Who Should Be Allowed to Sell Water in California? Third-Party Issues and the Water Market

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Foreword

Over 40 years ago, Jack Hirshleifer, James C. DeHaven, and Jerome W. Milliman introduced the idea of California water markets in *Water Supply: Economics, Technology, and Policy.* Since then, numerous presentations have shown how California's existing system of aqueducts could be used to move water to the highest bidder. Why then has the development of water markets—a policy that might provide enough water for decades of growth—taken so long to gain acceptance?

Part of the answer is provided in Ellen Hanak's report, *Who Should Be Allowed to Sell Water in California? Third-Party Issues and the Water Market.* The report notes many obstacles to the expansion of water markets; however, Hanak focuses on a key player—local governments. Local officials, especially in rural areas, are fearful of losing a resource that is a key component of future economic growth. And the specter of bone-dry Owens Valley haunts residents, officials, and investors alike. For these and other Californians, the problem can be put very simply: "No water, no life."

Although the amount of water sold through markets is only 3 percent of all water used in the state, 22 of the state's 58 counties have adopted ordinances restricting groundwater exports. With the rise of groundwater transfers during the drought of the early 1990s, the fear of uncontrolled "mining" of the aquifers became widespread in many rural counties. In effect, the counties—through a burdensome review process and the prospect of negative public opinion—have discouraged potential sellers from seeking permits in the first place. Hanak finds that, controlling for other factors, these counties have been selling less water, and more of their sales have been to in-county buyers.

The report also points to the need for effective policies pertaining to land fallowing, or idling crops to sell water. If fallowing affects other employment and business opportunities, a case can be made for economic mitigation. Some stakeholders are concerned, however, that

direct compensation to those whose businesses are affected would establish a dangerous legal precedent, generate excessive claims, and create unrealistic expectations about the potential community benefits from water transfers. Given such concerns, communities may prefer the status quo to the risk of losing the benefits that flow from the control of this precious resource. Fair and sustainable rules for fallowing would go a long way toward balancing the needs of local users with the potential gains that result from water transfers.

Finally, the report helps explain why it has taken so long to implement water markets. The concerns expressed at the local level—including the prospect of rapidly growing urban centers appropriating water without adequate compensation—are as real as ever. Nevertheless, Hanak shows that there are solutions in the making, and that with proper concern for users, local communities, and the environment, markets could play a key role in addressing California's water supply problem for decades to come.

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Summary

At current patterns of water use, California faces the prospect of chronic shortages of this vital resource before the year 2020. Among the measures that can alleviate supply and demand imbalances is the development of a water market. A market enables the historical holders of water rights—mainly farmers in the agricultural heartland—to transfer water to other users willing to pay more for it. Potential buyers include urban and industrial users, other farmers with higher-value crops and more limited supplies, and environmental programs to support fish and wildlife habitats.

Although significant trading has occurred since the state began promoting this solution in the late 1970s, obstacles remain. In particular, communities in the source regions have raised concerns over the potential adverse effects of water sales on local groundwater users and the local economy. In the absence of clear state-level policy on these "third-party" effects, many counties are attempting to gain an oversight role through local ordinances.

This study examines the issue of third-party effects of water transfers in California from the economic, institutional, and legal perspectives. It also evaluates potential mechanisms for resolving the conflicts between those wishing to trade in water and the wider community. Drawing on a range of data sources, including a new database on water transfers and an extensive set of interviews with water users and county officials, the analysis aims to answer the following questions: How has resistance to water transfers affected California's water market to date, and what are the likely effects of that resistance? What distinguishes cases where conflicts have been successfully resolved from the stalled deals? Are revisions of state water law a necessary or desirable means for dealing with third-party issues, or should solutions be left to local institutions? We begin with some background on the water market and the rise in local resistance to it.

Water Market Trends

Jumpstarted by a prolonged drought in the late 1980s and early 1990s, California's water market is now a firmly established—if modest—feature of the state's water allocation process, with annual trades accounting for roughly 3 percent of water use. The state has been a major player, notably by running drought year water banks and purchasing water for the environment. As expected, agricultural water districts are the main suppliers, with Central Valley farmers typically accounting for three-quarters of all sales and farmers in the desert valleys of Imperial and Riverside Counties furnishing the rest.

Contrary to expectations, urban agencies have played a limited role in market growth. Instead, the main sources of demand have been directly and indirectly linked to new environmental regulations. Direct purchases for instream uses and wildlife reserves have accounted for over one-third of the increase in purchases since 1995. The other growth sector, accounting for over half of market expansion, has been agriculture in the San Joaquin Valley. Farmers there whose contractual water deliveries have been cut back by environmental mitigation programs have turned to the market for replacement water.

However, municipal agencies are the principal buyers of long-term and permanent contracts, which account for roughly 20 percent of all sales. Legislation passed in 2001 requiring that local governments demonstrate adequate water supplies for development should increase urban demand for long-term water transfers. Municipalities' success in forging these deals and ensuring new supplies will depend on their ability to smooth the waters of community resistance in the source regions.

The Rise of Local Resistance to the Water Market

Concerns in the source regions relate to two distinct types of negative effects of water marketing on third parties. When sales reduce the quantity or degrade the quality of water available to other users, this constitutes a *physical externality*. California law protects other surface water users, including fish and wildlife, from such effects under the "no injury" statutes of the Water Code. These protections do not extend to groundwater users, however, because groundwater—a major source of

supply in many regions—is not regulated by the state. Once the state made it clear that the market was open for business during the early 1990s drought, the fear of uncontrolled "mining" of the aquifers became widespread in many rural counties.

The other type of negative effect can occur when farmers idle cropland to sell water. Any resulting losses to the local economy—in jobs, sales, or local tax revenues—constitute an economic effect or *pecuniary externality*. There is no legal tradition in California or elsewhere in the United States for protecting third parties from this type of effect. The state's widespread use of fallowing contracts to purchase water for the 1991 drought water bank generated considerable discord in some Sacramento Valley counties, where local businesses and farm workers were affected.

Rural communities have responded to the lack of state-level, third-party protections by putting in place local restrictions on water marketing. By late 2002, 22 of the state's 58 counties had adopted ordinances requiring a permit to export groundwater or to extract groundwater used in substitution for exported surface water. Counties' right to invoke police powers to protect groundwater resources was upheld in a 1994 appellate court decision favoring Tehama County. In effect, the absence of state protections for groundwater users provides the legal justification for county-level action.

In some counties, the ordinances reflect a broader intent to discourage any type of transfer—whether or not linked to groundwater—that might harm the local economy. Counties do not have the legal authority to ban crop idling for water sales, but some water districts have adopted policies to that effect. This appears mainly to be a practice of districts whose boards are elected by the community at large rather than districts where only landowners have a vote. The recent controversy over a proposed long-term transfer from the Imperial Irrigation District to San Diego erupted when Imperial—whose board is elected by popular vote—was pressured to fallow land despite district policy against the practice. Landowner-run districts have been more likely to fallow land for the water market, especially in periods of low crop prices when the water is less valuable in agricultural uses.

Effects of County Restrictions on the Water Market

To measure the effects of local resistance on the water market, the study assessed the role of county ordinances restricting exports. In counties with ordinances, those wishing to export groundwater or surface water that is replaced by additional groundwater pumping can go through an environmental review process to obtain a county permit. The very low number of permit applications suggests, however, that this process is more useful as a deterrent than as a screening mechanism. High up-front costs and the likelihood of negative public opinion guiding the decision process are both factors discouraging parties from filing.

A lack of groundwater permits will not necessarily block transfers if alternatives such as land fallowing are available and acceptable to farmers and their water districts. In the aggregate, however, there is likely to be an effect on the market, both in reducing total sales and in shifting some water to in-county users, who will typically be willing to pay less than outsiders. A statistical analysis of county trading behavior from 1990 to 2001 provides evidence of both effects. In any given year, the presence of an export restriction reduced a typical county's trades by 14,300 acre-feet and shifted 2,640 acre-feet to in-county buyers. Since 1996, total out-of-county sales, or "exports," were reduced by 932,000 acre-feet, or 19 percent, and total sales by 787,000 acre-feet, or 14 percent. Overall, the negative market effect of county restrictions cancelled out the positive effect of a generally improved trading environment resulting from state and federal regulatory changes.

The Scope for Resolving Third-Party Issues

Local resistance is likely to remain a force to reckon with in market development, especially for the long-term, interregional transfers from agricultural users that municipalities will seek to support growth. Moving forward requires finding solutions that provide communities in source regions with adequate safeguards against the potential negative consequences to local water users and the local economy. What have the experiences to date taught us about the scope for positive resolution of

these conflicts, and what role can policy play in this process? The responses are distinct for the two types of third-party effects.

From Groundwater Protection to Groundwater Management

Groundwater is a shared resource, with many users drawing from the same aquifer. In the absence of regulation, these users do not have clear incentives to avoid overexploiting the resource. Because the state does not exercise authority over groundwater, the onus for developing management systems falls on local users. Concerns over the groundwater effects of trade have arisen in California's rural heartland, where local management systems are inadequate or altogether absent. In this context, county ordinances restricting exports can be justified as a first-step precautionary measure to protect local water users from the effects of an unbridled water market.

This defensive strategy is nevertheless suboptimal from the standpoint of local as well as statewide interests. A policy limited to restricting exports does little to stabilize the aquifer in places subject to overdraft. It also makes it difficult, if not impossible, to make economic use of the underground storage space through groundwater substitution transfers and banking of imported surface water. Attaining these goals requires a more assertive, comprehensive strategy of groundwater management that protects local users while providing opportunities to address supply and quality problems and allowing those with sound transfer and banking projects to participate in the market.

California's rural areas have so far eschewed the more comprehensive management systems that govern groundwater in Southern California and in many coastal counties. In these regions, high population densities and special technical problems such as saltwater intrusion have led to the introduction of adjudicated basins and special districts with full regulatory authority over the resource. Nevertheless, there is a movement under way toward more active groundwater management in some of California's rural counties. In some places, the county itself or a special district with countywide jurisdiction has played a convening role for county water users; in others, water districts overlying a shared basin have grouped together to develop a groundwater management plan.

Key ingredients of active management include the establishment of effective basin monitoring systems and the development of guarantees to mitigate any harm to third parties from market-related activity. A question that remains on the table is whether a strictly voluntary management principle is adequate—a policy still favored by many rural Californians—or whether target levels and pumping restrictions need to be developed for the program to be effective.

Developing effective local groundwater management systems places a central responsibility on local authorities—water districts and city and county governments. But the state also has a key role to play, given the statewide benefits of sound local management. Three current forms of state support are appropriate: providing technical assistance, making funds available to support system development, and encouraging the adoption of programs with sound content by attaching conditions to the release of state funds. Once systems are in place, there is also an opportunity for private funding of groundwater infrastructure, especially for municipal supply projects.

Mitigating the Economic Effects of Land Fallowing

For fallowing, the problem is one of determining the ground rules under which those with access to water rights may take land out of production and sell water to others. Available studies suggest that the aggregate local effects of fallowing have been quite small for programs idling anywhere from 6 to 29 percent of acreage, with local gains from the program largely balancing out local losses. But the modern track record is limited, and popular sentiment in rural areas tends to be shaped by the dire consequences of fallowing for the local economy in the Owens Valley almost a century ago.

The key policy issues on the table concern the rules to limit negative community effects: rules on the scale and content of fallowing program design and rules concerning financial mitigation. Both state law and locally determined guidelines already address the first point. Section 1745.05 of the Water Code requires public review of fallowing that exceeds 20 percent of the local water supply. In designing fallowing programs, water districts increasingly include restrictions to maintain the viability of the idled land and to make sure that participating farmers are

not solely in the business of selling water. The economics of fallowing also plays a natural mitigating role. Farmers have incentives to fallow the crops that generate the least profit per acre-foot, and these tend to be the low-value, highly mechanized commodities that generate the lowest on-farm employment and the least value-added through further processing.

Even with this combination of operating rules and incentives to limit negative effects to the local economy, there remains the question of whether the community should receive some sort of compensation. At the federal level, there are some precedents for mitigating economic effects when policy changes shift employment and business opportunities in some sectors or regions. With different degrees of success, federal mitigation programs have aimed to assist affected workers and businesses to make a transition to other economic activities.

A parallel case could be made for mitigating the economic effects of sizable, long-term fallowing operations, especially if they generate systematic hardships for low-income groups or local governments. In two large long-term deals pending approval, a transfer from the Palo Verde Irrigation District to the Metropolitan Water District of Southern California and one from the Imperial Irrigation District to San Diego, funds have been earmarked for local communities. This will no doubt become a standard component of any future deals of this type, where large volumes of water are sold to distant urban agencies over more than a decade, with expectations of some systematic effects on local employment opportunities affecting low-income immigrant communities.

For temporary or intermittent fallowing operations, such as those undertaken in the Sacramento Valley since 2001, there are larger questions about the appropriateness of mitigation. Two buyers, the Department of Water Resources and Metropolitan, have developed a policy to provide mitigation funds, but it remains unclear what damages, if any, merit mitigation. Many are uncomfortable with the term mitigation because it implies the direct compensation of affected parties. In part, this wariness stems from an expectation that the fallowing programs will generate little if any hardship to low-income workers, given the highly mechanized nature of production process for the rice crop being fallowed and the considerable workload generated by land

maintenance and improvement activities on fallowed acreage. It also stems from a concern that a direct compensation program would establish a dangerous legal precedent, generate excessive claims, and ultimately create unrealistic expectations about the potential community benefits from water transfers. For these reasons, it may make more sense to think of such funds as providing opportunities for community development rather than mitigation.

Since 1998, the legislature has considered three bills to institutionalize mitigation, but none has met with approval. Further legislative actions on the fallowing question should be avoided for the time being, for two reasons. First, there is a limited track record on fallowing and no experience with implementing mitigation funds. Second, in the major short- and long-term fallowing programs slated to occur, the transacting parties themselves have been adopting design measures to limit negative effects and setting up funds to benefit the community. These cases provide the opportunity both to assess the consequences of responsible fallowing and to experiment with use of funds for community benefit. If, as the farmers in the Sacramento Valley and Palo Verde argue, the overall effects are not harmful to the local economy, this may help build wider confidence in a new model for fallowing that can displace the ghost of Owens Valley.

Contents

Figures

Tables

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Acronyms

AB	Assembly Bill
AVEKWA	Antelope Valley–East Kern Water Agency
BMO	Basin management objective
CALFED	Multiagency state and federal program for the San Francisco Bay Delta
CEQA	California Environmental Quality Act
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
DWR	Department of Water Resources
EIR	Environmental impact review
EWA	Environmental Water Account
GCID	Glenn–Colusa Irrigation District
IID	Imperial Irrigation District
KWCA	Kern County Water Agency
MWDSC	Metropolitan Water District of Southern California
NHI	Natural Heritage Institute
PVID	Palo Verde Irrigation District
RCRC	Regional Council of Rural Counties
SB	Senate Bill
SDCWA	San Diego County Water Authority
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
UC	University of California
USBR	U.S. Bureau of Reclamation
WAC	Water Advisory Committee
YCWA	Yuba County Water Agency

1. Water Marketing and Third Parties

Over most of the past century, the water needs of California's growing economy and population have been met by increasing water supplies. The result has been a complex mosaic of hydraulic investments in surface storage and conveyance undertaken at local, state, and federal levels. This "developed" surface water system provides the state's agricultural, residential, and industrial customers with roughly two-thirds of the water they use, the remaining third coming from groundwater reserves.

Until recently, the system generally has met the needs of these users, except in periods of severe drought. Concerns that insufficient water resources were being devoted to the environment—and in particular to the survival of endangered wildlife—have led to reductions, beginning in the early 1990s, in the amounts available to some agricultural and municipal users. With the environment now explicitly considered as a user with legitimate (and sometimes paramount) requirements, and with the promise of continued, rapid population growth, the state's Department of Water Resources projects chronic water shortages before the year 2020 at current patterns of use (Department of Water Resources, 1998).

Redressing supply and demand imbalances through additional surface reservoir development has become more difficult. Hydrological options are less favorable, cost considerations loom larger, and concerns about the potential environmental consequences of such investments play a much greater role in the public decisionmaking process. This difficulty has prompted considerations of alternative technologies to increase supply, through "groundwater banking"—or storing excess run-off in underground aquifers—and through recycling and desalination. It has

also heightened interest in making better use of the existing supply through conservation efforts and the development of a water market.

