

### **Copyright Permission**

**Note:** Permission of the Publisher has been given to the International Food Policy Research Institute (IFPRI) to post this article to its web site as allowed under the copyright law of the United States (Title 17, United States Code) which governs "fair use" or the making of photocopies or other reproductions of copyrighted material. Photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research."

The correct citation for this article is Rosegrant, Mark W. 1995. **Water transfers in California: potentials and constraints**. *Water International* 20(2): 72-87.

Reprinted with the permission of [International Water Resources Association](#).

Thank you in advance for respecting these conditions. For additional information, contact [IFPRI-library@cgiar.org](mailto:IFPRI-library@cgiar.org).

---

# Water Transfers in California: Potentials and Constraints

---

by *Mark W. Rosegrant*  
*International Food Policy Research Institute*  
*WASHINGTON DC 20036*  
*U.S.A.*

---

## INTRODUCTION

Several factors have combined to stimulate interest in improving the flexibility of water market transfers in California. Rapidly growing urban and environmental demand for water, the high economic and environmental costs of developing new water supplies, public rejection of infrastructure options such as the peripheral canal linking the relatively water-rich north with the increasingly water-scarce south, and serious droughts in recent years have brought the issue of water market transfers, as a component of comprehensive demand management, to the forefront of the water policy dialogue in California; In 1982, California adopted a statewide policy of encouraging voluntary water transfers between agencies throughout the state. This policy was based on the assessment that there are fewer environmental impacts associated with transfers than with construction of conventional projects, and that although transfers are difficult to implement, they can be accomplished more quickly and usually at less cost than additional facilities can be constructed. Since 1982, several laws have been passed to facilitate the sale, lease, exchange, or transfer of water and to ensure that water conveyance facilities are available in transferring water [ 1].

Demand for water has grown rapidly in California. Between 1960 and 1990, urban water use rose from two million acre-feet (MAF) to six MAF, and legally mandated natural runoff for environmental purposes increased from one MAF to 24 MAF, or 28 per cent of the total water supply. Water use in irrigated agriculture also increased, from 20 MAF to 24 MAF (Fig. 1). Growth in demand for water is expected to continue. California's population is projected to increase to 49 million people by 2020 (from about 30 million in 1990). According to the California Water Plan Update [2], even with extensive water conservation, urban annual net water demand is projected to increase by about 3.8 MAF to 10.5 MAF by 2020. Almost half the population increase is expected

to occur in the water-scarce southern coastal region, raising that region's annual water demand by 1.5 MAF.

Severe droughts in recent years have revealed the need for greater flexibility in water trading. The 1987-92 drought required increased water conservation in much of California, causing mandatory water rationing for urban users, sharply diminished surface water supplies for many agricultural users, and strained environmental resources. The prolonged drought prompted urban water agencies to develop drought emergency plans to address water supply shortages of up to 50 per cent of normal supply and led to the development of the California State Emergency Drought Water Bank, which brokered large-scale water trading in 1991 and 1992.

However, despite increasing demands on water supplies and laws explicitly encouraging water trading, California water law and policy is characterized by conflict between the desire to facilitate water transfers and the desire to protect a wide range of constituencies against possible adverse effects of water trades. The controversy over water markets is typified by the environmental movement's ambivalence toward water transfers. While water trading is seen as a partial solution to the problem of meeting increasing urban demands without building new water projects, there are serious concerns that temperature and flow fluctuations caused by the water releases will harm fish and wildlife, particularly salmon eggs and fry. These concerns are heightened by the fact that many transfers must be pumped through the Sacramento-San Joaquin Delta, an area where environmental and water quality problems are already complex, because most of California's precipitation falls on the northern part of the state and the greatest demand for water is in central and southern California.

This article will examine how the complex tradeoffs between flexibility and regulation of water transfers are resolved in practice in California. It will: discuss briefly trends in water transfers; describe the historical development of water rights in California and the implica-

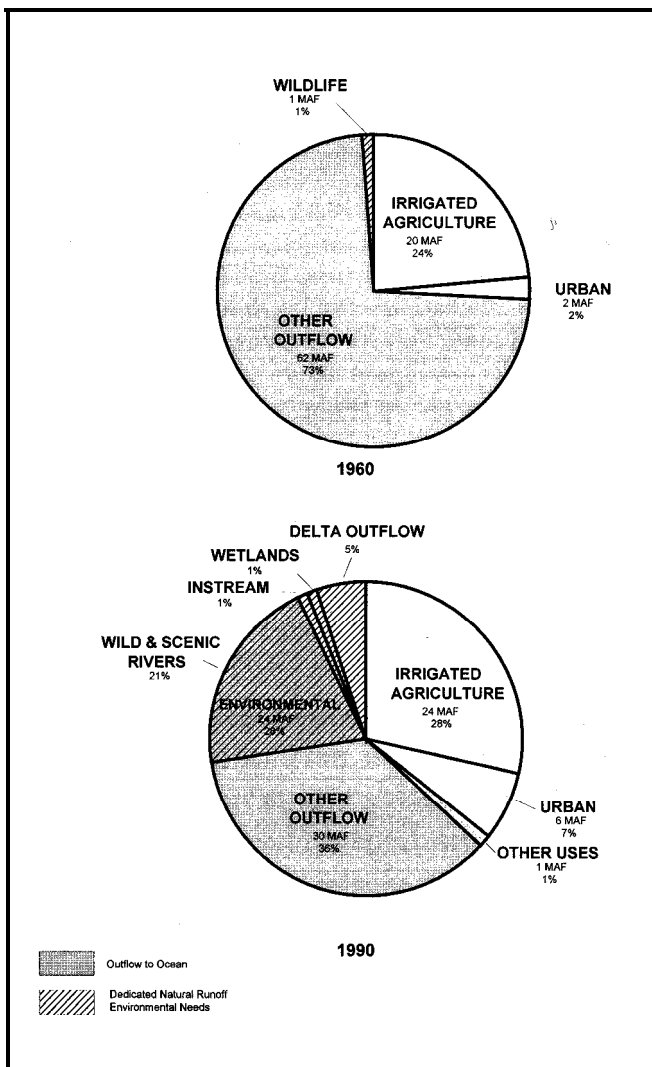


Figure 1. Disposition of average annual water supply, 1960 and 1990. The total of 85,000,000 acre-ft includes groundwater. Source: Draft California Water Plan Update, 1993.

tions of this legacy for tradability of water; examine the regulatory structure governing water transfers and specific protections and constraints that condition water transfers; identify recent legal and policy innovations that have developed in response to these potentials and constraints; and discuss implications for the future of water transfers.

## TRENDS IN WATER TRANSFERS

Based on available evidence, the annual volume of water market transfers has grown, albeit slowly. Nearly all water transfers in California are sales of specific amounts of water during a specific period, not a sale of the water right itself. Although most types of water rights can be transferred, typical transfers are structured so that the original holder retains the water right. Several statutes provide that the transfer of water does not impair the water right. As will be shown below, the regulatory

framework governing transfer of water follows directly from the legal definition of water rights.

