water system will be magnified under the new economic realities of the future. However, there are powerful reasons for arguing that as long as new supplies of water are made available to growers at artificially low prices, there will be no strong political support for these reforms. Interestingly, in states such as Colorado and Arizona, where water is relatively much more scarce than in California, such reforms have been effected. The conclusion must therefore be that no new water resource development should be permitted until reforms are in place. Denying the water interests SB 200 will create much stronger political incentives for reforming water resource development and California will save itself many billions of dollars in unnecessary facilities.

# WATER PRICING REFORM

## by George Miller

Fear of environmental catastrophe has been the major motivation behind concern for our natural resources policies in recent years. But today, economic reality is compelling major changes in our country's water policy. The heavy subsidization of costs of irrigation water furnished by federal Bureau of Reclamation projects amounts to *billions* of dollars a year for the taxpayer. In direct contradiction of current fiscal policies, these subsidies stimulate construction of pork barrel water projects and encourage wasteful use of limited water resources by discouraging more efficient irrigation techniques.

The Rand Corporation concluded that water misuse in California is due to "a myriad of legal and institutional restrictions that dictate that water use be inefficient." The biggest single cause of that inefficiency, and the greatest stimulus to construction of financially unjustified and ecologically destructive water projects, is the pricing subsidy to irrigators.

That subsidy was originally envisioned as a means of encouraging the development of family farms in the West. But farm operations have dramatically changed in past decades, and today beneficiaries of the continuing subsidies include many of the nation's largest and most profitable corporations, including many oil, railroad, and land development companies.

Almost every federal project was originally intended largely to pay for itself. Instead of beneficiaries of the project paying the bills, however, it is the general taxpayer who assumes most of the burden of the repayment cost of these projects. According to the General Accounting Office's review of six new water projects, beneficiaries will repay as little as 2%, and in no case more than 7%, of the actual cost of the project. Some irrigators enjoy water at bargain basement prices locked into inflation-free, forty-year contracts signed decades ago.

Most irrigators can afford to pay more realistic prices for the water they use. Take the long-controversial Westlands Water District, for example, which has a contract for water at a cost of $7.50 an acre-foot. (An acre-foot equals about 326,000 gallons of water, equivalent to the annual consumption of a family of five.) Westlands receives more than 1,150,000 acre-feet from the government every year. The price was set on the basis of studies completed in the mid-1950s. The contract provides for no modification of the price until 2007. Today, the cost of delivering that acre-foot of water is nearly $14. Westlands' farmers, according to the same government officials who sell them the discounted water, can afford to pay several times that amount. But Westlands' farmers are not satisfied; some of them are suing the federal government for even more water at the subsidized price.

Such massive subsidies cost taxpayers billions of dollars and encourage the profligate misuse of limited water resources. The General Accounting Office has estimated that as much as half of all federally supplied water never reaches the crops for which it is intended. Incredibly, no requirement for efficient use is imposed on federal water customers.

Congress may be on the verge of adopting my proposal to reform Bureau of Reclamation water pricing standards by requiring those who directly benefit from its projects to pay for those projects instead of passing the cost on to taxpayers.

I have long insisted that water subsidies be significantly reduced, if not totally eliminated, particularly for prosperous, large-scale farmers. The House, the Senate, and the Administration appear to have accepted the concept, which I first introduced in 1977, to reduce drastically the water subsidy to big farmers. Reclamation reform legislation, HR. 5539, which includes the most far-reaching water pricing reform in history, was recently approved by the House Interior Committee.

Charging more realistic water rates will *not* drive farmers out of business. Farmers who purchase water from the California State Water Project pay substantially more than federal project customers (although they still enjoy a subsidy of more than $25 million a year). In addition, those western farmers who receive Bureau of Reclamation water, farming only 1% of the nation's farmland, have a competitive advantage over irrigators elsewhere in the country who rely on more expensive water from other sources. A study by the U.S. Department of Agriculture

recently concluded that higher prices for water could mean bigger profits for farmers, who would be motivated to greater efficiency in production, and no higher food costs for consumers.

## Peripheral Canal

Reducing water subsidies will force exploration of alternatives to new water projects, such as the $2 billion, 43-mile Peripheral Canal, whose fate California voters will decide in June. Environmental impacts aside, the economics of financing the Peripheral Canal undermine the arguments for its construction.

Water customers in Los Angeles, who use only 7% of the Metropolitan Water District's water but subsidize farmers by paying over one-third of the bills, might want to consider the spectre of more than a 1000% increase in domestic water costs — to $1,250 an acre-foot — if the Canal is built, according to John Burnham, the former chief economist of Southern California's Metropolitan Water District.