Water Marketing as a Component of California's Water Future

A market permits the temporary, long-term, or permanent transfer of water from the existing rights-holders to other water users in exchange for payment. In California, these rights generally have been appropriated for many decades under the state's "first in time, first in right" legal system. Water transfers are seen as a way of adding flexibility to the state's water supply—both to address temporary drought conditions and to accommodate longer-term changes in the pattern of demand.

Because water systems have been intimately linked to the development of California's agricultural heartland, the bulk of use rights are held by farming interests in the Central Valley and the desert counties to the south that rely on Colorado River water (Hundley, 2001). In normal water years, agriculture uses about 34 million acre-feet of water, or 80 percent of the total used by Californians for their combined residential and business needs (Department of Water Resources, 1998). Agricultural users often pay significantly less for water than municipal and industrial users do in the coastal metropolitan areas, even allowing for differences in transportation and treatment costs.

Ready availability of water has enabled California to become the nation's largest agricultural economy, with one of the world's most extensive irrigation systems. This can be seen as a successful outcome of past federal and state support to the development of western agriculture through large-scale hydraulic projects. As other demands for water continue to grow, however, there has been increasing pressure to weigh this policy goal against one emphasizing the scarcity of this natural resource. In an era when pricing has been advocated as a solution for a whole range of resource allocation issues, water transfers are seen as a way to accommodate the changing pattern of demand while compensating water-rights-holders for forgoing their own access. The discussions on water marketing have often emphasized the potential of the market to move water from agricultural to growing urban areas, many of which are

willing to pay more for the water than it is worth to the seller in the next-best agricultural use. But a water market can also help balance supply and demand within the agricultural sector, as farmers with higher-value uses for the water purchase it from those with more-senior rights and less-productive farms. Finally, market-based transfers are seen as a potential tool for reallocating water from agriculture to the environment through voluntary means rather than rationing.

State and Federal Support for Water Marketing

California's foray into water marketing began in 1977, a year of severe drought. Two reports commissioned at that time, one by the governor and one by the legislature,[1] strongly endorsed water marketing as a component of the state's water future. The governor's commission also advocated a number of changes in the Water Code to facilitate transfers, notably provisions to ensure the security of water rights for transferring parties and access to the use of conveyance facilities. Although many of the recommendations were accomplished in the years that followed, the 1980s saw little uptake in market activity.

In the early 1990s, several events significantly changed the trading climate. First, natural conditions provided the occasion for a large-scale experiment in water trading when a multiyear drought prompted the state to initiate an emergency water bank in 1991. The following year, in response to findings that the federally run Central Valley Project (CVP) was having deleterious effects on the indigenous wildlife of the San Francisco Bay-Delta water system, Congress passed the Central Valley Project Improvement Act (CVPIA). The CVPIA mandated that 800,000 acre-feet of project water (of a total of 7 million) be returned to instream uses to regenerate salmon runs and that another 400,000 acre-feet be allocated to wildlife refuges. The CVPIA also contained provisions to facilitate water marketing and introduced a mechanism for the project to purchase additional water for environmental purposes. In 1994, contractors of the State Water Project (SWP) concluded negotiations for the Monterey Agreement, a revision of project operating

[1]Governor's Commission to Review California's Water Rights Law (1978); Phelps et al. (1978).

rules that included measures to make it easier for contractors to transfer water to one another.

At the close of the decade, two further state and federal actions were significant. Under instructions from the Secretary of the Interior in 1996 and 1997, California began to devise a plan to reduce its use of Colorado River water to the contractually allocated amount of 4.4 million acre-feet over a 15-year period. This 4.4 Plan created strong incentives for water transfers between agricultural and urban users of Colorado River water within California. In 2000, state and federal authorities launched the Environmental Water Account (EWA), a program of water purchases for the environment under CALFED, a multiagency state and federal program to restore health to the fisheries of the San Francisco Bay-Delta system while securing water supplies to agricultural and urban users.

The Rise of Third-Party Concerns in the Selling Regions

Although substantial trading resulted from these policy changes, those wishing to enter the water market—on either a short- or long-term basis—have encountered a number of obstacles. Central among these is the question of how to deal with the "third-party" or indirect effects of the transfers on other water users and the larger communities where water is being sold. Community resistance has soured a number of deals over the past decade and has likely prevented others from being proposed. Many of California's rural counties have introduced ordinances that directly restrict groundwater exports and indirectly restrict the sale of surface water. In several counties, the ordinances circumscribe the rights of individuals and local water agencies to engage in groundwater banking.

These measures respond to the potential consequences of the transfers on the local community. Short-term transfers during the drought water bank in the early 1990s raised two contentious issues. First, communities were concerned about local economic consequences when some farmers fallowed their land to sell water, simultaneously drying up demand for labor and other farm inputs and cutting off the

supply of raw materials to local processors. Second, farmers who sold their surface water and maintained their crops by pumping more groundwater than usual were in some cases seen as reducing the overall quantity and quality of supplies available to other water users.

Community concerns can be exacerbated if the seller makes a multiyear commitment. For the proposed long-term transfer of water from the Imperial Irrigation District to San Diego, negotiated as part of California's 4.4 Plan to reduce Colorado River use, leaders in the Imperial Valley have been reluctant to agree to multiyear land fallowing. Sending water toward urban coastal areas adds to the uneasiness of such long-term transfers: Will such areas take precedence in the future, regardless of the terms of the transfer?

Some observers express a general skepticism regarding the market for water, given the sharp regional disparities between the wealthy metropolitan areas on the coast and California's agricultural valleys, which lag far behind in terms of income, employment, and education levels. In this view, arguments about market efficiency are little more than a justification for draining the poorer hinterland of the resources it may need for more favorable growth and development in the years ahead. Although the tone of the debate is at times highly charged, local officials' resistance to transfers can be seen as a precautionary approach to a potential irreversibility problem: Once the water is gone, they will lack the money and political influence to get it back. Reinforcing this concern is the specter of the Owens Valley affair—the notorious deal in the early 20th century wherein Los Angeles bought up so much of that region's water that the local agricultural economy collapsed.

Community opposition to water transfers challenges the notion that water rights belong to users and suggests instead that water is a community resource. The county ordinances are an attempt to impose a level of local oversight on water transfers not provided for in state law, which is not uniform in its treatment of transfers or in the assessment of effects on third parties. State approval is required only for transfers involving surface water rights acquired since 1914, certain types of groundwater banking, and any water that is "wheeled" (conveyed) through a publicly owned facility (e.g., the California Aqueduct). Only in the latter case must the state ensure against unreasonable negative

economic effects on the source county; for the other transfers, there is simply an obligation not to harm other legal users of the surface water (i.e., other rights-holders), fish, and wildlife. There is no provision to protect other groundwater users, as groundwater rights remain largely unregulated by the state.

Although there is some question as to whether the county ordinances would stand up to a legal challenge, there is no doubt that they arise where communities are not confident about the existing legal and political process governing transfers. The question nevertheless remains as to whether counties are managing community interests effectively; specifically, an overly conservative policy on transfers can lead to missed opportunities for enhancing collective welfare.

The Scope for Resolving Third-Party Issues

This study examines the issue of third-party effects of water transfers in California from the economic, institutional, and legal perspectives. It evaluates potential mechanisms for resolving the conflicts between those wishing to trade in water and the wider community. By drawing on a range of data sources, including original survey work, the analysis aims to answer the following questions: How has local resistance to water transfers affected California's water market to date and what are the likely future effects? What distinguishes the cases where conflicts have been successfully resolved and the stalled deals? Are revisions of state water law a necessary or desirable means for dealing with third-party issues, or should solutions be left to local institutions?

The report begins by providing some background on the water market and on the extent of community response. Chapter 2 presents an overview of the statewide water market since the mid-1980s, drawing on a new dataset developed for this study. It shows the evolution of total volumes transferred and the composition of the market—by geography, types of water users, and shifts in end use—in response to the state and federal policy changes outlined above.

The next two chapters document the rise in local restrictions on water marketing, with a specific focus on the adoption of county ordinances. Chapter 3 summarizes the statewide trends and discusses some of the legal, economic, and operational issues that the ordinances

raise. Drawing on county-level economic indicators and qualitative information gathered from interviews with county officials and water users, Chapter 4 explores why certain counties have adopted export restrictions and others have not.

Chapter 5 examines whether and how local opposition affects the water market. This examination includes a review of the permitting process for exports in counties that have adopted restrictions and a statistical analysis of the factors influencing water transfer behavior at the county level.

The study then turns to the policy questions that arise from the economic effects of land fallowing and the physical effects on water users arising from transfers involving groundwater. Both economic theory and institutional practice provide justifications for mitigating negative effects of water transfers. In theory, any transfer that truly raises efficiency by moving a resource into a higher-value use will generate sufficient gains to enable the losers to be compensated, such that the well-being of all parties is enhanced or maintained. For transfers that affect the availability of the physical resource to other water users, compensation is justified on grounds of efficiency as well as equity (Coase, 1960).

This principle already underlies the state's policy to "make whole" other surface water users affected by a transfer. More generally, it forms the basis for environmental mitigation of development projects. Measures might include providing alternative sources of water supply to the affected party or devising some other form of financial or in-kind compensation. Compensation mechanisms are not always easy to devise and reach agreement on, however, particularly when the damages are unclear or difficult to quantify. Chapter 6 examines these issues as they apply to the economic effects of land fallowing, and Chapter 7 investigates the physical effects on water users of groundwater transfers and the related practice of groundwater banking.

Mitigating harm to groundwater users implies the existence of an effective system for managing groundwater resources more generally. Because these resources are almost always shared by multiple parties, groundwater management usually requires collective oversight. In California, there is a vigorous debate concerning the appropriate level of governance for groundwater. At one extreme are those who argue that

groundwater should come under the jurisdiction of the state alongside surface water (Sax, 2002). At the other extreme are those who argue against any restrictions on individuals' rights to pump.

The middle ground in this debate has sought solutions involving local institutions. Two potentially competing approaches have grown in popularity since the early 1990s—the establishment of groundwater management plans by local water entities overlying a shared basin and the coordination of groundwater management at the county level through groundwater protection ordinances. Chapter 7 examines the policy and institutional questions that arise from these approaches, with a particular focus on the role counties are and might be playing.

Chapter 8 concludes by summarizing the policy issues that face state and local governments in addressing third-party issues and the role local entities can and should play in the statewide water market.

2. California's Water Market, by the Numbers

This chapter documents the evolution of the state's water market from the mid-1980s to 2001, drawing on a new dataset on individual water transfers developed by the author from a variety of state, federal, and local sources. The data allow an analysis of volumes transferred by duration, region of origin and destination, initial and final use, type of transacting party, and affiliation (if any) with the large state and federal water projects. The discussion highlights two areas of particular interest. First, to what extent has the market responded to the policy measures to encourage trading over the past two decades? Second, does the trading that has occurred correspond to expectations?

Who Can Sell Water and What Kinds Can They Sell?

The state's Water Code provides two basic guidelines on who can participate in the water market and what they can sell: Sellers must be rights-holders, and the water they sell must be "wet." "Wet water" is the term commonly used to contrast with "paper water"—water rights held on paper for which actual water is not available. Under the appropriative rights doctrine governing most of the state's surface water, the "use it or lose it" clause dictates that rights lapse for any water not used for five consecutive years. The Water Rights Division of the State Water Resources Control Board (SWRCB) estimates that there are roughly three times as many paper claims on surface water as water available in the system. Water-rights-holders must therefore demonstrate that the water they propose to part with is indeed water that they would otherwise use in some way. Without this safeguard, the seller would end up transferring "paper" water that someone else is already legally using.

Sources of wet water are of four basic types: surface storage, excess surface water, conserved surface water, and groundwater. The first two sources are not widely available. Only a limited number of rights-holders have surpluses available in surface storage, and the use-it-or-lose-it principle limits conditions under which excess surface supplies are actually considered wet. Contractors with the CVP and SWP projects are the only ones who have been able to sell regular excesses of surface supplies, on grounds that their rights are determined by contract rather than the appropriative doctrine.[1] Otherwise, rights-holders may sell the excess surface water generated in very wet years. These are times when overall market demand is more limited.

Conservation and groundwater are more generally available options. Conservation can be achieved through investments to improve the efficiency of the conveyance and use systems (e.g., canal lining, installation of drip irrigation, recycling), or through land fallowing. Groundwater can be transferred directly or, more commonly, can be used on-site in lieu of surface water transferred to another party. This latter practice, known as "groundwater substitution" or "groundwater exchange," is a form of "conjunctive use" of groundwater and surface water. With conjunctive use, the groundwater aquifer serves, in effect, as an underground reserve that can be drawn on to a greater or lesser degree as the quantity of available surface water varies. In some places where prior pumping activity has generated unused space in the aquifer, active storage or banking projects are increasingly popular. As a consequence, storage in underground banks is becoming a new source of water for the market, much like surface storage.

Although the initial appropriation of water rights in the second half of the 19th century primarily involved individuals and private companies, most surface water rights today are held by local public agencies: special water and irrigation districts and some municipalities. Legally, some of these parties actually hold long-term "contract entitlements" rather than "rights" to surface water; the large state and federal projects they contract with hold the actual water rights. In some

[1]A loosening of restrictions on such trades among Central Valley Project contractors is arguably the main effect of the CVPIA on the water market to date.

water districts, individual farmers have specific contractual amounts of water (or "allocations") assigned to them and are therefore in a position to sell their surface water.

Generally, the right to pump groundwater (and hence, potentially, to sell it) is available to all private individuals overlying the aquifer. As we will see in greater detail in subsequent chapters, there are few places where rights are "quantified" (i.e., where users have rights to a specific quantity of water) or where local agencies, rather than individuals, effectively control access to the aquifer. Current groundwater banking operations typically involve local agencies (for instance, the Semitropic Water Storage District and the Arvin-Edison Water Storage District in Kern County each run programs) or consortia of private and public agencies (for example, the Kern Water Bank). Such programs could conceivably be run by a single private entity if it were sufficiently large to cover the banking area. A case in point is the recently abandoned Cadiz groundwater storage and dry-year supply project. In this project, a private agribusiness firm with land holdings in eastern San Bernardino County would have banked and sold water to the Metropolitan Water District of Southern California.

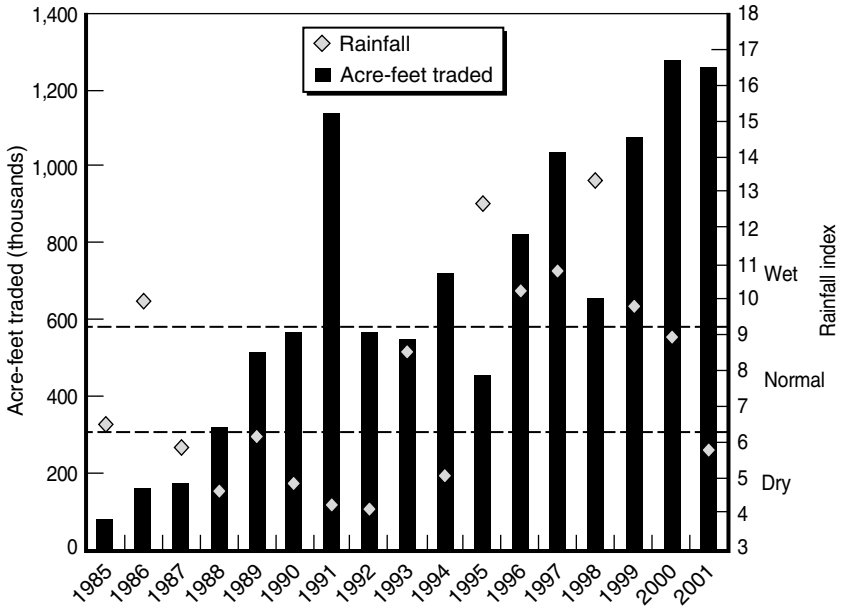
The approval process for transfers varies according to the nature of the water right as well as the source of water. The SWRCB must approve transfers (changes in purpose or place of use) involving surface water rights established from 1914 onward, the year the state's "modern" Water Code became effective. Transfers of surface water among contractors of the federal and state water projects generally do not require SWRCB approval because they do not involve a change in the purpose and place of use assigned to the overall water right. The projects themselves must authorize these sales. The general practice is for farmers to go through the water district, which negotiates the transaction, and for the state or federal project to decide whether the district may make the sale. Transfers of groundwater and of surface water held in pre-1914 appropriative rights do not require SWRCB approval. However, they do come under state or federal jurisdiction if government-owned conveyance facilities are involved, which is likely to be the case in most parts of the state.