Table 1 shows the annual water transfers using the facilities of the State Water Project and those transfers reviewed and approved by the State Water Resources Control Board (SWRCB). These figures do not represent a comprehensive accounting of water transfers in California, since many transfers do not require reporting. As will be described in more detail, water transfers do not need approval from the SWRCB if the water rights involve a pre-1914 appropriative right, if the transfer is exempted from SWRCB approval (for example "water leases") or if posttransfer use is consistent with original use. Moreover, many water transfers within or between irrigation districts do not need approval, and the districts do not report these transfers to the state.

Table 1. Water transfers in acre-ft using facilities of the State Water Project and temporary transfers approved by the State Water Resources Control Board, 1982-93. Source DWR and SWRCB files.

Year	SWP Transfers	SWRCB-approved Transfers	Total <sup>a</sup>
1982	162,947	5,000	167,947
1983	187,461	0	187,461
1984	324,122	2,366	326,388
1985	425,169	5,868	430,937
1986	193,511	5,000	198,511
1987	488,619	83,144	488,663
1988	742,640	111,950	744,590
1989	626,950	274,700	894,650
1990	620,424	229,950	850,274
1991	619,194	249,950	861,644
1992	387,719	52,000	439,719
1993	323,304	188,500	451,804

<sup>a</sup> SWRCB approved transfers using SWP facilities are counted only once in total.

Nevertheless, the trends shown in Table 1 appear to be broadly indicative of the general pattern of water trading during the past several years. There has been a slow upward trend with pronounced increases during the peak drought years of 1988-91. At the peak volume of transfers, 890,000 acre-feet in 1989, the two types of transfers documented here represented about 3 per cent of total annual agricultural and urban demand for water in California. Combined with unreported transfers, this volume represents an important degree of flexibility in water allocation at the margin. However, many analysts have argued that restrictive policies have kept the volume of water transfers far below what is needed for efficient water use [3-5]. The remainder of this article will explore the potentials for and constraints to enlarging the market for water transfers, beginning with a discussion of the existing system of water rights in California.

### *Appropriative and Riparian Rights*

California operates under a dual system of water rights for surface water that recognizes the doctrines of both riparian and appropriative rights. Under the riparian doctrine, a landowner has the right to divert a portion of the water naturally flowing by his land for reasonable and beneficial use on his land adjacent to the stream and within its watershed, subject to certain limitations. Under the appropriative doctrine, a landowner or other water user has a right to divert, store, and use water regardless of whether the land on which it is used is adjacent to a stream or within its watershed, provided that the water is used for reasonable and beneficial purposes and is surplus to water from the same stream used by earlier appropriators. These rights and restrictions are embodied in Article X, Section 2 of the California Constitution, which places significant limitations on water rights by prohibiting the waste, unreasonable use or method of use, or unsuitable method of diversion of water.

### *Water Rights, Permits, and Licenses*

The Water Commission Act of 1914 codified and consolidated existing water law, recognizing that all water within the state is the property of the people of the state, but that the right to use the water may be acquired in the manner provided by law. The act established a system of state-issued permits and licenses to appropriate water and placed the responsibility for administering appropriative water rights with what is now the State Water Resources Control Board (SWRCB). The act also provides procedures for adjudication of water rights, including court references to the SWRCB and statutory adjudication of all rights to a stream system.

### *Groundwater Rights*

Groundwater is available to any person who owns land overlying the groundwater basin. Groundwater management in California is accomplished either by judicial adjudication of the respective rights of overlying users and exporters or by local management of rights to extract and use groundwater as authorized by statute or agreement. Most of the larger groundwater basins in Southern California, where water is relatively scarce, are managed according to court adjudication or by an agency with statutory powers. Most basins in Northern California, where water is relatively plentiful, are not adjudicated or under agency management.

In 1992, the legislature authorized local water agencies to adopt groundwater management plans, which were subject to the approval of landowners holding 50 per cent of the assessed valuation of land within the local area. Plans may include: control of saline water intrusion; identification and protection of wellhead and recharge areas; regulation of the migration of contaminated water; provisions for abandonment and destruction of

wells; mitigation of overdraft, replenishment, monitoring, and facilitation of conjunctive use; identification of well-construction policies; and construction of cleanup, recharge, recycling, and extraction projects by the local agency [2].

### *Water Rights in Federal Water Projects*

Another type of water right is exercised within federal water projects run by the U.S. Bureau of Reclamation. The reclamation water right, like most other water rights, begins with an appropriation of water to the Bureau under prevailing state water code requirements. Initially, the Bureau of Reclamation holds the legal title (the appropriative water right). The Bureau then enters into a service agreement with (or turns its legal title over to) a delivery entity, such as a special water district or an irrigation district. Finally, the irrigators who contract to receive reclamation water own equitable title to the water right and thus are entitled to continued delivery by the federal government throughout the duration of their contracts.

---

## **The historical development of appropriative rights has defined the fundamental characteristics of modern water rights in California**

---

### APPROPRIATIVE RIGHTS DOCTRINE

This article focuses almost exclusively on appropriative rights, because most of the water in the tradable margin is held according to these rights. The historical development of appropriative rights has defined the fundamental characteristics of modern water rights in California, which permit water to be traded while imposing strict requirements for determining tradability. This section reviews the development of the appropriative rights doctrine in California, relying heavily on the excellent treatment of Western water law by Johnson and DuMars [6].

The first appropriative water rights statute was enacted in California in 1872 and codified existing traditional rights. A landowner could acquire such water rights by posting, at the point of diversion, a document stating the intended amount of the right and its purpose, filing for the right in the county recorder's office, and taking the necessary steps to "perfect" the right (put the water to beneficial use) with "due diligence." Appropriative water rights originated with gold mining, which required the diversion of large amounts of water from rivers and streams. A basic tenet of mining law is that the miner who initially stakes a claim ("first in time") is protected in development of the claim against other miners ("first

in right”). This practice carried over to the use of water, becoming a recognized tradition that was protected by the courts.

The appropriative rights doctrine defines tradability of water as having several essential characteristics. The first of these is the requirement of beneficial use: the water user is entitled to only the amount of water that he can put to beneficial use, whether for mining gold or irrigating crops. The second defining characteristic is the principle of priority: “first in time is first in right.” A chronological hierarchy is created, and in times of shortage senior rights holders are protected up to the available supply, while junior users (who established rights later) receive no water at all. A corollary to the “first in time” principle can be called “use it or lose it.” Water rights holders who fail to use the water to which they are entitled receive little protection. When water rights are relinquished through nonuse, the water returns to the watercourse and is available to meet the needs of junior users.

Another characteristic of prior appropriation is the need for a diversion, which establishes intent to use the water and provides a limited means for measuring the water used. The amount of water that can be extracted from the stream is based on a “water duty” (the amount of water a user needs per acre to successfully irrigate his crops) multiplied by the number of acres he irrigates, and is defined in terms of diversion amounts (flows). Because downstream irrigators depend on the water that is not consumed, the “return flow,” or excess water flowing off the field, is “owed” to the watercourse and downstream users. This principle forms the basis for definition of the “transferable portion” of water rights in terms of consumptive use, which will be discussed extensively below. Note that under the diversion doctrine, instream uses were not originally recognized as sufficient to demonstrate intent to use, although modifications to the law now allow instream flows to be considered beneficial use.