What will be the impact on water-consuming industries when water and power bills skyrocket? Residential users and industries receive little water subsidies, but their electric rates make up for the reduced prices paid by farmers (who use eighty-five percent of California's water). Only a few years ago, power rates in some areas of California doubled in order to make up deficits caused by subsidies to agricultural water users, and comparable increases are planned in the near future even if no new projects are built.

There *is* a water problem in California, but it will not be solved by building bigger projects subsidized by the taxpayers. Indeed, the Rand Corporation predicts that the Peripheral Canal will encourage even more inefficient use of water in California.

What will solve the water problem will be better management of our resources. We are not running out of water; we are running out of *cheap* water. Charging for the true costs of water will encourage conservation and make new technologies cost-effective. Drip irrigation, which uses just one percent of the water consumed by traditional methods, for example, is used to irrigate even row-crops like cotton in Israel, where water is regarded (and priced) like the precious resource it is. By using modern watering methods, Israeli farmers can grow as much on poorer land with half as much water as their American counterparts. But such advanced irrigation technologies are little used in the United States, where subsidies permit antiquated and wasteful practices to be continued. The forty-three-mile Peripheral Canal, for example, would be an unlined ditch, in all probability the least efficient water transportation method possible.

The outcome of this year's Congressional debate will determine how serious policy-makers in Washington are about cutting waste in government programs and in improving the efficient use of our limited water resources.

# IRRIGATION WASTEWATER — A PROBLEM

### by Blaine R. Hanson

Agricultural irrigation is necessary when the natural water supply, such as rainfall, is insufficient to meet a crop's water needs. But irrigation itself often produces problems. When soils do not drain well naturally, the subsoil may become waterlogged and salts from the irrigation water may accumulate in the soil. Both waterlogging and salts in the root zone can reduce crop yields. With continued salt accumulation good land may become only marginally productive.

The common solution for high water tables is to put in a subsurface drainage system consisting of perforated plastic pipe installed at regular intervals throughout a field at a depth of five to seven feet. Such a system increases the rate of subsurface drainage and also controls the depth of the water table. However, there must be a method of disposing of the drainage water.

The San Joaquin Valley now has approximately four and a half million acres of irrigated land. About 400,000 acres are affected by high water tables now and over a million are expected to be in the future. The affected acreage is along the west side of the valley from the southern part of San Joaquin County to Kern County.

Within these problem areas, adequate disposal facilities for subsurface drainage water generally are not available. Growers have three choices: do nothing and thus possibly reduce crop yields, install subsurface drainage systems and discharge the water into the irrigation supply, or use evaporation ponds. Discharging the drain water into the irrigation water is unacceptable in many cases because it degrades the quality of the irrigation water and affects users downstream. Recirculating the drain water for irrigation purposes back onto the drained acreage is sometimes possible but recycles the salts, too, and should be considered an interim measure only.

Evaporation ponds are used in some areas for disposal of drainage water, in some places in an area-wide disposal system, in other places in small on-farm evaporation ponds. However, as much as one acre of pond may be needed for every four to five acres of drained land. Unless a grower has unproductive land for this purpose, farm ponds will require loss of too much productive land.

## Proposed Solution

The San Joaquin Valley Interagency Drainage Program, including state and federal agencies and a public advisory committee, was formed in 1975 and was charged with

San Luis Drain. Photograph by Joseph L. Medeiros.

recommending a feasible valley-wide method of disposing of drainage water. Alternatives considered included:

1. No valley-wide action. Drainage disposal methods would be developed by local entities.

2. Evaporation ponds, locating all ponds within the valley or locating ponds serving the southern part of the valley on the Carrizo Plain, in the latter case, pumping the water up to about 2000 feet.

3. Direct discharge to the ocean either in Monterey Bay (near Moss Landing) or in Estero Bay (near Cajucos).

4. Discharge to the San Joaquin River. Discharging drainage water as generated, discharging as generated but with dilution, or discharging only between November and February and storing the water during the non-discharge period.

5. Discharge to the Delta-Suisun Bay. Discharging untreated water near Antioch or near Martinez without storage or regulation, treating the water to remove nitrogen and discharging near Antioch, or discharging untreated water near Antioch but regulating discharge to minimize any adverse impact.

Discharge to the Delta-Suisun Bay was chosen as most economical while being equal to the others in respect to environmental considerations. Based upon this concept, a master plan was developed to utilize the existing San Luis Drain as the first segment. It would then be extended southward to Kettleman City and eventually to a location in Kern County. Northward, it would be extended from Kesterson Reservoir, the terminus, to a discharge point near Chipps Island, offshore from Pittsburg.