It was not possible to track systematically the type of water being sold in the data presented below. On average, local public agencies (water districts, irrigation districts) account for over 90 percent of the volumes sold since the mid-1980s, with private parties and mutual water companies making up the balance. The share of direct private activity was highest during the early 1990s, when the state contracted directly with individual farmers for a substantial portion of the water acquired under the drought water bank.

The data presented focus on annual flows of water resulting from temporary transfers (under one year), long-term transfers (over one year), and what we have termed "deferred exchanges," which involve a promise that the buyer repays the water (along with a cash payment in some cases) to the seller at a later date. The data on a fourth category, the permanent transfer of water rights or contract entitlements, are presented separately. Such transfers amount to an outright sale of the rights to use the specified amount of water in perpetuity or for the remaining duration of the contract in question. Because the actual amount accessible to the buyer can vary with the conditions of the water year, it is not strictly appropriate to consider an annual flow of water transferred. For more details on the sources and methods used to construct the water transfers database, the reader is referred to Appendix A.

Overall Market Trends

The statewide water market got a jumpstart during the last multiyear drought, which began in 1988 (Figure 2.1). Market growth was largely driven by direct interventions of the Department of Water Resources. DWR began making dry-year purchases to offset lower deliveries to State Water Project contractors and wildlife refuges in the first year of the drought. These early operations, which involved only a handful of Sacramento Valley water districts (most notably the Yuba County Water Agency), quickly brought the total volume traded to over 500,000 acre-feet, three times the pre-drought levels. In 1991, when the dry-year market was opened up to any willing buyers and sellers, DWR purchased 821,000 acre-feet of water for resale, bringing the overall market volume to over 1.1 million acre-feet. Water banks and other dry-year purchases were also operated in 1992 and 1994. From 1988 to the end of the



NOTES: For details, see Table A.1. Rainfall is measured by the Sacramento Valley 40-30-30 index, an indicator of water supply conditions for the state's primary river system (see Appendix D).

Figure 2.1—Short- and Long-Term Water Transfers in California Since 1985

drought in 1994, state and federal dry-year purchases for resale and environmental uses accounted for over 40 percent of a market that had jumped from an average of 150,000 acre-feet to over 600,000 acre-feet per year. [2]

Although the second half of the 1990s saw a succession of wet years, market activity remained strong, with volumes typically exceeding the drought-year levels, especially by the end of the decade. The only dips in

[2]The average market volume as measured by end-user purchases is just over 500,000 acre-feet for the 1988–94 period. This discrepancy arises mainly because DWR's purchases were higher than its resales to other users in some years. The gap was most notable in 1991, the first year of the water bank, when purchases exceeded resale volume by over 400,000 acre-feet. In several years in the 1990s, there were also smaller discrepancies between purchases and sales of water user pools, notably the SWP "turn-back" pool, described in the text, and the Sacramento River Water Contractors' Association, a pool run by some CVP contractors.

a generally upward trend in purchases occurred in the exceptionally wet years of 1995 and 1998, when many areas of the state experienced flooding. With annual trades now exceeding 1.2 million acre-feet—eight to ten times the levels of the mid-1980s—the market appears firmly established as a component of California's water allocation process.

It is also useful to consider the size and scope of the market from three other perspectives. First, the statewide market at current levels represents only 3 percent of all water used by Californians for municipal, industrial, and agricultural purposes (Department of Water Resources, 1998). Second, although there has been an increase in the number of long-term transfer agreements, the market continues to be dominated by short-term transactions, negotiated on an annual basis, which account for about 80 percent of the total volume transferred. Finally, the size and scope of the market are strongly influenced by the intervention of state and federal authorities. This influence stems not only from their important direct role in purchases but also from the relative ease water users have in gaining approval for transfers within the confines of the state and federal projects.

Since 1988, direct government purchases have accounted for nearly one-third of the total volume traded. Transfers among contractors within the same projects (SWP, CVP, and the Colorado River Project) account for more than half of all water sold (Figure 2.2). Transfers within the CVP and the SWP have generally increased in response to the more-flexible trading rules adopted by those projects in the early 1990s. The growth has been most pronounced within the SWP, for which internal transfers were rare before the Monterey Agreement. By contrast, the "open market," a residual category defined broadly to include any transfers between water users not associated with the same project, accounts for only 15 percent of the water transfers recorded over the 14-year period. This share initially increased immediately after the drought, but it has been on the decline again recently, as direct government purchases for environmental programs have been on the rise. In this context, it is noteworthy that a provision in the Central Valley Project Improvement Act to allow project water to be sold to noncontractors, considered a major innovation at the time, has gone virtually unused. Such transfers invoke a $25 per acre-foot

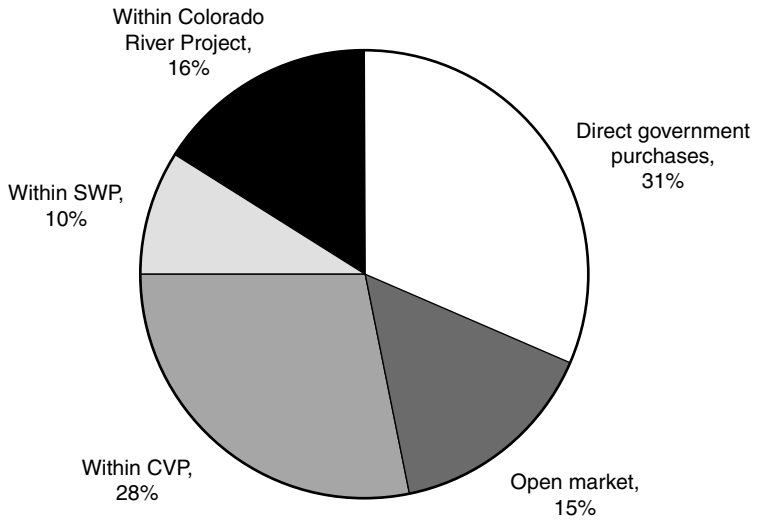


Figure 2.2—Share of Total Water Transfers, by Type of Market, 1988–2001

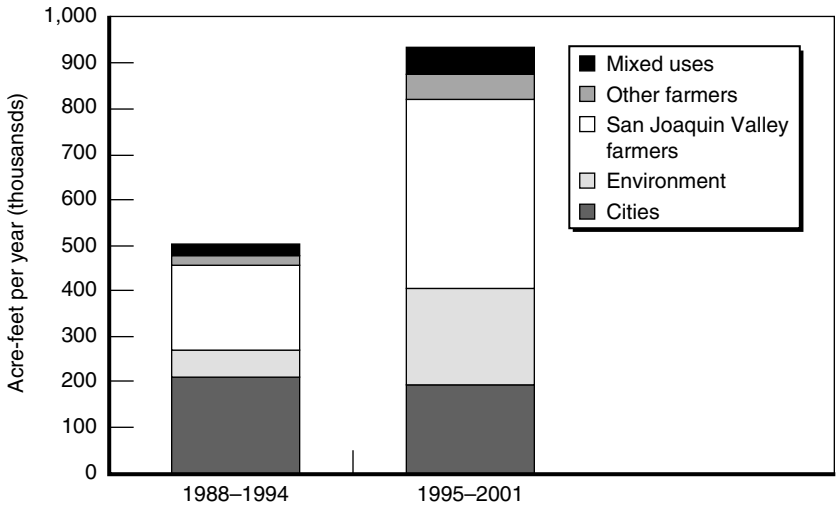
environmental surcharge, a fee that appears to have proven prohibitive until now.[3]

Water for the Environment: A Key Factor in Market Growth

Market growth in the aftermath of the drought has been largely driven by environmental concerns. The influence of environmental policy is most readily seen by comparing the patterns of water purchases during the multiyear drought (1988–1994) to those in the more recent period (1995–2001), when rainfall has generally been above normal (Figures 2.3a and 2.3b).

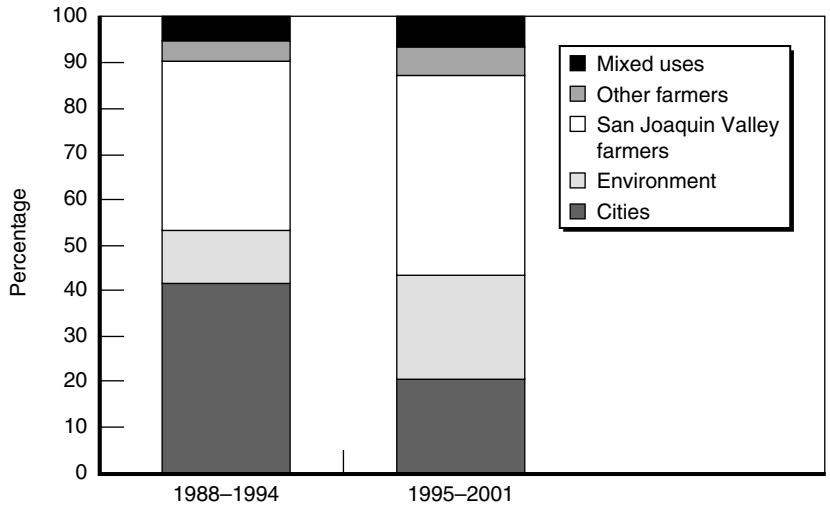
The most obvious element of the new role for the environment is the rise in direct purchases for instream uses to support aquatic life and for wildlife refuges, through federal and state programs and most recently

[3]With the aid of a simulation model, Loomis (1994) predicted that this surcharge would make it unlikely for out-of-project transfers to occur except under severe drought conditions, when buyers would be willing to pay enough to cover it.



NOTE: For details, see Table A.2.

Figure 2.3a—Annual Volumes Purchased, by Type of End User



NOTE: For details, see Table A.2.

Figure 2.3b—Market Share of End Users

the CALFED EWA. As one of the beneficiaries of DWR's drought purchases, the environment already accounted for 12 percent of demand during the 1988–94 drought. Since 1995, this share has doubled on average; it reached a third of total demand in 2001, the first full-fledged year of the EWA. On an average yearly basis, environmental purchases have increased by 155,000 acre-feet, out of a total market gain of 430,000 acre-feet.

The less obvious component of environmentally related demand is the rise in purchases by San Joaquin Valley farmers. Although this group's change in market share is less dramatic (moving from 37 percent to 44 percent over the two periods), its increase in volume (228,000 acre-feet per year) accounts for over half of total market growth. Much of this growth can be linked to the changes introduced under the CVPIA in 1992, which mandated that a portion of project water be returned to instream uses. Since then, the CVP's agricultural service contractors located south of the Delta received full project deliveries in only the two very wet years, 1995 and 1998. One outcome has been the development of an active water market, as certain contractors (most notably Westlands Water District) sought to offset reductions in deliveries via purchases. Within the San Joaquin Valley, CVP service contractors' market share of purchases has risen from 63 percent to 87 percent across the two time periods.

The corollary of this growth has been a decline in the relative importance of municipal and industrial water users. Whereas cities were the main recipients of traded water during the 1988–1994 drought with 42 percent of all purchases, their share since 1995 has been halved. With the exception of 1991, when purchases nearly reached 500,000 acre-feet, volumes have remained relatively flat, at around 200,000 acre-feet per year. The modest role of urban demand contrasts with the frequently voiced assumption that a water market would develop primarily as a response to population growth and the ability of urban dwellers to pay more than agricultural users for water.[4] As we will see below, cities are significant players in defining the market for long-term and permanent

[4]See Phelps et al. (1978) and Vaux and Howitt (1984) for early economic arguments in favor of a water market in California.

transfers of water. This pattern suggests that their role may increase as this part of the market develops.

Agriculture's Leading Role in Market Supply

Economists have typically assumed that agriculture would be the leading source of water supply, and this assumption is confirmed by the data. In most years, agricultural water users provide at least 90 percent of supply. It is nevertheless interesting to note that the introduction of "turn-back" pools within the State Water Project has made a significant amount of urban agency water available to agricultural users in wet years. Under the program, introduced as one of the reforms in the 1994 Monterey Agreement noted in Chapter 1, SWP contractors are able to sell back amounts of project water they will not need if there are willing SWP buyers.[5] From 1998 to 2000, the turn-back pool generated 200,000 acre-feet or more of water per year, or roughly one-fifth of total market supply.

Given the primacy of agricultural supply, it is not surprising to find that the main source regions are the Central Valley (served by the CVP, the SWP, and several large, autonomous, surface water projects) and the agricultural valleys to the south served by the Colorado River Project (Table 2.1). In most years, the Central Valley has furnished about three-quarters of the total volume transferred. Within this region, there are pronounced shifts, depending on the nature of the water year. From 1988 to 1994, Sacramento Valley farmers and districts supplied about 45 percent of all water sold. Although this share fell considerably after 1994 (in some years, to under 10 percent of the statewide market), the region again provided over 40 percent of the water in 2001, the first dry year experienced since the previous drought. In the interim, the market shifted to the San Joaquin Valley, which established a vibrant intraregional market to supply water-short districts within the region. In every normal to wet year since 1993, the first year of CVPIA

[5]Because the sale price is fixed below the level of per-acre-foot charges incurred by the seller for project water, the pool's attractiveness to sellers is relative, not absolute: It enables them to pay less than full price for contract amounts in excess of current needs.

Table 2.1

Regional Sources and Destinations of Water

	1988–1994	1995–2001
Sales by water users		
Sacramento Valley	1,924,937	1,057,064
San Joaquin Valley	1,363,037	3,715,039
Southern California	970,942	1,577,597
San Francisco Bay Area	87,195	82,575
Other	3,055	88,694
Total sales	*4,349,166*	*6,520,969*
Purchases by water users		
Sacramento Valley	135,079	515,509
San Joaquin Valley	1,450,917	3,253,292
Southern California	1,187,157	1,234,555
San Francisco Bay Area	313,197	43,505
Other	6,152	14,993
Purchases of environmental water	408,672	1,484,255
% from Sacramento Valley	74	17
% from San Joaquin Valley	25	81
Total purchases	*3,501,174*	*6,546,109*
Exports (imports) of nonenvironmental water		
Sacramento Valley	1,488,725	288,383
San Joaquin Valley	(190,683)	(739,455)
Southern California	(216,215)	343,042
San Francisco Bay Area	(230,738)	9,070

NOTES: For details, see Tables A.3 and A.4. The bulk of the difference between total purchases and total sales in the first period is the surplus purchased by DWR and distributed through means other than sales to other end users. There were also some small discrepancies in both periods between purchases and sales of user pools. These discrepancies account for the fact that nonenvironmental exports and imports do not sum to zero. See footnote 2 in this chapter. All water measurements are in acre-feet.

implementation, San Joaquin Valley farmers and districts have furnished at least half of the total amount transferred. It is common for agricultural districts in this region to restrict out-of-district transfers to cases where land in the recipient district is owned or leased by the same farmer.

The two Central Valley regions are the principal suppliers of environmental water (Table 2.1). There has been a major source shift from north to south of the Delta since the early 1990s drought, with the institution of restoration programs along the San Joaquin River system, supplied by area water districts. Kern County water users have also been major suppliers of the EWA. Most environmental water is used in the region of purchase; the main exceptions are EWA purchases of water north of the Delta, which facilitate the delivery of project water to users in the south while protecting Delta fisheries.

The Southern California region, defined broadly to include both the desert counties and the coast, generates most of the remaining quarter of total supply. The largest single source has been the Imperial Irrigation District, which has operated a 110,000 acre-feet per year long-term transfer with the Metropolitan Water District of Southern California (MWDSC) since 1988. In the mid-1990s, there was also a large two-year transfer to the MWDSC by the Palo Verde Irrigation District, another agricultural contractor on the Colorado River Project.

With the exception of the early 1990s drought, when several Bay Area cities made substantial purchases, no other region has played a significant role in the market on either the supply or demand side. The Bay Area's share in demand has dropped from 9 percent of the total in the drought years to only 1 percent in the more recent period. This region's share in supply is about 2 percent.