The appropriative rights doctrine firmly established the principle of water tradability. In 1859 (even before codification of the appropriative rights law), the California Supreme Court recognized the right to use and trade water under the appropriation doctrine as “substantive and valuable property.”

Under the law of this state as established at the beginning, the water right which a person gains by diversion from a stream for a beneficial use is a private right, a right subject to ownership and disposition by him, as in the case of other private property [6].

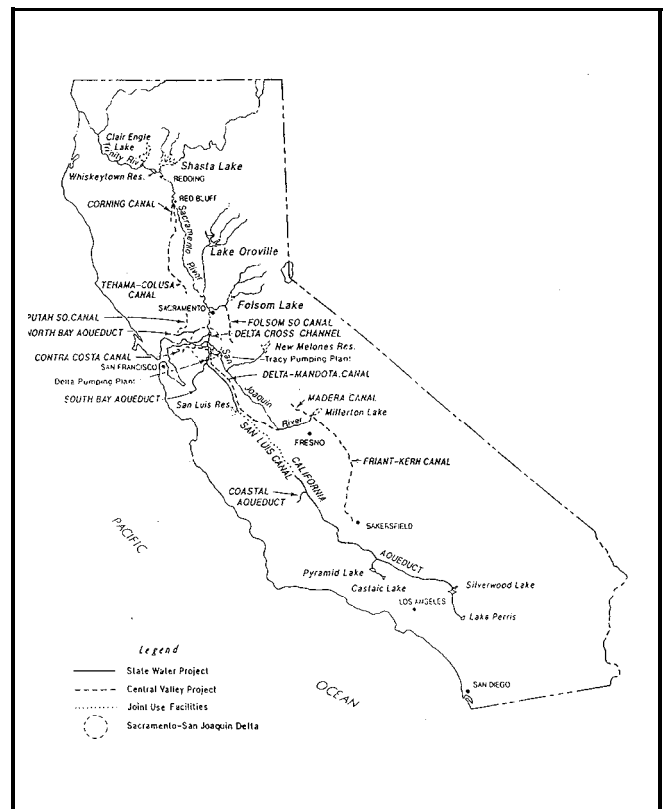
An appropriative water right thus became a constitutionally protected property interest. It can be sold, leased, or transferred in other ways. Transfer of water rights need not be permanent: water rights can be leased for a season, a year, or many years. Protection of the water right as a property right was deemed necessary to promote investment of capital and to protect long-term fi-

nancing of economic development activities that depended on water use.

The implications of the appropriative rights doctrine to the potential for water transfers today will be explored in detail below. First, however, the physical setting that conditions water transfers in California will be described briefly.

## THE PHYSICAL SETTING

If water transfers are to be made on a large scale in California, a substantial portion will be transported by either the California State Water Project (SWP) or the federal Central Valley Project (CVP). These projects pump the water through the Sacramento-San Joaquin Delta, a 1,153 square-mile region located where



**Figure 2. California State Water Project and Central Valley Project. Source: State Drought Water Bank - Program Environmental Report.**

California’s two biggest rivers converge and flow into San Francisco Bay. Forty-two per cent of the state’s annual runoff flows through the delta. The SWP and CVP water facilities in the south delta pump water to supply farms and cities in Central and Southern California, providing water to about two-thirds of the state’s population. About 60 per cent of the water used in the San Francisco Bay area is provided by these projects and by local facilities. The delta is a rich agricultural region, where a combination of flat topography, mild





featured conflicting testimony from competing water-user groups. Environmentalists and some fishery biologists have argued that the export of fresh water from the delta is responsible for declining fish populations, and that the restoration of significant freshwater flows is necessary for the health of the estuary. But water-user groups and other biologists have responded that factors other than fresh water exports deplete fish stocks. They have argued that available water would be better utilized, for agriculture and a growing population than for increased delta outflows [7].

Following withdrawal of draft water quality control plans in 1988 and 1991 due to objections from the public and the U.S. Environmental Protection Agency (EPA), the SWRCB decided in 1992 to establish interim Bay/Delta standards, which would last five years and provide immediate protection for fish and wildlife. Water-rights hearings were conducted from July through August 1992, and draft interim standards (proposed Decision 1630) were released for public review in December 1992. Concurrently, under the broad authority of the Endangered Species Act, the federal government was moving toward developing standards and upstream measures to protect the threatened winter-run chinook salmon. In February 1993, the National Marine Fisheries Service issued a biological opinion governing CVP and SWP operations and environmental regulations in the delta that in certain months were more restrictive than SWRCB's proposed measures. On April 5, 1993, the U.S. Fish and Wildlife Service officially listed the delta smelt as a threatened species and on May 24 issued a biological opinion on CVP and SWP operations with conditions designed to protect the delta smelt and its habitat for 1993-94. Again the conditions generally were more restrictive than SWRCB's proposed measures for CVP and SWP operations.

In April 1993, the governor asked the SWRCB to withdraw its proposed Decision 1630 and to focus efforts instead on establishing permanent standards for delta protection, since the recent federal actions had effectively preempted state interim standards and provided interim protection for the Bay/Delta environment.

Strict delta protection requirements may severely constrain the potential for an increased volume of water transfers through the delta. To minimize impacts on the winter-run chinook salmon, delta smelt, and striped bass, and to avoid disruption of service to existing contractors, pumping of water by the SWP and CVP through the delta to meet transfer agreements has been limited mainly to the months of August through October. In the short-term, SWP and CVP contractors relying on the delta for all or a portion of their water supplies face an uncertain outcome from the results of the Bay-Delta Proceedings. For example, in 1993, an above-normal runoff year, environmental restrictions limited CVP deliveries to Westlands Irrigation District to only 50 per cent of contracted supply. Until solutions to the complex

delta problems are identified and put into place, even existing contractors relying on transport through the delta will experience more frequent and more severe water supply shortages, and the potential for more active trading of water, which would increase flows through the delta, will be highly problematical.

Many observers argue that even if firm standards are eventually established, they will not solve the long-term problems of declining fisheries, water quality, and poor water-transfer conditions. These observers contend that the long-term solution lies in the construction of a peripheral canal that would skirt the eastern edge of the delta, carrying Sacramento River water directly to project pumps. Proponents argue that a canal would improve water quality and reduce problems associated with "reverse flows," when project pumps actually reverse the natural fresh water flow pattern, drawing fish into the pumps and poorer quality water into southbound channels. Canal opponents contend that a canal would further harm fish and lead to greater water exports from Northern to Southern California [7].

The merits of a peripheral canal are still being debated, more than a decade after voters defeated a controversial 1982 canal/water-development package, effectively ending large water projects in California. Since then, the Department of Water Resources (DWR) has sought to develop smaller delta improvement projects. These plans include dredging and widening key delta channels to improve fresh water flow to the pumps and constructing new storage facilities or enlarging existing facilities south of the delta to hold winter runoff. Four new pumps have also been added to the SWP delta pumping plant for increased peak-flow pumping. Successful resolution of the complex problems of balancing competing demands in the delta will be a key to future expansion of water trading in California.