A series of marshes along the drain's route would be managed so that peak flows in summer could be stored and evaporated as necessary, to be released during the winter when Delta outflows are highest and dilution would be greatest.

Studies were made of the potential environmental impact of the drain discharge. Major concerns were effects due to salinity, nutrients and biostimulation, and toxic materials.

Primary chemical constituents contributing to salinity of the drain discharge are calcium, magnesium, sodium, chloride, and sulfate. Modeling studies showed that effects of salinity could be minimized by moving the discharge point westward and using the marshes for seasonal regulation. Modeling studies also showed that in the vicinity of the discharge point, nitrogen levels would increase, but, through dispersion and dilution, would not produce significant quantities of algal biomass. However, information was not sufficient accurately to predict effects in shallows, on phytoplankton, or when the saltwater-freshwater interface is downstream of the discharge point.

Possible toxic effects were evaluated in a preliminary way only. Boron appeared to warrant the greatest concern

## DRAINAGE POND OR REFUGE?

The 5900 acres of the Kesterson National Wildlife Refuge were acquired in 1969 by the Bureau of Reclamation not for a wildlife refuge but for a different purpose — to serve as evaporation and storage ponds for agricultural wastewater as part of the San Joaquin Valley Master Drain. Completion, however, has been delayed by political, financial, and environmental considerations, and because of its high natural value, the Kesterson unit has been given interim status as a national wildlife refuge. To date only 1300 acres have been converted to regulating ponds. The Bureau in January 1982 withdrew its application to construct further ponds at Kesterson while it considers other plans to enlarge the San Luis Drain. A new proposal will probably not be ready to present to Congress before 1985.

The remaining 4600 acres of Kesterson, encompassig a mosaic of native valley plant communities, provide a tremendous opportunity to preserve scarce natural habitat. Dense bunchgrasses occupy higher ground amidst vernal pools. Lower areas support marshlands and sloughs. An extensive stand of iodine bush (*Allenrolfea occidentalis*) is a reminder of once-widespread alkali scrubland. *Plagiobothrys histriculus* and *Cordylanthus mollis* subsp. *hispidus* designated by CNPS as rare plants, grow at Kesterson. A relative of *Pogogyne douglasii* found there may be a new, rare, San Joaquin Valley endemic. Coyotes, kit foxes, kangaroo rats, horned lizards, badgers, and many other small vertebrates live there, along with birds, especially raptors such as owls, hawks, harriers, falcons, and eagles. But the future of this remnant of a once enormous natural landscape is uncertain.

Importation of more water to irrigate San Joaquin Valley farmlands by means of projects like the Peripheral Canal will increase the amounts of drainage waters laden with salts, nutrients, and toxins that must be disposed of. Yet no fully satisfactory method for disposal is known even for today's levels of wastewater — they are merely to be exported to someone else's "backyard," in this case the already abused San Francisco Bay and Estuary. And more natural areas like Kesterson will be considered for use as dumps for agricultural wastes.

Joseph L. Medeiros

among the minor elements, but modeling studies showed that dispersion in the receiving waters would keep concentrations away from the discharge location to less than standards set by the Environmental Protection Agency (EPA) in 1972. Concentrations of chromium, iron, lead, and mercury also all exceeded background concentrations and governmental standards. Arsenic exists in drainage waters from some parts of the southern San Joaquin Valley and might necessitate local evaporation ponds to reduce levels in discharged waters. Residues from several pesticides — DDT, dieldrin, and toxaphene — also are projected to exceed EPA criteria.

According to the IDP, these studies indicate that the discharge will not be toxic to the receiving waters. However, a recommendation was made that bioassay studies (in which aquatic organisms are used to detect or measure presence or effect of a substance) and more intensive monitoring of drainage discharge of currently installed drainage systems be conducted prior to issuing any wastewater discharge requirements.

As a result of the IDP recommendations, Assembly Bill 1376 was introduced last spring. It aims to insure that receiving waters be protected from adverse effects of the drain water by several provisions:

a. Requirements of federal and state water quality acts must be satisfied prior to discharge.

b. No discharge shall be allowed into Monterey Bay.

c. The drain shall be operated in a way that protects beneficial uses of the Delta, Suisun Marsh, and bays westerly to the Golden Gate.

d. No added costs will result to water users required to use a substitute water supply as a result of the drain.

e. Receiving waters shall be satisfactorily monitored prior to and during operation of the drain.

f. Any leakage from the drain shall be confined to the drain's right-of-way.

g. Drainage water will be made available for any beneficial uses such as powerplant cooling, marsh development, and reuse for irrigation.

h. Repayment fees shall be based upon the quantity of effluent discharged into the drain by a grower, the concentration of salts in the effluent, the distance of transport of the effluent, and the quantity of water applied in areas contributing to the drainage problem.