Most Transfers Are Local or Regional

We have already seen that the San Joaquin Valley is both a major supplier and a purchaser of water. The market in Southern California is also primarily regional in nature (Table 2.1). The only exports leaving the region are the transfers by municipal agencies to the SWP turn-back pool, purchased by San Joaquin Valley agricultural districts. In the Sacramento Valley, the only region in the state where water users purchase significantly less than the volume sold, exports are concentrated in dry years. In years with normal to high rainfall, two-thirds of the water is transferred to other water users within the region.

Another way of seeing the shares of local and regional markets is to look directly at the source of water obtained by users. Figure 2.4 shows

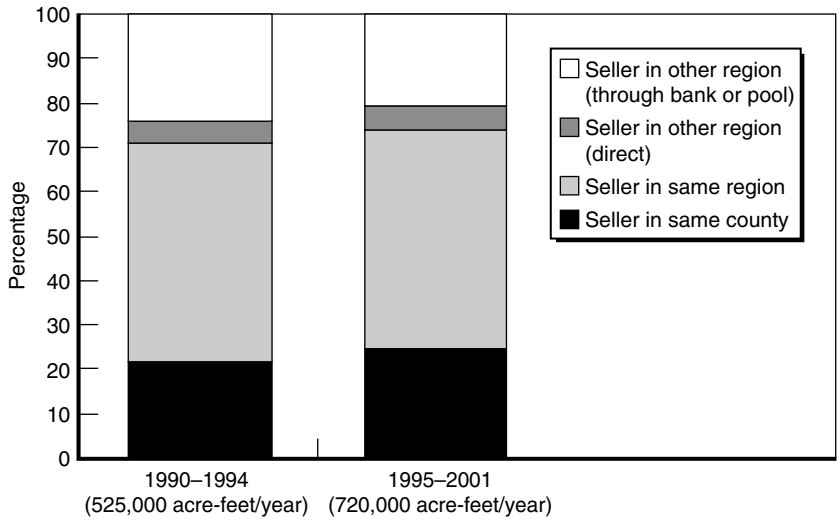


Figure 2.4—Nonenvironmental Water Purchases, by Location of Selling Party

this breakdown, for nonenvironmental water only, according to the location of the selling party in relation to the buyer. Nearly one-quarter of total volume is purchased from parties in the same county and another half from parties in the region. Interregional transfers account for the remaining 25–30 percent of the market.[6] Only a relatively small fraction of these transfers (one-fifth) are negotiated directly between parties in different regions; the lion's share moves through banks and pools run by DWR. This pattern highlights again the important role played by the government agencies in California's water market.

Given the need for federal and state agency approval for the use of conveyance facilities, this role is indispensable for any interregional transfers of water physically moving across the Delta. Approval decisions are complicated because pumping additional water through the Delta can affect water quality standards and put protected fish species in danger. When an agency acts as an intermediary, it is able to facilitate the movement of water across the Delta. Agency input has also been crucial

[6]Because this graph presents data from the standpoint of end-user purchases, it includes only the water bank volumes that were actually resold in the first period, not the full amounts acquired by DWR.

in successful district-to-district transfers—for instance, the 2001 transfer of 160,000 acre-feet from Sacramento Valley CVP contractors to the Westlands Water District. Many observers believe that the absence of state or federal agency sponsorship significantly complicates the approval process for cross-Delta transfers.

From Farms to Cities: A Key Element of Long-Term and Permanent Transfers

Our records show 15 approved long-term transfers and 14 permanent transfers of surface water rights or entitlements from 1985 to 2002.[7] At least ten additional transfers were pending approval in late 2002. As noted, long-term transfers have generally accounted for about one-fifth of all trades since the late 1980s. Volumes traded surpassed the 250,000 acre-feet mark for the first time in 2001. Contract duration runs from a low of two years to a high of 35, with an average of 15 years. The permanent transfers, bunched at the end of the decade, total another 175,000 acre-feet. These mainly concern the transfer of SWP contract entitlements under the Monterey Agreement (representing over 110,000 acre-feet) and the transfer of pre-1914 water rights among parties within Kern County.

Almost all these transfers involve shifts of water from agricultural to urban uses. The handful of exceptions includes one long-term deferred exchange and one long-term transfer between districts with a large municipal customer base (Solano County Water Agency and the Mojave Water Agency; Placer County Water Agency and Northridge Water District, respectively) and several long-term transfers from agricultural districts to the environment (most notably, as part of the negotiated agreement for the restoration of the San Joaquin River). Only two long-term transfers between agricultural districts appear, one in the Sacramento Valley and one in San Joaquin, and two permanent transfers of contract entitlement among agricultural users (both in the San Joaquin Valley).

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[7]For details on the transactions discussed in this section, see Tables A.5 and A.6.

This trend holds for transfers pending approval in 2002. Key among these are two large long-term agriculture-urban transfers within the Colorado River Project (Imperial Irrigation District to San Diego, Palo Verde Irrigation District to MWDSC) and several permanent transfers of CVP contract entitlement from agricultural water districts to towns in the San Joaquin Valley. Thus, agricultural users remain the largest single source of demand for water in today's market, but they conduct their purchases almost entirely through temporary arrangements.

Also noteworthy is the highly local character of much of the long-term and permanent transfer market. Transfers involving CVP contractors and water agencies with their own surface supplies have essentially taken place in the neighborhood, between districts and municipalities in the same or adjacent counties. The only cross-regional movements of long-term or permanent water involve SWP contractors and Colorado River contractors.[8] In both cases, the transfers came about mainly as part of global renegotiations of project operating rules. Under the Monterey Agreement, Kern County agriculturalists negotiated the sale of contract entitlement to municipal users in Southern California and the San Francisco Bay Area in exchange for greater certainty of supply for their remaining SWP entitlement. Contractors within the Colorado River group have been under intense pressure to set up transfers from the agricultural valleys of the desert counties to coastal municipal agencies as part of California's obligation to reduce its use of Colorado River water under the 4.4 Plan referred to in Chapter 1.

The stronger presence of municipal agencies in the market for long-term and permanent water contracts is logical, given their need to ensure reliability of supplies for growing populations. Looking ahead, we should expect residential demand to increase, as a consequence of demographic trends themselves and recent legislation that makes a tighter connection between water supplies and land-use planning. In 2001, the legislature passed the "show me the water" bills, SB 610 (Costa) and

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[8]Although technically within the same region (Southern California), most of the Colorado River transfers involve buyers and sellers at quite some distance from one another. The one deal involving close neighbors is the pending transfer from Imperial Irrigation District to Coachella Valley Water District.

SB 221 (Kuehl), which require that local governments demonstrate the adequacy of water supplies for growth.[9] Long-term transfers are among the measures considered adequate for this purpose.

Summing Up

Jumpstarted by a prolonged drought in the late 1980s and early 1990s, California's water market has now become a firmly established feature of the state's water allocation process. The market remains largely intraregional in nature, with the state's Department of Water Resources directly mediating most transfers across regions. The market is also highly segmented, with over half of the volumes traded among contractors of the large state and federal water projects and another third involving direct purchases by state and federal agencies for drought relief and environmental mitigation.

Outside drought years, when urban agencies have been important buyers, the main sources of demand have been directly and indirectly linked to environmental concerns. Direct purchases for instream uses and wildlife reserves have accounted for over one-third of the increase in purchases since 1995. The other growth sector, accounting for over half of market expansion, has been agriculture in the San Joaquin Valley, as farmers whose contractual water deliveries have been cut because of environmental mitigation programs have turned to the market for replacement water.

Municipal agencies are the principal buyers of long-term and permanent contracts. In light of the state's rapid population growth, it is not surprising that municipal agencies are taking the lead in negotiating long-term and permanent arrangements for water supply. Legislation passed in 2001 requiring that local governments demonstrate adequate water supplies for development should increase urban demand for long-term water transfers. As we shall see, municipalities' success in forging these deals and assuring new supplies will depend on their ability to smooth the waters of community resistance in the source regions.

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[9]See Association of California Water Agencies (2002) and Department of Water Resources (2002b).

3. The Rise of Local Restrictions on Water Marketing

As state and federal authorities have taken steps to facilitate water marketing in California over the past two decades, concerns over potential negative effects of the market on the source regions have prompted many county governments to erect new barriers to trade. This chapter describes the statewide trends in county adoption of groundwater protection ordinances and raises some of the key legal, economic, and operational questions concerning their implementation.

The Mobilization of Rural Counties

By the end of 2002, 22 of California's 58 counties had adopted ordinances that restrict the export of groundwater. Although the specific language of the ordinances varies, one common thread is their focus on the regulation of exports, as distinct from groundwater uses on-site. In most ordinances, "exports" are defined as shipments of water beyond the county's administrative boundaries. Although several counties apply instead an "out-of-basin" definition of exports, and several others an "off-parcel" definition, a review of the implementation record suggests that these nonadministrative boundaries reflect an intent to protect the ordinance against potential legal challenges (discussed below) rather than to regulate groundwater use within the county.[1]

The precursor to this movement was the adoption by three northern counties (Butte, Glenn, and Sierra) of urgency ordinances prohibiting

[1]Counties with "out-of-basin" restrictions include Inyo, Kern, Mono, and Siskiyou. Counties with "off-parcel" restrictions include Tehama, San Benito, and Sierra. Imperial County's ordinance has separate restrictions on exports leaving the county and on groundwater extractions for within-county use. As discussed in Chapter 5, only three counties within this group—Imperial, San Benito, and Sierra—have enforced a permitting process for within-county uses. For details, see Hanak and Dyckman (2003).

the "mining" of groundwater in 1977, a year of severe drought. Modoc County followed suit early in the following year, with an ordinance limiting transfers outside the groundwater basin. Over the next 15 years, a handful of Sacramento Valley and mountain counties introduced ordinances with explicit export restrictions. The slow pace may be explained in part by the fact that two counties, Inyo and Nevada, saw their ordinances successfully challenged at the trial court level during the 1980s.[2] The floodgates opened once a third county, Tehama, won an appellate court victory in 1994, upholding its authority to regulate groundwater.

Since the Tehama decision, which was widely publicized in water law and county government circles,[3] 14 counties adopted explicit export restrictions for the first time, and three counties regularized urgency ordinances adopted earlier (Figure 3.1).[4] Geographically, the group is concentrated in rural California: the mountain counties to the north and east, the Sacramento and San Joaquin Valleys, and Imperial County to the south (Figure 3.2). By and large, these counties fall into the group traditionally considered "source" regions for the state's water supply; many have relied heavily on groundwater for agriculture.

Over this period, five other counties adopted groundwater protection ordinances that focus on management of groundwater resources within the county or in a particular geographic subarea.[5] The regulations include various types of restrictions on extraction for on-site use (e.g., well permitting, flow monitoring, pump taxes). In effect, the county

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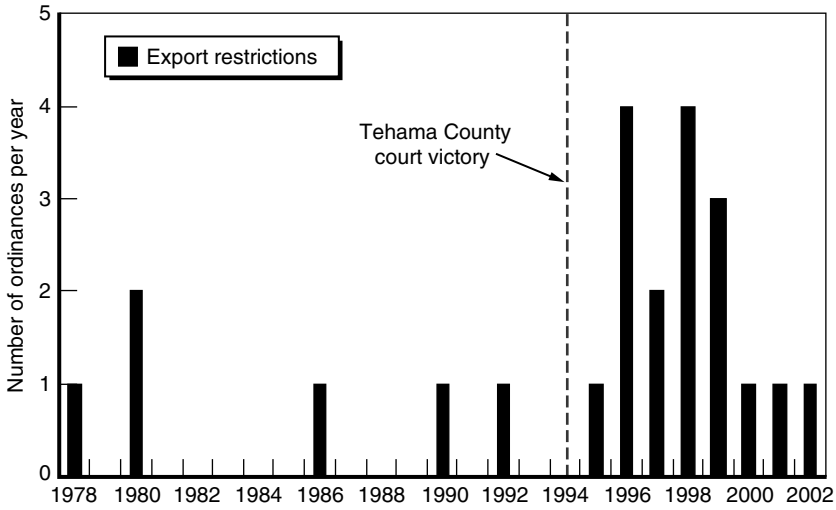
[2]Inyo County's ordinance was successfully challenged by the City of Los Angeles in 1983 (*City of Los Angeles, Department of Water and Power v. County of Inyo*, case no. 12,908, July 8, 1983). Nevada County's ordinance, introduced in 1986, was successfully challenged in a suit brought by the Truckee-Donner Public Utility District in 1988. Inyo pursued the matter through negotiations with the City of Los Angeles and reintroduced a revised ordinance in 1998. Nevada County did not seek review and has not reintroduced an ordinance subsequent to the Tehama holding. For this reason, we have not counted Nevada among the 22 counties with export restrictions.

[3]See Goldsmith (1995a, 1995b) and Bunn (1997).

[4]In addition, Modoc County introduced a more stringent ordinance restricting exports out of the county rather than the basin in 2000, and Inyo reintroduced an ordinance in 1998 to replace the one invalidated by its court proceedings in the early 1980s.

[5]For details, see Table B.1, middle column.



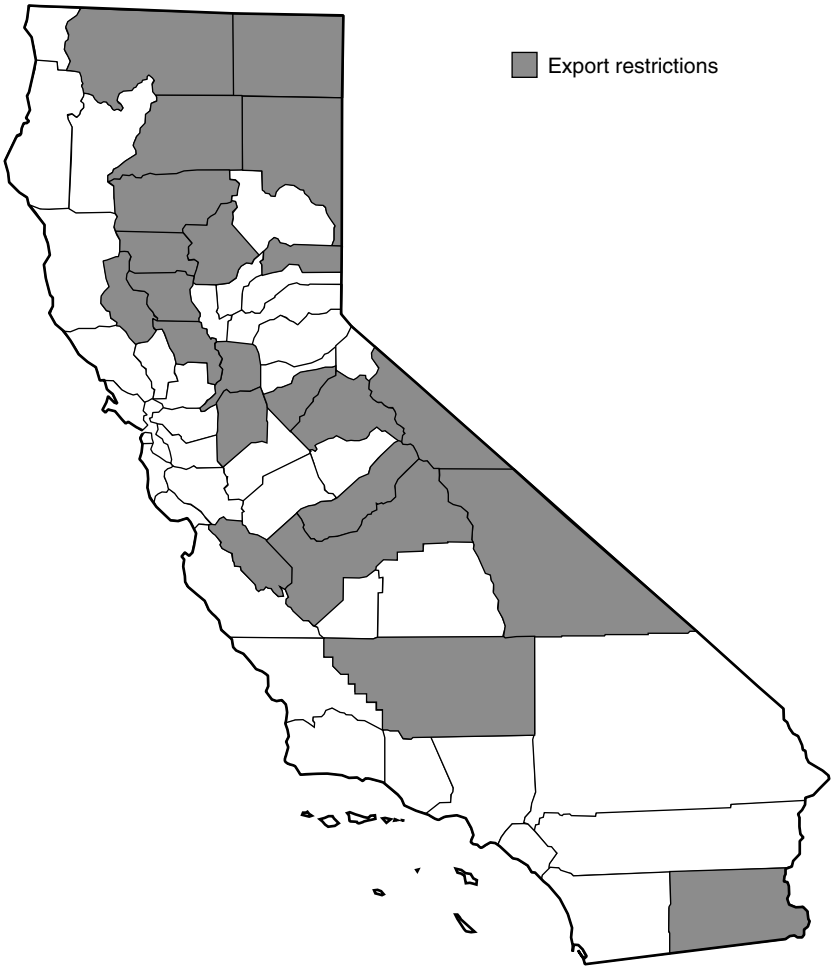
NOTES: For details, see Table B.1. The dates refer to the adoption of regular ordinances restricting exports.

Figure 3.1—Adoption of County Ordinances Restricting Exports

assumes an authority resembling that exercised by other specialized groundwater institutions present in the state: basins adjudicated by the courts, special groundwater management districts created through acts of the legislature, and certain special water districts that exercise full control over access to the resource.[6] In adjudicated basins, use rights are attributed to individual users in much the same way as surface water rights. In the special districts with groundwater authority, the districts have the authority to regulate individual water use, typically through pump taxes.

Counties with these types of groundwater management institutions tend to be located along the coast and in Southern California; most have significant urban populations. The on-site groundwater protection ordinances appear to substitute for or complement the activities of special districts and adjudicated basins. Ordinances substituting for other measures include those of San Diego and Napa Counties; in Napa,

[6]For maps showing the location of these institutions, see Figures B.2 and B.3.



NOTE: Kern County's ordinance is limited to the southeast portion of the county within the Lahontan hydrologic region.