## GENERAL REGULATORY FRAMEWORK

Under existing law, holders of both pre-1914 and modern appropriative water rights (established under the terms of the Water Commission Act of 1914) can transfer water. Holders of pre-1914 appropriative rights may transfer water without seeking approval of SWRCB, provided no other legal water user is injured. As shown in Table 1, holders of modern appropriative rights may transfer water, but SWRCB must approve any transfer requiring a change in terms and conditions of the water right permit, such as place of use, purpose of use, or point of diversion. Short-term (one year or less), temporary transfers of water are exempt from compliance with the California Environmental Quality Act (CEQA), but SWRCB must find no injury to any other legal users of the water and no unreasonable effect on fish, wildlife, or other instream beneficial uses. CEQA compliance is required for long-term transfers. Because of the complex environmental problems in the delta, the SWRCB

has announced that it will not approve long-term transfers that increase delta pumping until completion of an environmental evaluation of the cumulative impacts. In addition, permits from fish and wildlife agencies may be required if a proposed transfer will affect threatened or endangered species.

Water held pursuant to riparian rights is not transferable from place to place, although downstream appropriators may contract with riparians to leave water in a stream for potential downstream diversion. Transfers of groundwater, and groundwater substitution arrangements whereby groundwater is pumped as a substitute for transferred surface water, may be subject to restrictions designed to protect groundwater basins against long-term overdraft and to preserve local control of groundwater management.

---

## The potential of this new code section is just beginning to be explored

---

In an important modification of the appropriative rights doctrine, Water Code Section 1707, allows the SWRCB to authorize conversion of an existing appropriative right into an "instream appropriation" to benefit fish or wildlife or for other instream beneficial use. The potential of this new code section is just beginning to be explored. Water obtained pursuant to a water supply contract is also potentially transferable. However, most water supply contracts require the consent of the entity delivering the water.

### PROTECTION AGAINST ADVERSE IMPACTS

Embedded in this regulatory structure are very strong protections against possible damages that could arise from water trades. This section describes in detail how regulations protect direct third-party effects, general economic effects, and environmental impacts and discusses how shortages are allocated under the appropriative doctrine.

#### *Protection Against Direct Third Party Effects: Real Water and Paper Water*

Because the appropriative right is defined in terms of diversion, but the transferable portion of the appropriative right is determined by consumptive use, there is a strong burden of proof on the part of the prospective water seller when determining how much water is tradable. The DWR recognizes six sources of tradable water: fallowing (not irrigating crops); shifting to less water-intensive crops; substituting groundwater for surface irrigation water; direct delivery of groundwater; conserved water; and water from reservoir storage. In regulating each of these types of transfer, the DWR distinguishes

between new water, which is water previously not available to the system; real water, which is water available for transfer that is not derived at the expense of other water-rights holders; and paper water, which is water proposed for sale that does not actually increase system supply. Each category contains strict requirements for identifying the new or real water available for transfer.

*Fallowing.* Water saved by withholding irrigation water from the field for an entire irrigation season can be transferred to another use. Although this concept appears straightforward, determination of tradable water requires verification of farmer intentions, adequacy of water supply, and computation of consumptive use. What would farmer planting intentions have been without the fallowing agreement? To determine farmer cropping intentions, the DWR uses long-term crop and water records and personal knowledge of extension agents and other experts. Determining availability of water requires information about the rights and contracts pertaining to the fallowed farm, together with an estimate of actual availability of irrigation water during the period of transfer. Arriving at this estimate for short-term transfers is relatively easy, but not for long-term transfers, since future availability can vary due to droughts, operational restrictions, or legal and policy changes affecting future contracts.

The final step in determining tradable water is computing consumptive use. In California, the concept of "consumptive use" has evolved over time, and there is still some uncertainty in interpretation. However, the generally accepted definition is actual crop evapotranspiration plus percolation of water lost to further use. Under the 1992 CVPIA, water available for trade includes "water that would have been consumptively used" and water "irretrievably lost to beneficial use." Thus, water that would otherwise percolate to the degraded groundwater in parts of the San Joaquin Valley would be tradable, but water draining to wetlands or used by vegetation that provides significant wildlife habitat would not be tradable [8].

Recently adopted Water Code sections have added some uncertainty to the definition of consumptive use. The new sections define "consumptively used" as "the amount of water which has been consumed through use by evapotranspiration, has percolated underground, or has been otherwise removed from use in the downstream water supply as a result of direct diversion." However, the DWR has interpreted the phrase "has percolated underground" to mean only water that has been irretrievably lost to beneficial use, which is consistent with the CVPIA definition.

*Shift in cropping patterns.* Shifts from water-intensive crops to crops which use less water (i.e., from tomato to safflower, or corn to wheat) can also produce tradable savings in consumptive use. The verification process is basically the same as for fallowing, but becomes even more complicated if the substituted crop

grows during a different season than the original crop. Wheat, planted in late fall and harvested in late spring, relies mainly on rainfall, but may utilize one or more applications of irrigation water in dry years. Corn grows during the summer and depends almost entirely on irrigation water. The amount of water that is saved by a wheat-to-corn shift therefore depends on how dry the spring wheat season is [8].

**Groundwater substitution.** Tradable water is also generated if a farmer grows the same crop but utilizes groundwater instead of rights to surface water. For the sake of efficient operations in an emergency, the Water Bank groundwater substitution contracts allowed the transfer of one acre-foot of unused surface water for each acre-foot of groundwater pumped. In fact, DWR recognizes the interconnectedness of groundwater and surface water: pumping creates a local depression in groundwater levels that creates a draft on future surface flows. Thus, groundwater recharge can deplete future surface flows, causing in effect an involuntary reallocation of surface water rights, depending on whether recharge occurs during periods of surplus water availability or during periods when water would otherwise be used beneficially. The precise, location-specific relationships between groundwater and surface water are complex and poorly understood, and future groundwater substitutions are likely to require more detailed hydrologic examination, with the possibility that considerably less than one acre-foot of surface water could be sold for each acre-foot of groundwater substituted.

**Direct groundwater delivery** Groundwater can also be pumped for transfer, but there is generally significant opposition and there are strong legal limitations to out-of-basin transfers. All overlying landowners have superior rights, and groundwater management plans that have been adopted in many regions limit or prohibit out-of-basin transfers. The potential for in-basin sales to higher-valued uses appears greater, but again the hydrologic complexities involved in estimating actual transferable groundwater must be addressed.

**Conservation.** Water conserved through a reduction in crop consumption, canal lining, use of improved irrigation technology, and an environmentally acceptable reduction in consumption by nonagricultural vegetation can also be traded. An example is the 1987 contract by which the Metropolitan Water District of Southern California (MWD) paid for the lining of canals and other physical and management improvements in the Imperial Irrigation District (IID) in exchange for most of the water conserved through the improvement [9].

A key to the success of the MWD-IID arrangement is that in this case, conserved water is clearly new water, because it otherwise would have drained to the Salton Sea, a salt sink [8]. While conservation may be of significant benefit to a given farmer or irrigation district, the contribution of conservation to overall system water supplies must be carefully analyzed to determine how

much "conserved" water is actually tradable. To the extent that conservation simply reduces drainage that has beneficial use downstream, new water is not generated.