The Bureau of Reclamation, which operates the San Luis Drain, is formulating studies in order to gain information to apply to the State Water Resources Control Board for a permit to discharge wastewater. The studies proposed include:

a. Evaluation of the impact of the drain on the receiving waters under various conditions.

b. Evaluation of the effect on receiving waters of nutrients in the drainage waters and establishing when treatment will be needed to prevent troublesome biostimulation.

c. Ascertain the amounts of boron to be acceptable in the drainage waters and methods to meet these levels.

The Bureau's proposals do not cover potential toxicity effects. Programs addressing these concerns will be developed.

The solution to drainage problems in the San Joaquin Valley is complex. Environmental concerns and problems of financing, routing of the drain, and effects on rare and endangered species must be resolved. The agricultural land of the San Joaquin Valley is a significant factor in the state's and the nation's food supply and economy. Preservation of this resource should be given at least the same priority as preservation of the Delta and receiving waters. It is hoped that a solution can be obtained that will restore agricultural land in the valley to full productivity with a minimum impact on the Delta and other receiving waters.

# A FISHERIES VIEW OF THE DRAIN

## by R. Bruce MacFarlane

Discharging saline irrigation water in the Chipps Island area has definite environmental implications. This area already experiences increased salinity resulting from diversions of fresh water to the San Joaquin Valley and Southern California. Further increases in salinity from the drain may significantly impair the biological communities dependent upon this area. This is a critical habitat for oceanic fishes that enter fresh water to breed, particularly striped bass. For example, changing salinity patterns can alter the composition and abundance of prey species resulting in reduced production of striped bass, a fish already suffering substantial decline. Additionally, the effectiveness of man-made marshes in purifying wastewater is in initial stages of testing and is still questionable.

Projections of environmental impact are largely the results of mathematical models. The Delta-Suisun Bay is a highly complex system. Modeling such a system is difficult and in many cases not justified by current knowledge and understanding. Model results must be interpreted with caution and cannot be accepted as definitive. Estimates of concentrations of substances in the drain water vary widely from report to report, casting more doubt on the validity of model forecasts. (Compare, for example, estimates in the Interagency Drainage Program — IDP — report to those in the Draft Supplemental Environmental Impact Statement for the San Luis Unit.) Concentrations alone, without knowledge of the volume of drainage discharge and the rate of flow of receiving waters, are not very useful in assessing likely effects. The IDP report on the San Joaquin Valley Master Drain projects eventual discharges amounting to 22% of the total water flowing into the San Francisco Bay system. If municipal sewage discharges are added in, then 32% of the "fresh water" entering the Bay will be of degraded quality. This certainly suggests that biological impacts will not be negligible.

Reservations regarding projections of the impact of additional nitrogen are certainly justified, especially in the case of shallows, where potential for explosive growth of algae is high. However, the impact of added heavy metals and pesticides must also be looked at critically. The National Marine Fisheries Services (NMFS) at Tiburon has considerable evidence that present levels are adversely affecting abundance and health of striped bass in the area. Projections of concentrations of heavy metals and pesticides reveal that many will exceed background levels and government standards. IDP's conclusion that the discharge would not be toxic clearly misunderstands the intent of water-quality criteria and disregards the possibility of accumulation of toxins by organisms. These reflect current knowledge of what will protect the health and welfare of aquatic organisms and humans.

Implementation of this drainage plan seems premature. There are too many questionable assumptions and unresolved problems with potentially serious consequences for this alternative to be considered acceptable. The NMFS is on record as favoring evaporation ponds to dispose of saline, subsurface drainage water. The NMFS also favors alternatives that would reduce demand for more surface water for irrigation, thereby reducing salt accumulation in soils. These alternatives would include water-pricing reform, water conservation (including more efficient irrigation techniques), groundwater management, and selection of crops more compatible with environmental conditions, such as higher salt tolerance or lower water requirements.

# FOR FURTHER READING


*California Water Atlas*. State of California. General Services, Publications Section, P.O. Box 1015, North Highlands 95660

*Desertification of the United States*. Council on Environmental Quality, Washington, D.C.

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*Final Report*. Governor's Commission to Review California Water Rights Law. 1978.

*Ground Water Basins in California*. Bulletin 118-80, Department of Water Resources, P.O. Box 388, Sacramento 95802.

*Layperson's Guide to Ground Water*. Western Water Education Foundation, 1107 Ninth St., Suite 618, Sacramento 95814.

*Riparian Forests in California*. Institute of Ecology, Univ. of California, Davis. Reprinted, 1980, by Agricultural Sciences Publications, Univ. of California, Berkeley, Publ. No. 4101.

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