Figure 3.2—California Counties with Groundwater Export Restrictions, 2002

officials view the ordinance as an alternative to a costly adjudication process. Counties where the ordinances complement other institutions include Monterey, Mendocino, and San Bernardino. In Monterey, the ordinance applies to several zones not already covered by a special groundwater district. Mendocino's ordinance applies only to the town of

Mendocino, where a special district has groundwater authority. The San Bernardino ordinance applies to desert regions of the county not already under a local management system and notably excludes the Mojave Basin, which is adjudicated.

At first glance, several of the mountain counties (Lassen, Modoc, Mono, and Sierra) seem to be exceptions to this geographical division because they have adopted both special groundwater management districts and countywide ordinances restricting exports. However, all but one of the six special groundwater districts in these counties were set up with the primary purpose of controlling exports rather than for local use management.[7] Siskiyou County also appears as a partial exception, by virtue of the presence of one adjudicated basin. As noted above, several of the counties with export restrictions have ordinances that would, in principle, provide authority to regulate in-county uses as well. However, this authority appears to be exercised actively in only three counties—Imperial, San Benito, and Sierra.

An Overview of Export Restrictions

All 22 ordinances restrict the direct export of groundwater; those adopted since 1996 also implicitly restrict exports of surface water by regulating the extraction of groundwater used to replace exported surface supplies. Sacramento's ordinance overtly restricts surface water exports of any kind. A handful of counties (Madera, San Joaquin, and Fresno) have specific restrictions on the use of county groundwater basins as storage sites for groundwater banking projects. San Joaquin County supervisors recently introduced a separate ordinance restricting the location of aboveground storage as well, in response to a proposed project to convert two islands in the Delta into surface storage areas.

In most counties, restricted activities require a county permit, which invokes a review under the California Environmental Quality Act (CEQA).[8] Permit applicants are expected to conduct from one to several

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[7]The exception is the Sierra Valley Groundwater Management District, which was initially intended to regulate agricultural pumping in response to drought conditions.

[8]In four of the five counties with ordinances oriented toward local groundwater management (San Diego, Mendocino, Monterey, and Napa), the process involves

studies. Applications go through a multilayered review by county departments and commissions, with the final decision most often in the hands of a political body (the board of supervisors or a body appointed by the board). If approved, permits generally run from one to three years.

Most ordinances provide certain categorical and conditional exemptions to the permitting process. Water districts or landowners with service areas or holdings overlying adjacent counties typically do not need permits for water use on those lands. Most counties also provide a blanket exemption to permitting as long as quantities remain within historical use levels. A number of the mountain counties exempt bottlers of spring water, as long as the bottling is done within the county. Finally, various counties exempt specific types of local entities—such as incorporated cities and water districts—from permitting altogether, either because the counties have assurances that the entities already engage in sound groundwater management practices or because there are questions of regulatory authority and an interest in avoiding jurisdictional conflicts.

Legal Issues

The question of jurisdictional authority is at the heart of the legal issues raised by the county ordinances.[9] In California, municipalities may invoke police powers to protect the public welfare in areas not regulated by the state. This is the basis for the groundwater protection ordinances, because groundwater falls outside state jurisdiction.

The lawsuit filed in 1992 against Tehama County by two landowners, Baldwin and Myers, challenged this position, arguing that some provisions of the California Water Code already dealt with local groundwater protection, thereby "preempting the field." Three areas of state intervention were cited: the specially enacted groundwater management districts (noted above); Section 1220 of the Water Code

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incorporation of a groundwater review or overlay in a regular ministerial process, rather than application for a discretionary permit with CEQA review.

[9]For a detailed discussion of the legal issues raised by the ordinances, see Hanak and Dyckman (2003).

(enacted in 1984), which restricts the direct export of groundwater out of the Sacramento River Basin; and the recently enacted AB 3030 (Water Code Sections 10750–10753.9), which authorizes existing water agencies to create groundwater management districts. The county lost in trial court but prevailed at the appellate level, with a holding that the cited state legislation did not preempt the county's ability to regulate an arguably open field by establishing a review process in the interest of public health and safety.[10]

The Tehama case was the first appellate decision to address the issue of county authority to regulate groundwater extraction. As noted, it followed at least two earlier Superior Court rulings that took the opposite position, holding that the state had preempted the power of cities and counties in this domain.

Although there have been no further proceedings against county groundwater ordinances, several potential legal concerns were not addressed by the *Baldwin v. County of Tehama* case. The first of these relates to provisions of the Water Code governing surface water transfers, where it would be difficult to argue that the state has not occupied the field. Sacramento's ordinance, which openly restricts any surface water exports, would suffer under such a legal challenge. County ordinances that indirectly restrict surface water exports by restricting groundwater substitution may also conflict with the state's authority in this area.

Some ordinances may also be open to legal challenge on the grounds that they exceed the county's police power. Court decisions have tended to take the view that governments, in exercising this power, should take the minimum steps needed to protect public health, safety, and welfare. In counties where it is possible to demonstrate that there is already a significant problem of overdraft, imposing export restrictions is a classic use of police power, as it protects residents' ability to exercise their property rights.

However, a number of counties are not in a position to justify the export restrictions on the basis of current needs. The widespread exemptions for historic use levels are, in effect, an admission that there is

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[10] *Baldwin v. County of Tehama*, 31 Cal. App. 4th 166, 173-74 (1994, 3rd Dist.); *review denied*, Cal. Sup. Ct., March 17, 1995.

no current threat to public health, welfare, and safety. In such cases, applying restrictions could amount to barring present use somewhere in the state to preserve future use in the areas of origin. In addition to potentially exceeding the extent of police powers, an overly protective ordinance may violate Article X, Section 2 of the California Constitution, which requires that "the water resources of the state be put to beneficial use to the fullest extent of which they are capable."[11] Many counties are in the process of incorporating the ordinances into their General Plans as a way of shoring up the basis for the restrictions.

In a different vein, there is some debate over whether the ordinances could be subject to a federal Commerce Clause challenge. As noted above, the language in most of the ordinances is jurisdictionally based, restricting exports beyond the administrative boundaries of counties rather than hydrologic basins or some other distinction that reflects the physical links between groundwater extraction and harm to adjacent users. This language raises the potential for a challenge of discrimination based on arbitrary distinctions.[12] Although this issue has not been raised in any of the court challenges to date, it has been of some concern for ordinance drafters in several counties, as reflected in the move to an "out-of-basin" or "off-parcel" permitting system.[13]

A final, and arguably more significant, legal concern is that the ordinances generally do not distinguish between native groundwater and imported surface water banked underground. As a result, even

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[11]In the Tehama case, the 4th Appellate Court rejected this argument, observing in a footnote that the issue "is not so simple as plaintiff's cursory argument supposes." Counties may nevertheless have reason for some concern over a potential future legal challenge against "hoarding water." Note too that the source of county regulatory authority—police power—relates to current threats and not anticipated future threats.

[12]The case law precedent is *Sporhase v. Nebraska ex rel. Douglas (1982),* in which the U.S. Supreme Court held that discriminatory groundwater export regulation interferes with interstate commerce (Getches, 1997).

[13]Counties that moved from a county to a basin restriction include Inyo, Mono, and Siskiyou. Discussions with officials in Inyo and Mono revealed that compliance with the Commerce Clause was a factor in this decision. Kern County drafted its ordinance with basin restrictions for similar reasons, following discussions with Inyo County officials. Constitutionality issues were also a factor in the drafting of the Tehama County ordinance, which restricts use off-parcel rather than out-of-county.

ordinances that do not directly address groundwater-banking projects do so implicitly because the county might claim authority to restrict the reexport of water brought in for temporary storage. The legal ambiguity on this question arises from overlapping and potentially conflicting jurisdictions, as the state governs the surface water brought into the county, whereas counties may seek to govern its reexport. The Water Transfer Workgroup convened by the SWRCB in 2000 recommended that county authority over imported banked water be limited to preventing injury to local users, which could arise if the banking project negatively affected either quality or quantity of water available locally.[14]

Economic Issues

The legal basis for county oversight of groundwater reflects the underlying economic justification for regulation of a collective resource. In an unregulated situation, a collective resource such as groundwater risks mismanagement. In general, individual users or water districts will not have the incentive to prevent overuse, with negative consequences for both quantity and quality of the water available in the basin. In the absence of state regulation, there is a strong case to be made for local oversight mechanisms that encourage sound management.

Against this background, California's county groundwater protection ordinances raise two questions from an economic standpoint. The first relates to the scope of the ordinances themselves; the second to whether counties are the appropriate level of local jurisdiction.

Concerning scope, the question is whether ordinances whose sole focus is restricting exports can contribute to better management of the groundwater resource. Export restrictions could be a sensible management tool, from an economic standpoint, in two situations. First, when there is uncertainty about the characteristics of the groundwater basin (size of the aquifer, recharge rate, etc.), restricting exports could be a reasonable precautionary measure. Second, in the absence of consensus on mechanisms to manage groundwater use by

[14]See the discussion of this issue in the report of the Water Transfer Workgroup (2002).

those within the basin, restricting exports at least ensures some upper bound on extraction rates.

Even where this precautionary strategy is a sensible first step in groundwater protection, however, it can quickly reach it limits as a management tool. A policy focusing on export restrictions can discourage active management of groundwater basins, a practice that can benefit local water users financially and enhance the regularity of supply in overdrafted basins. Active management can include various programs involving the conjunctive use of groundwater and surface water, such as the intentional recharge of aquifers that have been drawn down and the intentional drawdown of aquifers that are full.[15] In most places, active management programs require interactions with water users outside the area—notably through transfers of surface water in lieu of groundwater and through banking of imported surface water. Prerequisites include setting up information systems to better understand the aquifer and establishing some form of local oversight on groundwater use. All of this implies moving beyond export restrictions to a more comprehensive system of groundwater management.

In areas where the conjunctive use of surface and groundwater is not feasible because of limited surface supplies, the case for moving beyond export restrictions to active management is admittedly weaker. Even here, however, there can be benefits to understanding the limits and opportunities of the resource base. When groundwater supplies and recharge rates are more than adequate, a well-structured export program could be a boon to the local economy.

Are counties the appropriate level of jurisdiction to provide this leadership? The economic literature on the management of collective resources shows that success is greatest when local oversight institutions reflect a high degree of alignment of interests among concerned parties (Ostrom, 1990). The alignment can be geographical, increasing in the extent to which the physical boundaries of the resource management problem coincide with the jurisdiction of the local governing institution. The alignment can also be relational, increasing with the capacity of

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[15]For a description of conjunctive use programs used in California, see Purkey et al. (1998).

concerned parties to participate in or affect the deliberations of the governing institution.

In the case of groundwater protection and management, a natural point of geographical organization might be the aquifer—or the larger watershed draining into it. In all but a few cases, these physical boundaries correspond neither to those of the county nor to those of other local institutions, such as water districts. Recognition of this "misalignment" has led to the formation of multiparty institutions to address groundwater and watershed issues in many parts of the state. For groundwater, the most common institutional forms are groundwater management programs created under the AB 3030 legislation noted earlier or under joint powers authority. According to Department of Water Resources records, roughly 20 multiparty programs of this type currently exist. As we will discuss below, some of these programs show promise as a structure for local resource management.

Creating new institutions is not without difficulties, however, and there is some merit to considering counties as a potential rallying point for local resource management, even if their administrative borders do not coincide with the limits of the aquifer or watershed. Counties have the merit of having well-established representative institutions and public consultation mechanisms and can provide a convening point for parties. As such, they offer the potential for a high degree of relational alignment. Together with cities, they are also the only local institutions with the authority to invoke police powers, which could be a useful component of a local resource management program.

Operational Issues

The extent to which the ordinances can play a beneficial role in local water management also depends on the way certain operational issues are handled. Foremost among these is the review process for permitting. In many ordinances, this process is open-ended and involves significant up-front costs. A strong case can be made that those wishing to transfer water should be responsible for conducting the necessary environmental reviews (as is the practice for surface water transfer projects at the state level). In a number of counties, however, the initial requirements appear disproportionately high—effectively calling for a full-fledged study of the

aquifer before allowing any transfer project to go through, no matter how small. Whether intentional or not, this requirement can deter those seeking permits. It raises a potential legal issue of undue burden because the first applicant bears the cost of the background studies for all those who follow. In many counties, questions can also be raised about the transparency of the review process and the extent to which the technical characteristics of the project will be considered by the political body empowered to grant permits. Finally, the number of reviewing entities and effective amount of review time create other deterrents.

Summing Up

In the 25 years since the state adopted a policy in favor of water transfers, a movement to regulate the water market has gained momentum in California's rural counties. As of late 2002, 22 of the state's 58 counties had adopted groundwater protection ordinances requiring a permit to export groundwater or to extract groundwater used in substitution for transferred surface water.

Although this policy can be justified on economic grounds as a first-step precautionary measure in the face of uncertainty about the resource base, it is harder to justify in the longer run in the absence of a broader water management program. A strictly precautionary policy prevents the water users in the county from actively managing their groundwater resources, a practice that can reap financial and water supply benefits. It also makes counties susceptible to charges of "hoarding water," which is disallowed by the California Constitution. Because groundwater is a shared resource, active water management requires some form of local oversight. Whether counties or other local institutions are better suited to the task is an open question to which we will return below.

4. Why Do Some Counties Adopt Export Restrictions?

As we have seen, counties with ordinances restricting water exports are concentrated in California's inland rural regions—the mountain counties to the north and east and the Sacramento and San Joaquin Valleys in the center. Despite this common denominator, however, there are some clear distinctions within the group. Some counties are agricultural powerhouses; in others, farming is a marginal activity. Some are sparsely populated; others contain large and fast-growing metropolitan areas. Nor is geography a complete determinant: Over a third of the counties in these regions have not adopted ordinances.

This diversity suggests that the rural county ordinance movement is not monolithic; a range of factors may influence individual counties' choices. This chapter explores some of these factors, using two approaches. First, we examine whether there is a statistical basis for predicting which counties adopt ordinances, taking into account characteristics about county economic and water conditions and institutional factors. Second, we use a more qualitative lens, drawing on information obtained from interviews with county officials and water users. This discussion highlights the specific dynamics at play in each of the three regions noted above.

Factors That Make a Difference

Because the timeline of county adoption is idiosyncratic, we will confine the statistical analysis to a simple "yes" or "no" prediction of ordinance adoption and not attempt to model the factors determining the year of adoption. This leads us to focus on characteristics that vary across counties, measured, when possible, in the mid-1990s, when the adoption movement was fully under way.

Data on County Water Economy and Institutions

We could expect two structural factors to be important in the decision to adopt water export restrictions: the local economy's dependency on water and the extent to which exports might compromise the groundwater resource base. To measure the first of these, we have identified four indicators. Two capture the role of agriculture, the primary water-dependent economic activity: the share of farm jobs in total employment and the share of agriculturally related jobs, a category including agricultural services and agro-processing.[1] A third indicator, the share of irrigated acreage in total farm acreage, reflects the intensity of water use as an input. Counties with higher proportions of dry-land farming or rangeland will have lower agricultural water needs. The fourth indicator, the share of residential population dependent on groundwater, captures the relative importance of groundwater as a water source. Ideally, we would have included a comparable measure for agriculture, but the share of groundwater in farming is not known in many counties. We might expect all four of these measures to be positively related to the decision to adopt an ordinance restricting water exports.

We might also expect counties whose groundwater basins are experiencing serious overdraft to be more inclined to adopt precautionary measures than those whose aquifers are full. Identifying these locations proved difficult. A good measure of overdraft would be the extent to which the water table in an aquifer was declining on a long-term basis. There are no statewide measures of overdraft so defined, in part because the Department of Water Resources does not have access to well data in many areas, in part (and relatedly) because the issue raises thorny legal questions. Designation of overdraft has implications for the rights of groundwater appropriators and can serve as a basis for adjudication proceedings.

The last time DWR ventured an official designation of groundwater basins in difficulty was in the 1980 Bulletin 118-80 (Department of Water Resources, 1980). The bulletin provides a list, established

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[1]See Appendix C for a description of data sources.

through a process of data analysis and public review, of 11 basins that are "critically overdrafted" and four basins "with special problems."[2] Although conditions of individual groundwater basins in the state may have changed for better and for worse in the intervening years, this list remains the best indicator of counties with an at-risk groundwater basin. We would expect that counties overlying such basins would be more likely to have adopted some type of restrictions.