**Storage withdrawals.** The amount of stored surface water that would not otherwise be released can also be traded. If the storage is refilled from future surplus flows, this represents new water. However, again, complicated verification procedures can be involved. If the transferred storage water is replaced with water that otherwise would have been available for downstream water-rights holders, the transfer will harm these downstream holders. To protect downstream rights holders, Water Bank contracts for storage withdrawals included a refill clause, in which reservoir owners agreed to defer refill until high-runoff periods, when additions to storage would cause no detriment to others.

### **Protection Against Negative Indirect Economic Effects**

Water transfers can negatively affect business activities, local government fiscal capacity, and the quality of public services in areas from which water is being transferred, because of the reduction in irrigated area or production and associated reductions in agriculturally linked economic activities in the area-of-origin and in the property tax base. In addition, permanent transfer of water rights may limit future economic development in the area-of-origin. If, in the future, economic conditions make expanded irrigated agriculture, new industrial activities, or residential development economically attractive, then water may not be available locally to pursue these opportunities. Although some studies suggest that direct and indirect economic impacts of water transfers on the area-of-origin from the perspective of a state's economy generally are small, such impacts are a significant concern to area-of-origin residents [10].

Evidence from the only recent large-scale water transfer in California, the Emergency Drought Water Bank, indicates that general economic effects were small. According to a Rand Corporation study, farmers who sold water reduced farm operating costs by \$17.7 million, or 11 per cent, and crop sales by \$77.1 million, or 20 per cent. These reductions adversely affected the suppliers of farm inputs and the handlers and processors of farm outputs, but the impacts were not large when compared to the agricultural economy in the selling region. The study estimated that operating costs, crop sales, and agribusiness revenues dropped 2 to 3 per cent in selling counties because of the bank [11].

Despite these relatively small impacts, both state and federal law contain protections against general economic impacts, and more have been proposed. During the years when the CVP and SWP were being developed, area-of-origin legislation was enacted to protect Northern California supplies from being depleted as a result of the projects. County-of-origin statutes provide for the reservation of water supplies for counties in which the water originates when, in the judgment of the SWRCB, an

application for the assignment or release from priority of state water-right filings will deprive the county of water necessary for its present and future development. Watershed protection statutes require that the construction and operation of elements of the CVP and the SWP not deprive the watershed, or area where water originates, or immediately adjacent areas that can be conveniently supplied with water, of the prior right to water reasonably required to supply the present or future beneficial needs of the watershed areas or any of its inhabitants or property owners.

---

## **Both state and federal law contain protections against general economic impacts**

---

In 1984, additional area-of-origin protections were enacted covering the Sacramento, Mokelumne, Calaveras, San Joaquin, the combined Truckee, Carson, and Walker rivers, and Mono Lake. The protections prohibit the export of groundwater from the combined Sacramento River and Sacramento-San Joaquin delta basins, unless the export complies with local groundwater plans. Also, Water Code Section 1245 holds municipalities liable for any economic damages that result from their diversion of water from a watershed.

Further restriction on aggregate amounts of water that can be transferred are embodied in recently enacted provisions requiring that water suppliers limit the amount of transferable water made available by allowing to 20 per cent of the water that would have been applied or stored by the supplier. State law also prohibits the use of public agency facilities to transfer water unless a finding is made of no unreasonable impact on the overall economy of the county from which the water is being transferred. At the federal level, P.L. 102-575 prohibits the Secretary of the Interior from approving any transfer of CVP water that would have a long-term adverse effect on groundwater conditions in the transferor's service areas. It also prohibits transfers that would unreasonably impact the water supply, operations, or financial conditions of the transferor's district or its water users.

### *Environmental Protection*

State law prohibits water transfers that would have an unreasonable impact on fish, wildlife, or other instream uses. A wide range of environmental and water quality laws affects the feasibility of water transfers. Among these are (1) environmental review and mitigation regulations, which make water transfers for a duration of one year or more subject to review under the California Environmental Quality Act (CEQA), necessitating a state environmental impact report (EIR) that requires docu-

mentation of the environmental impacts of their actions, and identification and implementation of measures to avoid or reduce environmental damage; (2) minimum fish flow protection, which requires that the owner of any dam allow sufficient water at all times to pass through the dam to keep in good condition any fisheries that may exist below the dam; (3) protection of wild and natural areas, through the federal national and state Wild and Scenic Rivers Acts, which set aside many California rivers to preserve their free-flowing conditions; and (4) protection against water transfers that would significantly reduce water quality through a comprehensive water quality control law administered throughout the SWRCB. However, the environmental measure likely to be the most limiting to future expansion of water trading is endangered species protection.

Under the federal Endangered Species Act (ESA), which also governs state agencies and private individuals, an endangered species is one that is in danger of extinction in all or a significant part of its range, and a threatened species is one that is likely to become endangered in the near future. As noted earlier, the 1993 declaration of the smelt as a threatened species under the ESA tightened the required restrictions on delta water management. In general, Section 9 of the ESA prohibits the "take" of endangered species and threatened species for which protective regulations have been adopted. Take has been broadly defined to include actions (including water transfers) that could harm or harass listed species or that cause a significant loss of their habitat. State agencies and private parties are generally required to obtain a permit under Section 10(a) of the ESA before carrying out activities that may incidentally result in the take of listed species. The permit normally contains conditions to avoid take of listed species and to compensate for habitat adversely impacted by the activities. The California Endangered Species Act is similar to the federal ESA and must be complied with in addition to the federal ESA. Listing decisions are made by the California Fish and Game Commission.

---

## **Endangered species protection is especially significant for the future of water trading in California**

---

Endangered species protection is especially significant for the future of water trading in California because of the existence of listed species in the crucial Sacramento-San Joaquin delta. As described above, protection of the winter-run salmon and delta smelt severely limits the window of opportunity for pumping water through the delta. With a limited time frame within which water can be transferred through the delta and limits on

pumping volume during that time, the amount of water that can be traded from the relatively water-abundant north to the water-scarce south of the state is subject to physical limitations.

### *Flexibility to Respond to Water Shortages*

The appropriative rights doctrine also limits the flexibility of reallocating water to the most productive purposes in response to shortages induced by drought. The “first in time, first in right” principle in the appropriative rights system ensures that, when shortages occur, senior rights holders receive first priority to available water, whether or not the water is being utilized for high-valued purposes. However, because these priorities are not based on economic returns, but on chronological time of water right establishment, considerable economic inefficiencies can occur.

Water shortages in federal projects in theory are handled differently from privately acquired appropriative rights, in that water users within a reclamation district share the effects of drought. Thus, even the most “senior” irrigator in a water district may have to reduce water usage by the same percentage as every other user in the district. However, often the burden is deliberately shared unequally. In the San Joaquin Valley, for example, most water districts allocate surface water based on acreage served, and during shortages, many give preference to lands growing permanent crops [3].

Thus, under either state or federal water rights, top-down rationing of water is often invoked during droughts. The inability to get water to where it is most needed during shortages would be a serious limitation for any allocation system. The desire to facilitate the transfer of water to higher-valued uses during the severe drought of 1987-92 was a fundamental driving force behind the establishment of the biggest and most innovative step forward in developing more flexible water marketing in California: the Emergency State Drought Water Bank, described in the next section.