It is also likely that institutions play a role in the decision to restrict exports. One unquantifiable but integral aspect is the degree of harmony among the county's institutions. Counties where the water agencies are not in conflict with each other and with the municipal and county governments will be less likely, all else equal, to have the motivation to impose export restrictions as a controlling mechanism. This institutional concordance can result from a range of factors: limited number or low diversity of institutions, overlap of county and water agency governing bodies, or good working relationships borne of individual initiative.

Another important institutional factor is an affiliation with the Regional Council of Rural Counties (RCRC), an association of counties with populations generally below 300,000. It began in the early 1970s as an association of the mountain counties and subsequently expanded to cover most of the small counties in the state.[3] In 1995, on the heels of the Tehama County court victory, RCRC established a water program to promote the protection of member counties' water rights. The program encourages members to adopt groundwater ordinances and to reflect these in their general plans. RCRC influence is transmitted in two ways. For some counties, the secretariat has provided technical and legal advice; more generally, the board of directors, made up of a supervisor from each member county, serves as an important forum for information exchange.

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[2]See Figure B.4 for a map showing the location of these basins.

[3]As of 2002, RCRC had 30 member counties: Alpine, Amador, Butte, Calaveras, Colusa, Del Norte, El Dorado, Glenn, Imperial, Inyo, Lake, Lassen, Madera, Mariposa, Merced, Modoc, Mono, Napa, Nevada, Placer, Plumas, San Benito, Shasta, Sierra, Siskiyou, Sutter, Tehama, Trinity, Tuolumne, and Yuba. Imperial County officially joined in October 2002 but was informally affiliated with the group for some time before membership.

Cross-County Results

For several of these indicators, there is a considerable and statistically significant difference in the mean values between counties with export ordinances and those without (Table 4.1). On average, counties with export restrictions have twice the share of farm employment and 40 percent higher residential dependence on groundwater. They are also twice as likely to be members of RCRC. The ordinance adopters also register a third more irrigated farmland and appear nearly twice as likely to overlie a critical or specially designated groundwater basin, although the differences are not statistically significant at the 90 percent level of confidence. The one area where the groups do appear alike is in their share of agriculturally related employment, at roughly 2 percent of all jobs.

Several of these factors contribute to the probability of a county adopting an export restriction in the expected ways.[4] The most sizable effects are associated with membership in RCRC and the presence of an at-risk groundwater basin. These factors increase the likelihood of ordinance adoption by 30 and 26 percent, respectively. Farm employment also raises the likelihood of adoption. A county with 10

Table 4.1

Average Characteristics of Counties With and Without Export Restrictions

	Counties With Restrictions	Counties Without Restrictions	All Counties
Farm employment (%)	8.0***	3.8	5.4
Agriculture-related employment (%)	2.0	1.9	1.9
Irrigated farmland (%)	34	24	27
Residents using groundwater (%)	75***	54	62
Counties overlying critical/special basin (1980) (% of counties in group)	45	25	33
RCRC membership (% of counties in group)	77***	36	52
Sample size	22	36	58

***Indicates significant difference of group means at the 99 percent level of confidence.

[4]See Appendix C for a more detailed presentation of the statistical results discussed here.

percent of its workforce in agriculture is a third more likely to adopt an ordinance than a county with only 2 percent of farm jobs.[5]

Somewhat surprisingly, agriculturally related employment appears to have the opposite effect. For a given level of on-farm employment, counties with a higher share of value-added activities related to agriculture are less likely to adopt export restrictions. In effect, the geographical link between agriculturally related jobs and farming is less direct than is commonly thought. Many counties with a relatively low share of farming have significant processing activities. The statewide county average ratio of off-farm to on-farm agricultural jobs is 73 percent. Only one county with an export ordinance (Sacramento) exceeds that level. Thirteen counties without ordinances do so—including virtually all of the San Francisco Bay Area and Southern California. Many of these counties have more comprehensive groundwater management systems, which do not discriminate against transfers.

Regional Issues

To understand the reasons for adopting export restrictions, we interviewed county and water district officials and other resource persons in 36 counties, including most having some type of groundwater ordinance and the key agricultural counties without one.[6] The interviews sought background on the following types of questions: Was the ordinance a response to a specific local event or a general precautionary measure? Is the main concern with activities of private individuals or water districts? Which types of prospective buyers raise red flags—farmers in neighboring counties or distant municipal water suppliers? Is the objective mainly to control water exports or groundwater banking projects? Within the county, how contentious was

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[5]Neither the share of irrigated farmland nor the share of residential dependence on groundwater has statistically significant effects on the adoption of export restrictions.

[6]The only counties with ordinances for which interviews could not be conducted are Siskiyou and Monterey. Counties without ordinances for which interviews were conducted include Kings, Merced, Placer, Plumas, Solano, Sonoma, Stanislaus, Sutter, Trinity, Tulare, and Yuba. All 58 counties were contacted to verify whether an ordinance was in place or under consideration.

the adoption process? Were exemptions granted because of jurisdictional issues or because the exempted parties were considered to have an adequate groundwater management system in place?

Although each county has a unique story in some respects, we have opted to highlight the results of these interviews from a regional perspective.[7] The three regions singled out have different water supply conditions and a different set of demands for agricultural and residential uses. These factors lend a specific regional character to the nature of the perceived threat the water market brings with it. So, too, do historical events relating to water transfers. Within this context, the weight of the ordinance in a given county will depend on the local dynamics of the adoption process: whether it came in response to a specific event, the degree of internal conflict, and the extent of public involvement preceding adoption.

The Mountain Counties: The Legacy of Owens Valley

Counties in this region are sparsely populated and have limited agricultural production (Table 4.2).[8] Many rely heavily—some exclusively—on groundwater, although rivers and streams provide a source of surface water in others. An indicator of the extent to which groundwater is a local concern is the fact that six of the 15 counties overlie basins identified in Bulletin 118-80 as having "special problems."[9]

The history of one of these basins, Owens Valley, has indelibly marked the regional consciousness on water issues. In the early part of the 20th century, the City of Los Angeles bought up vast tracts of land in the valley and began exporting large quantities of groundwater. The transfer had immediate consequences for the local economy, where agriculture became unviable, and has proven over time to be deleterious to the environmental health of the valley. The expansion of pumping capacity in 1970 with the addition of a second aqueduct exacerbated the

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[7]For a list of counties by region and a map showing county locations, see Table B.1 and Figure B.1, respectively.

[8]The only county with over $100 million in gross agricultural product in 1999 was Siskiyou, which is part of the Klamath Project. Neighboring Modoc, also in the project, had output valued at just over $60 million in that year.

[9]Only Calaveras overlies a basin identified as subject to critical overdraft.

Table 4.2

Regional Characteristics (County Averages)

	Mountain Counties	Sacramento Valley	San Joaquin Valley
Population	37,870	234,335 (118,161)	430,075
Urban population (%)	0	41 (35)	39
Agricultural output per capita ($)	882	3,530	4,366
Residents using groundwater (%)	67	78	88
Counties overlying critical/special basin	7	0	8
RCRC membership	15	8	2
Export ordinances	8	7	4
Counties in group	15	10	8

SOURCES: Population figures for 2002 are from the California Department of Finance. Urban population share is from the 1990 Census, the most recent year for which this estimate is available. Per capita agricultural output is from the 1997 Agricultural Census. See also Appendix C.

NOTES: Numbers are county average values for each region. For a list of counties in each region, see Table B.1. For the Sacramento Valley, numbers in parentheses indicate values excluding Sacramento County.

environmental problems, both in Mono Lake and in the Owens Lake bed. Following years of difficult and acrimonious legal proceedings, Inyo County and a coalition of environmental groups reached mitigation agreements with the City of Los Angeles in the early 1990s. These have resulted in a considerable reduction in the flow of water out of Mono and Inyo Counties through the Los Angeles Aqueduct.[10]

The mountain counties also have an acute awareness of their status as source regions for the federal and state water projects and the projects developed by the City of San Francisco and East Bay Municipal Utilities District. Although these projects have not necessarily affected the volumes of water available to local water users, whose needs are limited,

[10]The settlement between the City of Los Angeles and the County of Inyo over Owens Valley was reached in October 1991, and the Mono Lake settlement was reached in September 1994 (Hundley, 2001). Together, these agreements have reduced the City of Los Angeles's exports by an annual average level of 150,000 acre-feet, or one-third of the conveyance capacity of the Los Angeles Aqueduct (personal communication, Jerry Gewe, Los Angeles Department of Water and Power, December 2002).

there is a tradition of vigilance in defending the area of origin status, by which counties can reclaim water they may need for future growth.[11] Moreover, contention over the regulation of instream flows can at times be significant. One case in point is the current dispute over Central Valley Project appropriations from the Trinity River. The federal government's decision to reduce off-take, in response to concerns by Native American tribes and environmentalists, has become the subject of legal proceedings with project contractors in the Sacramento and San Joaquin Valleys. A second is the dispute on the allocation of water between instream and agricultural uses on the Klamath River, which has pitted agricultural water districts in Siskiyou, Modoc, and neighboring Oregon counties against environmental and tribal advocates within the same region.

Against this backdrop, one might expect these communities to be wary of transferring water. Several of the basins bordering the state of Nevada have been the subjects of intense controversy for just this reason. A project to market groundwater to Nevada from Long Valley, one of the "special problem" basins underlying Lassen and Sierra Counties and neighboring Washoe County in Nevada, prompted the introduction of the state's first special groundwater management district act in 1980. Since then, potential export projects to Nevada from the Honey Lake Basin (Lassen) and the Surprise Valley Basin (another "special problem" basin underlying Modoc) led county officials to obtain special district status for these basins as well. In addition to the ability to limit exports, the special groundwater management districts have the authority to negotiate directly with the state of Nevada concerning joint basin matters.[12] County-level export restrictions have been adopted as an additional safeguard, with little substantive consequence for the management of these basins.

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[11]This includes the "County-of-Origin" statute (1927; Cal. Water Code Section 10505), the "Watershed Protection Act" (1933, Cal Water Code Sections 11460–11464), the "Delta Protection Act" (1959), and the "Protected Areas" statute (1984; Cal Water Code Sections 1215–1222). See Hundley (2001), pp. 531–533.

[12]This authority has been essential, but the border counties nevertheless find themselves at a disadvantage in cross-border basin management negotiations, because groundwater extraction in Nevada is regulated at the state level.

Although the potential for groundwater exports to Nevada has also been an issue in Mono and Inyo Counties (as well as San Bernardino, further south), the more-pressing concerns there have arisen from modern-day projects to export groundwater to Los Angeles. Inyo County's initial ordinance, passed by a ballot referendum in 1980, was part of the county's attempt to seek mitigation for the ongoing transfers to the City of Los Angeles begun decades earlier. But mitigation of both Mono Lake and the Owens Valley has spawned a new set of concerns. The freed-up capacity in the Los Angeles Aqueduct has sparked the interest of several private firms, which see the potential to use it for conveying water to the coast. The Inyo County ordinance was revised in 1998 to expressly limit transfers through the aqueduct and any sales to Los Angeles.

By contrast, in Calaveras and Tuolumne Counties, ordinance adoption appears to have been largely preventive in nature, sparked more by the Tehama ruling and RCRC encouragement than by any specific threat to the groundwater resources.

On the whole, the introduction of ordinances in this region has been spearheaded by county officials and has proceeded with little local dissent. The one exception is Calaveras County, where there were protracted negotiations on the terms of the ordinance because of the concerns of local farmers and the main surface water district. The challenges to Inyo's initial ordinance were raised by landowning "outsiders"—a private company, Anheuser-Busch, which hoped to export water to use in its plants in Los Angeles, and the City of Los Angeles itself, which sued the county and prevailed in the Superior Court.[13] Subsequent versions of the ordinance exempt the City of Los Angeles from the permitting process, as its water use is regulated by a separate agreement with the county.

Among the counties without ordinances, at least two have alternative institutional mechanisms in place for management. Plumas County overlies the Sierra Basin, for which a special groundwater management district was set up in 1980 to deal with in-basin supply problems, rather

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[13] *City of Los Angeles, Department of Water and Power v. County of Inyo*, case no. 12,908, July 8, 1983.

than in response to export threats. One commentator assured us, "Were there a need to, the Board of Supervisors could vote in an ordinance in no time." El Dorado's only groundwater supplies come from fractured rock—a geological formation that does not lend itself to recharge in the way alluvial basins do. Well permitting has been strictly controlled in the county for many years.

Sacramento Valley: A Balancing Act Between the Surface Water "Haves" and "Have-Nots"

The Sacramento Valley is an important agricultural region, producing rice, tomatoes, and various fruits and nuts (Table 4.2). It also contains one of the fastest-growing metropolitan areas, centered on the city of Sacramento. Unlike the mountain counties, the valley is simultaneously a source region for the large surface water projects and a major surface water user. The region is also relatively rich in groundwater, which is a primary supply for residential uses and for some farmers. In 1980, not a single aquifer in the valley was on the critical basin list. Although several counties are now concerned about cones of depression, or pockets of overdraft, the valley would still be absent from that list if it were drawn up today.

Debates on water marketing are colored by two characteristics of the region's water supply: the uneven distribution of surface water rights within the valley and the valley's overall abundance of supplies relative to other parts of the state. The distribution of surface water rights within the valley reflects the historical patterns of water district formation and construction of storage and conveyance facilities. A number of water districts and mutual water companies have senior rights to Central Valley Project and State Water Project deliveries, by virtue of having laid claim to the water before project inception. Most of these senior contract-holders are agricultural water users in the south-central and eastern parts of the valley, in Glenn, Colusa, Butte, and Sutter Counties. To the east, Yuba and Placer Counties are also rich in surface water, thanks to autonomous projects with aboveground reservoirs. Districts along the west side of the valley, served by the Tehama-Colusa Canal, have junior rights to CVP water, typically involving both lower per acre allocations and less-reliable supply from one year to the next. In several counties,

independent groundwater pumpers—i.e., those not affiliated with water districts—constitute a significant portion of the farming population.

"Area of origin" concerns—notably the perception that Southern California's thirst for the north state's water would never be quelled—are a longstanding component of the valley's water lexicon. A landmark event was the 1982 defeat at the ballot box of the project to build the Peripheral Canal, which would have facilitated the movement of water past the San Francisco Bay Delta to southern contractors of the federal and state water projects (Hundley, 2001). Voters in this region (as elsewhere in Northern California) were overwhelmingly opposed to the project, which still looms as a symbol of the need for vigilance on water rights.

Soon after this defeat, at the urging of valley and mountain counties, the legislature added Sections 1215-22 to the Water Code to firm up the area-of-origin protections. Under Section 1220, it is illegal to directly export native groundwater appropriated after 1975 outside the Sacramento River Basin without the authorization of the overlying county. To authorize, the county first has to establish a groundwater management plan to ensure that the export does not compromise supplies for local needs. Water purveyors south of the Delta were the intended targets of the section, because earlier area-of-origin statutes provided safeguards only with respect to the state and federal projects.[14] It appears that the measure was largely preventive in nature, rather than a response to specific transfer projects under consideration.

The multiyear drought of the late 1980s and early 1990s prompted renewed fears about the need to protect native groundwater. One source of the problem was actual transfer activity that occurred under the state-operated drought water bank. Various water districts and individual farmers in the region participated in the bank in all three years of its operation (1991, 1992, and 1994). In 1994, bank purchases sparked a well-publicized controversy in Butte County, where water districts with senior rights sold some of their surface water and engaged in additional

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[14]Personal communication, Clyde McDonald, September 2002. Mr. McDonald was a member of the staff of the bill's author, Senator Norman Walters, at the time of passage.

groundwater pumping for irrigation. When wells in parts of the county ran dry, some independent pumpers linked this development to the transfer activity. Because there was no mechanism in place to monitor the effects of the pumping or to mitigate third-party effects, the problem festered and a heated conflict erupted among local water users.[15]

Although the Butte conflict may well have had repercussions beyond county lines, the state's considerations about using the region's groundwater as a longer-term source of supplemental supply for users south of the Delta were probably at least as significant in generating concerns about groundwater protection. In the wake of the water bank experience, the Department of Water Resources began development of a supplemental water purchase program, intended to be a more systematic approach to future water transfers. Initially, the program envisaged annual purchases of up to 400,000 acre-feet of groundwater from Sacramento Valley basins.[16] Upon release of the draft document in 1996, local reaction was immediate and sufficiently spirited to condemn the proposal to mothballs. In our discussions with water users and officials throughout the region, the imprint of this proposal remains strong, although the details have faded into the haze. In explaining the reasons for county mobilization, a typical recollection runs something like this: "Back in the early 1990s, DWR decided to put a straw into the aquifer, so we knew we had to do something."

The other well-publicized groundwater transfer controversy, which provoked the drafting of the Tehama County ordinance, demonstrates that exports to points south of the Delta are not the only concern, however. This case involved the direct pumping of groundwater off a small parcel in proximity of the Tehama Colusa Canal, which the landowner planned to use to irrigate his farmland in Colusa County, farther south along the canal. Section 1220 of the Water Code would not be applicable in this type of situation, as it only limits the direct

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[15]Notably, DWR did not reserve the right in its purchase contracts to require cessation of pumping in the event that effects were encountered. A detailed case study is provided in Thomas (2001).

[16]Department of Water Resources (1996b), as discussed in Thomas (2001).

exportation of groundwater out of the valley, not transfers within the region.[17]

Thus, Sacramento Valley counties have put ordinances in place to control two types of behavior, depending on the specific water supply issues they face. In several of the west side counties with limited surface water supplies—Tehama, Shasta, and Yolo—the primary target has been direct groundwater exports by private landholders located alongside conveyance facilities, whatever the ultimate destination.

In a larger set of counties, the key issue is the dichotomy between water districts with senior surface water rights and other users who rely on groundwater. Concerns have focused on the potential for surface water districts to engage in indirect groundwater exports, by pumping more groundwater and selling their surface water. This problem has played out in quite different ways across the region.

In Butte, the controversy went to the ballot box. A coalition of citizens' groups angry with the water transfers sponsored an initiative to give the county fairly sweeping control over groundwater management, including the potential to introduce pump taxes. In reaction, the county farm bureau and local water districts proposed an alternative ballot measure, limiting the scope of county oversight to exports. It was this second measure, supported by greater campaign funding, that voters adopted in the fall 1996 elections. Although the air has cleared in the six years since its passage, the ordinance-by-initiative has left its mark on local water politics.

At the opposite end of the spectrum, Yuba County has avoided the controversy over groundwater substitution altogether thanks to a particular set of institutional conditions. The Yuba County Water Agency (YCWA), the wholesale purveyor to most of the county's agricultural water districts, has the entire county as its service area. All five county supervisors also serve as directors on the agency's board. The agency has adopted a policy of immediate mitigation in the event of any

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[17]The common interpretation has also been that Section 1220 does not apply to indirect groundwater exports via groundwater substitution, hence another argument for county ordinances.

well problems that could be linked to groundwater pumping for transfers.

In the three other counties with significant potential for groundwater and surface water interaction—Colusa, Sutter, and Glenn—this high degree of overlap between county and water district jurisdictions does not exist. Ordinances were proposed as preventive measures to protect local users from harm. In Colusa, the county took the lead with RCRC support, and the ordinance appears to have been passed with little dissension by water districts. In Sutter, county officials proposed an ordinance as early as 1995 or 1996 but have held off on adopting it in response to water district opposition.

Glenn is the only one of the three counties where, as in Butte, the ordinance adoption process reflected a serious disagreement between water users in the county. Although the supervisors unanimously adopted an export ordinance in 1990, a group of groundwater users considered that it did not have the teeth necessary to protect them from potential exports by the large surface water districts on the east side of the county. The group sought a legislatively sanctioned ordinance and succeeded in getting both houses to pass one during the 1992 legislative session.[18] The governor vetoed the bill on the advice of the county's water districts. It took a dramatic change in course by the largest water district, Glenn-Colusa Irrigation District (GCID), to enable a new set of working relations to develop among the county's water users.

Soon after the veto event, an internal management crisis within the district provoked the recall of the entire board and the hiring of new management. With the blessing of the district's new board and the county board of supervisors, one of the new GCID directors took the initiative to organize an ad hoc, countywide water users group. The point of departure for the group was to find ways for the county's different types of water users to coexist in harmony. GCID and some of the other senior surface rights districts recognized that there would be situations where they would be solicited and would want to transfer water south, as during the recent drought. The question was how to

[18]SB 867, the "Glenn County Groundwater Management Act," introduced by Senator Mike Thompson in March 1991 and vetoed by the governor in September 1992.

engage in transfers without harming other local users dependent on groundwater.

After several years of informal meetings, the county board formalized the process and nominated water users representing all the subbasins in the county to a Water Advisory Committee. In the discussions on management alternatives to export restrictions that followed, observers identified two key turning points. First, the irrigation districts came forward with a proposal for a new ordinance emphasizing "safe yield" of the aquifer. This proposal allayed the fears of some parties that there would not be safeguards for protecting the aquifer in the event of groundwater substitution-based transfers.

The question then became how to operationalize the concept of safe yield, which is difficult, if not impossible, to measure directly.[19] With input from DWR's Northern Office, the committee developed the ordinance to follow the concept of "basin management objectives" (BMOs). Under this system, water users in the different subbasins would be responsible for establishing a monitoring system and determining target levels for the aquifer under different water conditions. The target levels (or BMOs) are, in effect, a surrogate measure of safe yield. Exports will be restricted only if they lead to unacceptable groundwater levels as determined by the targets. Significantly, pumping for in-county use can also be limited if problems persist after exports are cut back. The Glenn County supervisors passed the new ordinance in 2000, and the first set of basin management objectives was adopted in 2001. These are subject to revision annually as data-gathering and knowledge improve.[20]

Over this same period, Sacramento County was involved in a similar process, on a much larger scale, to find consensual solutions to its water problems through the Sacramento Water Forum. One outcome has been the creation of a Regional Groundwater Authority to facilitate

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[19]"Safe yield" is generally used to mean a level of groundwater use that will not cause long-term decline of groundwater levels. Its estimation is complicated because records of groundwater extraction are limited and recharge rates are highly variable from one year to the next. See Dudley (2000).

[20]For a discussion of the background leading up to the passage of the new ordinance, see Brown et al. (2001). For details on the basin management objective philosophy and process, see Glenn County (2001) and Fulton and Dudley (n.d.).

groundwater management across a set of water entities.[21] The export ordinance, adopted in 1980, was a response to the 1976–1977 drought and to more general concerns about protecting water rights prevalent in that period. County water officials indicate that for local water management purposes, the Water Forum process has largely supplanted the ordinance. The ordinance, recently transferred from the county code to the statutes of the county water agency, may still be invoked for water exports, however.

Following Glenn's experience, a number of other northern counties are in the early stages of adopting a BMO-based system: Tehama, Modoc, Siskiyou, Lassen, Butte, and Yolo. As with Glenn, this represents the potential for a significant departure from the export-oriented approach of the past. We will return to a discussion of BMOs as a groundwater management alternative in Chapter 7.

San Joaquin Valley: Coping with Overdraft and Surface Water Scarcity

Favorable soils and climate and the availability of water for irrigation have enabled the San Joaquin Valley to become California's leading agricultural region. Historically, irrigation was developed with a heavy reliance on groundwater, as surface supplies were less plentiful than in the north. The availability of imported supplies through the federal and state water projects was a major boon to the valley's agriculture. Part of the motivation for these infrastructure investments was to remediate the problem of groundwater overdraft in the valley. In 1980, most of the valley's groundwater basins were classified as "critical," a result of decades of agricultural pumping in excess of natural recharge rates. All eight counties overlie at least one of these basins (Table 4.2, Figure B.4).

Concern with overdraft has spawned active conjunctive use programs in various parts of the region, whereby water districts take advantage of the higher levels of surface supplies in wet years to recharge the aquifers. The longest-running program of this nature is conducted by the members of the Friant Water Users Association, along the east side of the valley. Overdraft has also provided the opportunity for groundwater

[21] Thomas (2001) and McClurg (2002) provide detailed case studies.

banking. Kern County water districts have been the most active in this area.

Although water tables have improved in some places since 1980 as a result of natural and artificial recharge,[22] the region has been under new pressures because of environmental restrictions on Delta pumping. The reduced supply of imported project water, particularly to the CVP agricultural contractors on the west side of the valley, has been an important factor in the growth of the state's water market. Meanwhile, ensuring adequate water supply for municipal and industrial uses is becoming a bigger issue, as the valley is now one of California's fastest-growing regions. Over the next two decades, its population is expected to grow by 51 percent, or 1.7 million inhabitants.[23] The only region growing faster is the Inland Empire (Riverside and San Bernardino Counties).

Higher populations have also meant that most of the region's counties do not qualify for RCRC; only Madera and Merced are members. Ordinances restricting exports have nevertheless been proposed in six counties and adopted in four. The debates on adoption have been flavored by the problems of overdraft and surface water scarcity.

San Joaquin County put in place an ordinance in 1996 over concerns that groundwater transfers by farmers along the Delta Mendota Canal, in the southwestern portion of the county, had contributed to overdraft of that basin during the early 1990s drought. In the years that followed, ordinances motivated by similar concerns were proposed in Stanislaus, Tulare, and Fresno. In both Stanislaus and Tulare, where the proposals do not appear to have come in reaction to specific transfer activity, water districts successfully argued that they were already engaged in adequate groundwater management practices. In Tulare, most districts are members of the Friant Unit, and there is an active multiparty groundwater management plan linking a number of these.[24] In

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[22]This is the case in Kern County, for instance (Kern County Water Agency, 2002).

[23]Projections are for the period 2000 to 2020. See Hans Johnson (2002).

[24]Deer Creek and Tule River Authority, whose groundwater management plan was introduced in 1995

Stanislaus, several multiparty groundwater management plans and associations were in place at the time of the proposal.[25]

In Fresno, the impetus for an ordinance was an impending permanent transfer of surface water. After prolonged public discussions, the districts managed to gain concessions but not to forestall its passage. At stake was a transfer of CVP contract entitlement from a small water district on the west side of the valley. The Widren Water District had agreed to sell its entire entitlement (just under 3,000 acre-feet) to a real estate developer for a new residential development near the town of Tracy, in San Joaquin County.[26] County officials raised concerns that this agreement might lead to increased groundwater pumping to replace the transferred surface water. Although the amount of water was small, county officials feared that the transfer could set a bad precedent. The Widren deal was blocked, following litigation under CEQA and negotiation, but it convinced the board of supervisors to press for an ordinance to prevent further transfers out of the county.

The Fresno ordinance went through over two dozen formal drafts before adoption. In particular, water districts did not want restrictions on their ability to engage actively in the water market, on which many farmers depended as a supplemental source of supply. The version ultimately adopted in 2000 reflects many of these concerns and makes the Fresno ordinance unique. In addition to the standard exemptions for use by districts with lands in bordering counties, it categorically exempts both water exchanges and temporary transfers. It also provides for a ten-year permit, whereas the other ordinances require renewal every one to three years.

Although the initial impetus for the Fresno case was the potential for groundwater substitution, a number of observers share the view that the ultimate target is to retain existing surface supplies within the county, whether or not substitution is involved. While the Fresno ordinance was being debated, another permanent transfer of entitlement was proposed

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[25]On the east side of the county, two local groundwater associations, including most water districts and municipalities; on the west side, the Northern Delta Mendota Groundwater Basin management plan, including five CVP contractors.

[26]Campbell (2000) provides a detailed discussion of the background to this ordinance.

involving Mercy Springs Water District, a neighbor to Widren. Proposals have also been aired concerning the sale of entitlement from Broadview Water District, in the same area. All three of these districts overlie lands affected by drainage problems, which severely reduce their agricultural productivity and the likelihood of groundwater pumping. If the county attempts to block future transfers of surface entitlement, districts may argue in court that the county is overstepping its authority. However, the net effect of county opposition to transfers so far has been to keep most of the water within the county.[27]

In Madera and Kern, the two remaining counties with ordinances, the reasons for adoption were atypical for this region. The Madera ordinance was introduced to provide the county with oversight for groundwater banking projects. The controversial "Madera Ranch" project that mobilized county residents and officials involved the ranch owner, the U.S. Bureau of Reclamation (USBR), and several Central Valley Project contractors.[28] The project generated widespread county opposition over potential negative effects to local water quality and supply. Some parties also believed that the primary project participants were intentionally withholding information from local stakeholders. Although the Madera ordinance also regulates both direct and indirect groundwater transfers, these are generally not perceived to be major issues in the county. The two surface water districts that are members of the Friant Water Users Association were granted exemptions, as was the City of Madera.

At first glance, the appearance of an export ordinance in Kern County may seem surprising, given the major role water agencies there have played in the development of the state's water market over the past decade. The Kern County Water Agency and districts such as Arvin-Edison Water Storage District, a Friant Unit member, have actively facilitated water exchanges and transfers and have been leaders in the

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[27]There is still no long-term deal concluded for Widren's water, which is transferred annually to other agricultural users in Fresno. Part of the Mercy Springs entitlement will pass over to users in Santa Clara and Santa Cruz Counties, and part will stay in Fresno (see Table A.6). The county is also encouraging prospective Monterey County purchasers of Broadview's water to take only part of the supply.

[28]For case studies, see Campbell (2000) and Thomas (2001).

groundwater banking movement that has already helped ensure dry-year supplies. Closer examination reveals that the ordinance has nothing to do with water management in the San Joaquin Valley part of the county. Rather, the reasons for Kern County's ordinance hearken back to the water marketing concerns in Inyo and Mono.

The southeastern part of Kern overlies the Lahontan Basin, a hydrologic area that also encompasses Inyo and Mono Counties. The ordinance was developed in response to concerns over a proposal by a private water marketing company to buy a former alfalfa ranch overlying the basin and transfer 10,000 acre-feet per year over a 40-year period to the City of Los Angeles through the Los Angeles Aqueduct. In light of the low rainfall and lack of surface water in this desert and foothill area, people worried that Los Angeles would "recreate an Owens Valley in Kern County." Following a stopgap emergency ordinance, a permanent ordinance was rapidly put in place to require environmental review of any groundwater transfer out of the basin. This was passed with the approval of the Kern County Water Agency, and there was never any serious consideration of extending the ordinance to cover the San Joaquin Valley portion of the county.

Only two valley counties, Kings and Merced, have never had formal consideration of export ordinances. One observer suggested that Kings County has not felt the need for one because there is a relatively harmonious atmosphere among water districts, most of which operate with a fairly high level of groundwater monitoring and management. There is, notably, an active multiparty groundwater management plan for users overlying the Tulare Lakebed. Another observer noted that one local agency, the Kings County Water District, has had its own ordinance to prohibit groundwater mining since the 1950s. Like the Yuba County Water Agency, this district has board members who are also county supervisors.

Merced County has benefited from a highly effective water planning approach, spearheaded by the county's two main purveyors—the City of Merced and Merced Irrigation District. In the mid-1980s, dissatisfied with the ten-year planning horizon required by CEQA, the city decided to do a 40-year general plan. The plan raised questions over whether the groundwater system in place would be capable of sustaining the much

larger city of the future. The city began discussions with the irrigation district, and in 1991 the two parties embarked on a regional water supply planning exercise, with considerable input from outside consultants for the modeling work. A Technical Advisory Committee with representatives of county departments, other cities, the large water-using industries, USBR, the regional water quality board, and the state and federal environmental agencies provided regular input into the planning process.

The Merced Basin regional water supply plan was completed in the mid-1990s and provided the basis for a long-term regional conjunctive use program that could meet the basin's needs.[29] Following its release, the two lead agencies spearheaded the development of an AB 3030 groundwater management plan, involving 15 water purveyors in the basin. Founded in 1997, the Merced Area Groundwater Pool Interests, or MAGPI, has a board of directors that meets quarterly and a Basin Advisory Panel involving a wider range of stakeholders that meets monthly. Initially, the group focused on establishing an effective monitoring system for the basin. It has also begun investigating conjunctive use projects in association with the Department of Water Resource's Integrated Storage Investigation program.

This process, both highly participatory and involving a great deal of technical input, has preempted the need for alternative protective mechanisms in Merced County.

Summing Up

A statistical analysis of California's counties suggests that their likelihood of adopting export restrictions varies with economic, water supply, and institutional characteristics. Counties with a higher share of the workforce in agriculture are more likely to impose restrictions. Other key factors are the presence of a groundwater basin designated as "critical" or having "special problems" by the Department of Water Resources in 1980 and membership in the Regional Council of Rural

[29]The water plan was updated in the late 1990s in collaboration with the University of California, in connection with the plans to establish UC Merced.