## **RECENT DEVELOPMENTS IN WATER TRANSFERS**

Given a rather severe regulatory framework, which puts a strong burden of proof on the potential water seller, and the generally rather limited number and volume of water transfers, what is the long-term potential for water trading? Two recent developments appear to offer cause for some optimism for the future expansion of water trading: the Emergency State Drought Water Banks of 1991, 1992, and 1994, and the Central Valley Project Improvement Act of 1992.

### *State Drought Water Banks*

The creation of the State Water Banks of 1991 and 1992 was a direct result of the 1987-92 drought, and was designed to move water from areas of greatest avail-

ability to areas of greatest need. The temporary changes to the law, enacted in 1991 designed to facilitate the State Drought Water Bank, were made permanent in 1992. The law now authorizes water suppliers (local public agencies and private water companies) to contract with water users to reduce or eliminate water use for a specified period of time and to transfer the water to a State Drought Water Bank or other water suppliers and users. It also provides that water proposed for transfer need not be surplus to requirements within the supplier’s service area and specifies that use for a transfer is a beneficial use. There were three sources of water for the 1991 State Drought Water Bank: temporary surplus in reservoirs, surface supplies freed up by the use of groundwater, and surface supplies freed up by fallowing agricultural lands. Substitution of groundwater from an overdrafted groundwater basin for transferred surface water is prohibited unless the water was previously recharged to the basin as part of a groundwater banking program. The amount of water made available by land fallowing is limited to 20 per cent of the amount applied or stored by the water supplier, unless the supplier approves a larger amount at a hearing.

In operation, the Water Bank assumed a very active role as certifier, broker, financial banker, and public interest advocate in facilitating water transfers [9]. The Water Bank executed standard one-year contracts with agricultural water users, who agreed to sell their water and either to leave land fallow for the season or to irrigate with groundwater rather than surface water. In addition, the Water Bank purchased some water stored in reservoirs. The purchased water was stored and then released as needed to water districts that qualified to receive the emergency supplies. The Water Bank attempted to monitor local conditions in the sellers’ areas to assess the third-party effects, if any, of the transfers.

Tables 3 and 4 summarize operations of the 1991 and 1992 Water Banks. The 1991 Water Bank paid sellers a price of \$125 per acre-foot, based on an analysis of farm budgets and discussions with potential buyers, sellers, agricultural economists, and other advisors. Buyers were charged \$175 per acre-foot to cover the purchase price, the cost of water released to meet incremental delta outflow requirements, and associated administrative costs, plus the additional actual conveyance costs from pumping stations located in the southern part of the Sacramento-San Joaquin delta. The actual delivery price at a water district near Fresno was slightly more than \$200 per acre-foot [9]. Validation of consumptive use as the measure of tradable water followed the principles described above.

To be eligible for the emergency water, buyers were required to document that they had “critical need,” that they were using available water fully and judiciously, and that they had implemented a water conservation program. When planning the Water Bank, the DWR set the purchase target from 750,000 to 1,000,000 acre-feet [9].

Despite concern that the target would not be achieved, after a short initial delay, purchase contracts were quickly completed. By the end of the season, the department purchased 820,000 acre-feet of water for the Water Bank, 50 per cent from fallowing, 33 per cent from groundwater and 17 per cent from existing storage (Table 3).

**Table 3.1991 Drought Water Bank: purchases, allocations, and prices**

	Amount, acre-ft
<b>PURCHASES</b>	
<i>Water Source</i>	
Fallowing	410,000
Ground water	260,000
Surface water	150,000
<b>Total</b>	<b>820,000</b>
Delta Water Quality Requirements, Technical Corrections	-165,000
<b>Net Supplies</b>	<b>655,000</b>
<b>ALLOCATIONS</b>	
Urban uses	<i>307,000</i>
Agricultural uses	<i>83,000</i>
State Water Project (storage)	<i>265,000</i>

<b>WATER PRICE COMPONENTS</b>	<b>\$/acre-foot</b>
Basic purchase price	125
Other purchase costs, Delta requirements Technical corrections	45
Administration	5
<b>TOTAL</b>	<b>175*</b>

\*Plus delivery costs

Source: California Department of Water Resources, files.

Most fallowing commitments came from the Sacramento-San Joaquin delta rather than from rice, as had been expected. Rice farmers in the Sacramento Valley were subject to pressure from the local community and rice farmer cooperatives not to participate in the Water Bank. The northern rice growing regions opposed water sales for several reasons. Cooperatively owned rice processing organizations feared loss of volume, while some growers wanted a higher water price. In addition to these economic reasons, regional political leaders wanted to assert the independence of the area-of-origin of much of the state's water [5]. Thus, identification of short-term sellers even for short-term transfers to the Water Bank encountered constraints raised by concerns over indirect economic impacts and area-of-origin problems.

The Water Bank sold and delivered 390,000 acre-feet, 47 per cent of the amount purchased, and had an estimated 265,000 acre-feet (33 per cent) available for carry-over storage for 1992 in the SWP. Water allocated to maintenance of delta flows, conveyance losses, and evaporation accounted for the remaining 165,000 acre-feet (20 per cent) of the purchased amount. The carry-over storage was higher than expected, because substantial rains in March 1991 reduced anticipated demand, giving the Water Bank a greater margin for carry-over than expected. About 80 per cent of the water was delivered to urban areas in Northern and Southern California and 20 per cent to agriculture in the San Joaquin Valley (Table 3).

**Table 4.1992 Drought Water Bank: purchases, allocations, and prices**

	Amount, acre-ft
<b>PURCHASES</b>	
<i>Water Source</i>	
Fallowing	0
Groundwater and conservation	161,000
Surface water	32,000
<b>Total</b>	<b>193,000</b>
Delta Water Quality Requirements	-34,000
<b>Net Supplies</b>	<b>159,000</b>
<b>ALLOCATIONS</b>	
Urban uses	39,000
Agricultural uses	95,000
Department of Fish and Game	25,000

<b>WATER PRICE COMPONENTS</b>	<b>\$/acre-foot</b>
Basic purchase price	50
Other purchase costs, Delta requirements	45
Administration	5
<b>TOTAL</b>	<b>72*</b>

\*Plus delivery costs

Source: California Department of Water Resources, files.

The 1992 Water Bank operated under less stressful water availability conditions, and in anticipation of less demand for water, prices were set considerably lower, at \$50 per acre-foot. A total of 193,000 acre-feet was purchased and 159,000 acre-feet were sold, the remainder being allocated to delta flow. The Water Bank has been reactivated in mid-1994 as water supplies have tightened. As of August 1994, the Bank had contracted for supplies of 202,000 acre-feet from water agencies and irrigation districts and for deliveries of 159,023 feet for

short-term leases for irrigation and municipal use. Purchasers will pay \$67.50 per acre-foot for water delivered to the SWP or CVP pumping facilities in the delta, plus an average of about \$30.00 per acre-foot to cover transportation costs and the 20 per cent requirement for delta outflows. A total of 39,756 acre-feet of water has been allocated to augment delta streamflows to control salinity intrusion [12].

Although the changes initiated under the State Water Bank do much to facilitate water transfers by water suppliers, they do not address the issue of "user-initiated transfers," where the water user is not the holder of the water right but has a contractual entitlement to water from the supplier. The Bureau of Reclamation has in the past interpreted water sales as detrimental to project water service, and thus did not allow any CVP water to be sold to the bank. Exceptions were made for water based on water rights that some contractors held before the project was built.

The Water Banks have demonstrated that, with a strong central broker, large water transfers can be made quickly, even with existing restrictive rules on third-party damages. However, there also may be considerable benefits from a more decentralized approach to water trading, one that is acceptable to suppliers, users, and potential buyers, whereby users can initiate transfers subject to reasonable terms and conditions imposed by suppliers to protect their legitimate interests and those of other water users. A step in this direction was taken with the CVPIA in 1992.

### *The Central Valley Project Improvement Act of 1992*

The CVPIA is intended to increase the use of water transfers by providing that all individuals and districts receiving CVP water (including that under water-right settlement and exchange contracts) may transfer it to any other entity for any project or purpose recognized as a beneficial use under state law. The Secretary of the Interior must approve all transfers. The affected district must approve any transfer involving more than 20 per cent of the CVP water subject to long-term contract with the district. With this clause, allowing farmers to sell up to 20 per cent of their water without approval of their local irrigation or water district or agency, the CVPIA has, for the first time, vested the property right to the first 20 per cent of contract water directly in the individual user. The section continues by specifying that the transfer must be between willing buyers and sellers and based on mutual agreement. The conditions continue with the stipulation that "All transfers . . . shall be subject to the right of first refusal on the same terms and conditions by entities within the Central Valley Project service area" [13].

These conditions contrast sharply with the incentives facing potential water sellers in Bureau of Reclamation districts before passage of the CVPIA. Water transfers required permission from existing irrigation and water

districts in the project, and the transfer could not be detrimental to the project or to any senior appropriator. In effect, as long as any users in the district could use the water at its nominal cost, individuals could not sell water at market prices. With these legislative restrictions on gains from trade, water districts and groups of members often obstructed water trades [13].

The CVPIA also sets forth several conditions on the transfers, designed to protect the CVP's ability to deliver contractually obligated water or meet fish and wildlife obligations because of limitations in conveyance or pumping capacity. Transfers are deemed to be a beneficial use by the transferor, and are permitted only if they will have no significant long-term adverse impact on groundwater conditions within the transferor district and will have no unreasonable impact on the water supply, operations, or financial conditions of the district.

A three-tiered pricing system for federal water, introduced under the CVPIA, facilitates water marketing by increasing the opportunity cost to the farmer of holding water in relatively low-valued uses. The prices for each of the three tiers depend on the contracted price, the quantity of water used, and the CVP's full cost, with second-tier prices when water use reaches 80 per cent, and the third-tier prices beginning when water use reaches 90 per cent of total water contracted to the individual. The marginal price on the third tier is at the full cost of delivery of CVP water, including interest costs on capital, and is much higher than prices ordinarily paid. The full cost of a federal project includes interest costs on project capital that have traditionally been excluded when determining repayment charges for irrigation. As a result, irrigators are likely to reduce substantially the quantity of water diverted as the marginal price increases. However, it is not clear how much consumptive use will be affected by the tiered pricing system. To the extent that reduced diversions would have simply returned to the canal as return flow, there may be little savings in real water. Nevertheless, while farmers may respond initially to higher prices by maintaining consumptive use while reducing diverted amounts, in the longer run, the tiered pricing system should encourage investment in more significant on-farm water conservation, which would reduce consumptive use as well, freeing up water for trading to higher-valued uses.

The CVPIA also reflects the ambivalence embedded in California law over allocation of water by markets, by its nonmarket reallocation of water from agricultural to environmental purposes. Gardner and Warner [5] argue that, while the Act appears to promote water transfers in principle, it also gives fish, game, and wildlife interests special powers not accorded to other uses. Fish and wildlife interests are not required to compete in the market for water resources as are municipal, industrial, and agricultural users because the Act guarantees water even if other uses suffer. The CVPIA mandates that

800,000 acre-feet of CVP water, about 13 per cent of the total, be dedicated annually for fish, wildlife, and habitat restoration. This amount could irrigate over 200,000 acres of cropland producing cotton or tomatoes. Due to differing water-right priorities, this cut in project water only affects a third of the CVP irrigation regions, and in many years represents a 33 per cent reduction in surface supplies in these areas [5].

## **CONCLUSIONS: FUTURE DIRECTIONS FOR WATER MARKET TRANSFERS**

The trend toward increasing use of market and market-like transfers of water to meet growing demand in urban, environmental, and high-valued agricultural uses is likely to continue. Recent developments pointing in this direction include (1) the continued commitment of the state to increasing the flexibility of water transfers, exemplified by passage of a series of laws gradually easing restraints on transfers; (2) the successful implementation of the Emergency Drought Water Banks in 1991, 1992, and 1994 and market-like conservation measures such as the MWD/IID agreement, which have built up expertise and operating procedures for evaluating and making transfers; (3) liberalization of rules for trading

---

### **The trend toward increasing use of market and market-like transfers . . . is likely to continue**

---

water under the CVPIA, which should encourage increased user-initiated trading of federal water; and (4) the recent completion of the State Drought Water Bank Program Environmental Impact Report and near-completion of a more comprehensive EIR governing future "nonemergency" and long-term transfers. These documents will identify potential transfer pathways and transport schedules to DWR, SWP, SWRCB, Department of Fish and Game, and other interested agencies, and identify likely impacts in the delta and elsewhere. Completion of these EIRs should streamline future analysis of individual transfer requests, reducing the costs of verification and approval.

The growth in water markets is, however, likely to be moderate; markets will remain highly regulated, and implementation of market transfers will require considerable central participation from the DWR and other state and federal agencies and projects. This is because of (1) the strong burden of proof placed on potential transferors to verify consumptive use, and lack of direct and indirect damage to third-party and environmental interests under the appropriative doctrine as it has evolved under California law; (2) the necessity to balance powerful interest groups and competing demands for agricultural,

urban, and environmental purposes, a challenge that is accentuated by (3) the unique hydrological/geographical conditions governing water transfer in California, especially the fact that a large share of future water transfers will need to be transported through the delta, which will require complicated environmental tradeoffs; and (4) the related need for careful timing of water transfers, which will be made in most cases through storage and delivery infrastructure that is already heavily committed to existing contractors. The DWR (and the federal CVP) will therefore be expected to play a major role in facilitating transfers, including identifying transfer opportunities, determining the amount of water available for transfer under individual transfer proposals, certifying that trades do not cause third-party damages, and scheduling the actual transport of traded water in the SWP and other projects while meeting environmental requirements and contractual commitments.

Further legal and policy reforms could create a more decentralized and less regulated approach, even under the unique conditions existing in California. Reforms that could move water policy in this direction include the following:

*Reduction in the transaction costs of water trades through simplification of the process for determining the amount of water available for trade.* Simplified procedures, which would increase the probability of reduction of return flows due to trades, could be coupled with provision of financial compensation and/or reservation of a portion of the traded water to the SWP, water districts, or other water suppliers to be allocated to compensate for actual damages due to reduction in return flows not detected by the simpler procedures.

The simplest procedure would be to create a uniform presumption regarding consumptive use and return flows, which eliminates the need to determine consumptive use on a case-by-case basis. The Wyoming statute authorizing temporary water transfers creates a presumption of 50 per cent return flows, with the remainder considered the transferable quantity. Although attempts to rebut the presumption could be made, these would likely be infrequent if the presumption is a reasonable approximation. If, as is likely, a uniform statewide presumption is not feasible due to different agroclimatic conditions, regional presumptions could be established [14]. However, the uniform presumption of return flows has a serious flaw: it would tend to discourage investment in on-farm water conservation. Any return flow presumption generous enough to avoid challenges across a wide range of environments would likely overstate return flows (and understate recoverable real water losses from the system) in a significant subset of environments. The approach used in New Mexico appears to be an interesting compromise between the detailed case-by-case analysis of consumptive use and the uniform presumption of return flows. In New Mexico, the State Engineer's Office de-

termines transferable water quantities utilizing standard formulae together with historical and secondary data. Consumptive use (and transferable quantities) are computed based on existing data on cropping pattern, type of irrigation (drip, sprinkler, flood), temperature, per cent daylight hours, and effective precipitation in the area. The farmer or applicant for transfer is required to supply only information on cropping patterns and type of irrigation. In the absence of historical records of cropping patterns, the most recent information is used or obtained from aerial maps. Field visits by the Engineer's office to verify the information given by the potential user are rare. Reliance on standard transferable quantities for specific regions and irrigation types reduces the transaction costs incurred by applicants for hydrologic and engineering experts, saves water agency staff time, and creates more certainty in the transfer process [10].

*Reservation in major delivery systems, such as the SWP, of a portion of transport capacity rights for water transfers that have equal priority with existing contractual rights.* However, this policy would be strongly opposed by existing SWP contractors, who would vigorously defend against any weakening of their access to a conveyance system they utilize on a fully costed basis. The rights of contractors have already been weakened by limitations on delta pumping in order to meet delta outflow requirements and to protect endangered and threatened species, limitations that have in recent years made it difficult to meet existing contracts.

*Reconsideration of construction of the peripheral canal skirting the Sacramento-San Joaquin delta, which could reduce environmental problems while relying on existing regulations to protect areas-of-origin and other third-party interests against possible damages from water transfers.* The peripheral canal could improve water quality and reduce problems associated with reverse flows in the delta, which increase salinity and harm endangered fish species. However, the peripheral canal remains a highly divisive issue in California. Despite the various regulations controlling water transfers, there would be strong opposition on the grounds that the canal would cause a rapid expansion in water exports from Northern to Southern California.

*Reduction of mandated water allocations for environmental purposes and a requirement that these interests compete for scarce water in the market, combined with allocation of a portion of state revenues to fund purchases of water for environmental purposes.* The primary argument in support of mandated environmental allocations is that water allocations to fish and wildlife benefit a large number of people, so it is very difficult to form coalitions to purchase water rights. However, private groups have in fact begun to purchase instream water rights in California and elsewhere in the western United States. Allocation of some portion of public funds (the amount of which would be subject to public determina-

tion) for purchase of instream water would also facilitate a market allocation approach to environmental uses of water. The latter policy has already been implemented on a small scale in California. The Department of Fish and Game purchased 41,000 acre-feet of water from the 1991 Water Bank and 16,000 acre-feet from the 1992 bank for instream flow. Again, it must be noted that at least the first part of this policy would meet with strong opposition from environmentalists. Environmental groups have won substantial gains in mandating water for environmental purposes and would likely oppose a policy that rescinds some of these gains.

Many of these reforms would be highly controversial; some would require changes in interpretation of the Water Code; many would require significant new legislation to modify existing law. In the final instance, the evolution of California law and policy toward water transfer markets will be determined by the political process balancing agricultural, urban, and environmental interests. The dynamics of the political process suggest that the flexibility and volume of water market transfers will gradually expand, but that transfers will continue to be characterized by strong central direction and oversight.

## ACKNOWLEDGMENTS

The author wishes to thank David O. Kennedy, Director of the California Department of Water Resources, and many staff of the DWR, for their unstinting and invaluable provision of advice and expertise on California water.

## REFERENCES

1. Department of Water Resources, "Management of the California State Water Project," Sacramento CA, U.S.A., 1992.
2. Department of Water Resources, "Draft California Water Plan Update, Volume I," Sacramento CA, U.S.A., 1993.
3. Reiser, M., and S. Bates, *Overtapped Oasis Reform or Revolution for Western Water*, Island Press, Washington DC, U.S.A., 1990.
4. Vaux, H.J., Jr., and R.E. Howitt, "Managing Water Scarcity: An Evaluation of Interregional Transfers," *Water Resources Research*, Vol. 20, 1984, pp. 785-792.
5. Gardner, D.B., and J.E. Warner, "The Central Valley Water Project Improvement Act and Water Markets: Two Steps Forward-One Step Back," *Choices*, First Quarter, 1994, pp. 4-9.
6. Johnson, N.K., and C.T. DuMars, "A Survey of the Evolution of Western Water Law in Response to Changing Economic and Public Interest Demands," *Natural Resources Journal*, Vol. 29, 1989, pp. 347-387.

7. Brickson, B., and R. S. Sudman, "A Briefing on California Water Issues. Western Water," Water Education Foundation, Sacramento CA, U.S.A., Sept. 1992.
8. Department of Water Resources, "Water Transfers in California: Translating Concept into Reality," Sacramento CA, U.S.A., 1993.
9. Keller, J., N.S. Peabody III, David Seckler, and Dennis Wichelns, *Water Policy Innovations in California: Water Resource Management in a Closing Water System*, Winrock International Institute for Agricultural Development, Arlington VA, U.S.A., 1992.
10. Colby, B.G., "Economic Impacts of Water Law-State Law and Water Market Development in the Southwest," *Natural Resources Journal*, Vol. 28, 1988, pp. 721-749.
11. Dixon, L.S., N.Y. Moore, and S.W. Schechter, "California's 1991 Drought Water Bank Economic Impacts on the Selling Regions," RAND, 1993.
12. Smith, R.T., and R.J. Vaughan, eds., *Water Intelligence Monthly*, Stratecon, Inc., Claremont CA, July/Aug. 1994.
13. Howitt, R., "Water Markets, Individual Incentives and Environmental Goals," *Choices*, First Quarter, 1994. pp. 10-13.
14. Gould, G.A., "Transfer of Water Rights," *Natural Resources Journal*, Vol. 29, 1989, pp. 457-477.

## Objectives

---

The principal objectives of the International Water Resources Association are:

- *to advance water resources planning, development, management, administration, science, technology, research and education on an international level;*
- *to establish an international forum for planners, administrators, managers, scientists, engineers, educators, and others who are concerned with water resources; and*
- *to encourage coordination and support of international programs in the field of water resources, including cooperation with the United Nations and its agencies, and other international and national organizations, in activities of common interest.*