Counties, an association that has promoted groundwater ordinances since the mid-1990s.

A qualitative review of the reasons for ordinance adoption suggests a strongly regional character to the patterns observed. Many mountain counties have responded to specific threats of long-term groundwater exports from their basins to Nevada and to the Los Angeles region. Ironically, the mitigation settlements for Owens Valley and Mono Lake have kept the threat of new groundwater exports very much alive because of freed-up conveyance capacity in the Los Angeles Aqueduct. The menace of uncontrolled private groundwater pumping for sale to Los Angeles also motivated Kern County's ordinance, which covers only the southeast portion of the county adjacent to Inyo. Elsewhere in the San Joaquin Valley, ordinances have responded to concerns about transfer and banking operations in overdrafted basins and in an overall context of surface water reductions. In the Sacramento Valley, a major issue has been local disparities in the distribution of water rights—notably the ability of senior surface water-rights-holders to engage in groundwater substitution while others risk shortages.

In general, Central Valley counties without ordinances have benefited from greater institutional cohesiveness on water matters. Countywide, umbrella water agencies have played key leadership roles in both Yuba and the San Joaquin Valley portion of Kern County. Elsewhere, substantial efforts have been undertaken to create new institutions. In Merced, an initiative begun by the city and the largest water district in the early 1990s has led to a regional water planning exercise and an active groundwater management plan involving all players overlying the Merced Basin. In Glenn and Sacramento, stakeholder consultation has produced programs to actively manage the groundwater basin. In Glenn's case, this process culminated in the adoption in 2000 of a new county ordinance based on basin management objectives, which has effectively supplanted the export-permitting ordinance on the books since 1990. A number of other counties are now following Glenn's lead.

5. Water Market Effects: Do County Restrictions Have Teeth?

What effects, if any, are county policies having on the state's water market? Because most ordinances address both direct groundwater exports and surface water exports that result in additional groundwater extraction, we might expect significant overall market effects. In counties with restrictions, the only types of transfers not subject to local approval are those involving water held in surface storage (available to few water purveyors), excess surface water (available mainly in very wet years), or water conserved through efficiency gains or land fallowing (available only through investment outlays or forgone crop income). If the ordinances reflect a public view that out-of-county sales from any source should be discouraged, even these types of transfers could be affected. Of course, it is also possible that county restrictions have little practical consequence if enforcement efforts are ineffective.

This chapter assesses the market effects of export restrictions from two angles. First, it draws on information from county-level interviews to evaluate ordinance implementation. This discussion focuses on how the permitting process has worked for out-of-county transfers. Second, it looks at the effects of the restrictions on county water marketing activity, drawing on the database on water transfers presented in Chapter 2.

Export Permitting: A Largely Uncharted Territory

In counties with ordinances restricting exports, those wishing to engage in the restricted activity must obtain a county permit, which invokes review under CEQA. The permit-granting authority—in this case, the county—determines the extent of CEQA review. CEQA obligations can be met with a relatively simple environmental assessment,

if the county is satisfied that the permitted activity is likely to have little or no negative effect, or if adequate provision is made for mitigation. The county can also require a full-scale environmental impact review (EIR), in addition to preliminary studies. Moving from an environmental assessment to an EIR easily increases costs for the applicant by a factor of ten or more, with EIRs typically costing $300,000 or more.

In the years since counties introduced a review process for water exports, there have been few requests for permits and even fewer permits granted. Among the 22 counties with export ordinances, a total of 16 export permit applications have been tendered in four counties: Inyo (12), Mono (2), Tehama (1), and San Joaquin (1).[1] Of the 16 applications, only one has been granted, in Tehama, and four remain actively on file, in Inyo.

Most of the applications from Inyo and Mono have concerned private sector transfers to Los Angeles. The permit granted in Tehama was for the movement of a small quantity of groundwater to land owned by the same farmer in another county. The application in San Joaquin was for the reexport of imported banked groundwater by the East-Bay Municipal Utilities District in 1997.[2] After a protracted review process, the permit was denied in response to concerns about granting a noncounty entity access to the aquifer. A permit for groundwater banking was nearly filed in Madera by a private water firm, Azurix, a partial subsidiary of the Enron Corporation, which intended to pursue the Madera Ranch project that was at the origin of that county's ordinance. Whether Azurix's sale of the property in 2001 without filing

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[1]As noted in Chapter 3, three counties in this group have actively required permitting for some in-county water movements. In San Benito, there were five applications for small residential subdivisions, of which three were approved and two withdrawn. In Sierra County, one permit was granted for a transfer of treated wastewater from an industrial property to adjacent property in agricultural use. In Imperial County, 19 conditional use permits have been granted since 1994 under the well-permitting process instituted in 1972. Recently, Imperial County's Board of Supervisors rejected a groundwater use petition that had been pending for eight years for use on a farm near the San Diego County border. Among reasons for the rejection were apparent concerns that the applicants might subsequently transfer some of the water to the Borrego Water District in the neighboring county (Mitchell, 2003).

[2]For a detailed case study, see Thomas (2001).

was more a result of its own financial problems or the continued local controversy remains a matter of speculation. A broad local coalition of interests was against both the project and the involvement of an outside firm, and popular sentiment was prominently displayed on billboards along Route 99 admonishing Enron/Azurix to stay out of the valley.

In two other counties, those interviewed indicated that permit applications might be on the horizon. In Calaveras, where the ordinance is quite recent, the Calaveras County Water District is investigating a potential conjunctive use project and intends to launch an application if the study confirms the project's viability. In Sacramento, officials anticipate that a groundwater export being considered as part of a water quality mitigation program may trigger a permitting requirement.

The limited permitting experience in counties with export restrictions stands in stark contrast to that of counties whose groundwater protection ordinances were put in place to regulate within-county uses. In San Diego, Napa, and Mendocino, the review process has been active, with numerous approvals granted.[3]

When asked to account for the relative dearth of permitting activity in counties with export restrictions, observers offer three explanations. The first holds that there is little local interest in transferring water outside the county anyway; the ordinance is merely an expression of the popular consensus. The second explanation is that the ordinance may be ineffectual in screening exports that continue to occur. This could arise either through lack of public awareness of the permitting requirement or lack of good surveillance to ensure compliance of those inclined to avoid permitting. The third and most common view holds that the permitting process itself discourages transfers. Up-front costs of environmental review, the likelihood of rejection in places hostile to transfers, and the limited length of time for permits once granted are all cited as deterrents. In a number of counties, officials admit that this "discouragement factor" is at least partially intentional. Legally, counties cannot prohibit exports, but they can make it difficult for potential sellers to obtain approval.

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[3]San Bernardino's ordinance was approved late in 2002, too recently to have established a record on permitting. We were unable to obtain information on the implementation of Monterey's ordinance.

In principle, the information requirements and up-front study costs depend on the hydrological characteristics of the basin and the extent to which a knowledge base has already been established through prior studies. In practice, another consideration is the degree of public confidence in the process. In places where prior experiences have engendered a distrust of water transfers, the up-front requirements are bound to be higher than where there is no particular local history.

A case in point is Butte County, where water officials would like to see a permitting process that effectively screens transfers for third-party effects without blocking the possibility of water marketing. In light of the heated controversy surrounding the adoption of the ordinance, however, it is likely that the first test case would need to go through a full-scale environmental impact review. The cost might be worth it for a long-term transfer program, but it virtually precludes anyone wishing to engage in short-term transfers from applying. Faced with the opportunity to sell water under DWR's dry-year purchase program in 2001, farmers in the Western Canal Water District elected to generate surface water through land fallowing rather than applying for a permit to engage in groundwater substitution. As it happened, rice prices were sufficiently low that year that some farmers found it worthwhile to forgo crop revenues. More generally, it might have been better for all parties to consider groundwater substitution, but the district was effectively prohibited from pursuing that option.

Effects on the Water Market

The Butte example highlights the fact that the ordinances will not always limit trade in water if alternative means such as fallowing are available and acceptable to farmers. Because this will not always be the case, however, ordinances limiting the use of groundwater for transfers could have aggregate effects on the market. These effects would be compounded if the ordinances have a more general dissuasive effect on water exports from any source, which appears to be the intent in some counties.

Aggregate market effects of two types might be expected. In counties where there are willing buyers locally, the ordinances might be expected to shift supply from exports to in-county uses. In counties without local

demand, or where the local demand is more limited than the potential supply, there would be an overall reduction in the volume traded. The alternative prediction—of no effects on the volumes of total transfers and transfers leaving the county—would correspond to a scenario where the ordinances are generally ineffectual.

Data Sources

To examine whether there is evidence of these effects, we will employ the database on water transfers in California presented in Chapter 2.[4] The analysis covers the 12-year period beginning in 1990, the point at which data on counties of origin and destination become more precise. The aim will be to determine the effect of export ordinances on two county-level measures of water trading: annual sales and annual "exports," defined as transfers going to users outside of the county.

We will focus the analysis on two geographical groups. The first is the set of 34 "water trading" counties—counties that appear at least once in the transactions database over the period under review (Figure 5.1). This includes all 18 Central Valley counties, the Southern California region, the inland portion of the San Francisco Bay Area, and San Francisco itself. It excludes the mountain counties and counties along the north and central coast. These nontrading counties are excluded for statistical reasons; the key econometric models cannot be estimated when they are included. Moreover, there may be structural reasons for the lack of trading activity in many of these counties: Counties along the coast and to the far north rely on local river and groundwater sources and are not hydraulically connected to the state's main water arteries. It is possible that some local trades occur in these regions that we have not been able to trace with our sources.

The second geographical group is the set of 18 Central Valley counties. It is interesting to look separately at this region for two reasons. First, Central Valley counties have been the major source of water for the market since the early 1990s. Second, this region has the greatest potential for groundwater-related transfer activity, both through

[4]For a detailed description of data sources and methods used in the analysis, see Appendix D.

Figure 5.1—California's Water-Trading Counties, 1990–2001

groundwater substitution transfers and through groundwater banking.[5] The potential role of groundwater in this region stands in stark contrast to the situation in Imperial County, the other major water supplier. Although Imperial has imposed groundwater export restrictions since

[5]See Purkey et al. (1998) and related work from the Natural Heritage Institute on the potential for groundwater banking in the Central Valley.

1996, these restrictions are unlikely to have much practical influence on the overall volume of water sales. Imperial County has vast quantities of surface water rights from the Colorado River and few areas with usable groundwater.[6]

To see whether the presence of an ordinance affects county trading behavior, it is necessary to control for other factors that might also be important. Multiple regression techniques allow us to isolate the effect of the export restrictions while holding the influence of other factors constant. We have selected a set of seven variables—described in Appendix D—to account for agricultural and residential demand and water supply conditions. In addition, we will test for the effects of state and federal policy changes on the trading environment by including a time trend in the regressions. If the new operating rules are effectively increasing transfer activity, above and beyond what would occur because of changes in the other variables noted above, this variable should be positively related to sales. A time trend also captures the effect of "learning-by-doing" by water users as they gain familiarity with the market.

Results

County regulations have noticeably restricted sales in the statewide market. In any given year, the typical county with an export restriction sold 14,308 acre-feet less than a county without one. The estimated effect on exports is larger—at 16,948 acre-feet—although the difference is not statistically significant. These results suggest that the county restrictions have not only reduced sales but have also resulted in some shifting of water from external to within-county buyers, by an average of 2,640 acre-feet per year. The quantitative effect of export restrictions is even more pronounced when the analysis is restricted to the 18-county Central Valley sample. Holding other factors constant, export ordinances reduce overall sales by 20,789 acre-feet and out-of-county

[6]In large parts of Imperial County, the groundwater is too saline for agricultural uses. Salinity is also a limitation for groundwater use in San Benito County, the other non–Central Valley county within the "trading counties" group that has an export ordinance.

sales by 26,245 acre-feet. The corresponding increase in local sales induced by ordinances is nearly 5,500 acre-feet per county per year.

Since 1996, the point at which a number of counties began to adopt ordinances, the restrictions have reduced exports by 932,000 acre-feet, or 19 percent of all out-of-county sales (Figure 5.2). Of this total, 145,000 acre-feet that would otherwise have been exported have been sold locally. The lion's share (787,000 acre-feet) has simply been kept off the market. In all, this represents a 14 percent reduction compared to the level of predicted sales in the absence of county restrictions. For the Central Valley counties, these effects are even larger: a 39 percent reduction in exports and a 25 percent reduction in overall sales because of restrictive ordinances. The resulting shift from exports to the local market appears to have increased within-county sales by nearly 50 percent.

Meanwhile, state and federal measures to improve the trading environment, as measured by the time trend, have had a substantial positive effect on water sales. The typical county was likely to sell 42,000 acre-feet per year more in 2001 than in 1990, under identical conditions of water supply and agricultural demand. During the first six years analyzed here, the positive effect of state and federal support far outweighed the negative effect of county restrictions (Figure 5.3). As the

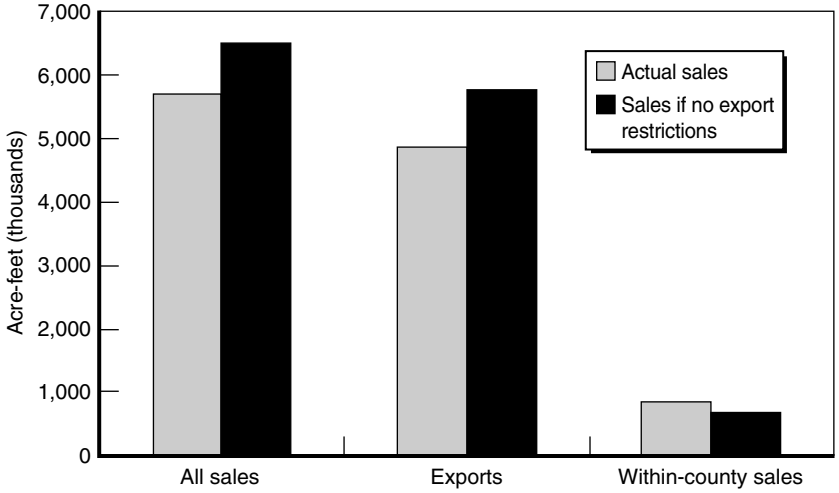

Figure 5.2—Market Effects of Export Restrictions Since 1996

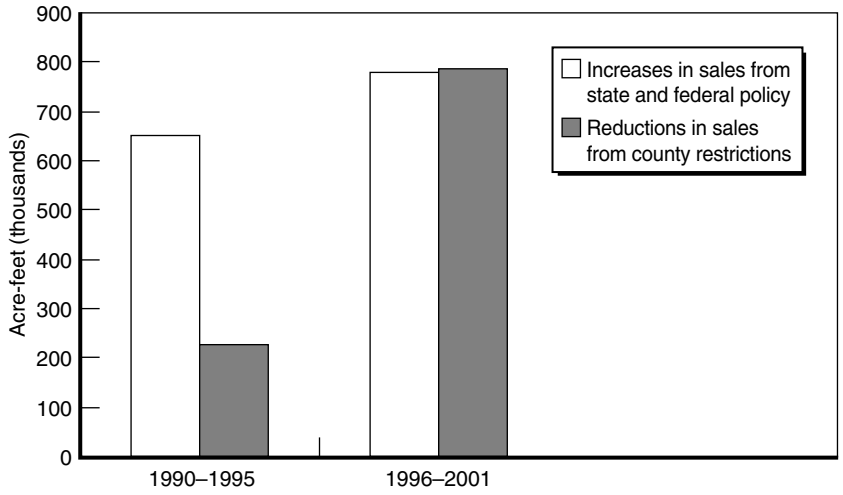

Figure 5.3—Market Effects of State and County Policy Environments

number of counties with restrictions has grown, this has ceased to be the case. From 1996 to 2001, county restrictions cancelled out the positive effect of state and federal policies to encourage trade.

Counties introducing export restrictions may have reduced their trading activity for reasons other than the ones captured in our model. In this case, the strong correlation we observe between ordinances and the reduction in sales and exports would not imply causality. In light of the reasons given for ordinance adoption, however, we regard this as unlikely.

The bigger question is whether the ordinances will continue to wield the same effect in the years ahead. The pending long-term transfers from the agricultural to the municipal contractors of the Colorado River Project, negotiated as part of California's program to reduce its overall use of project water, will substantially increase overall volumes traded statewide. The combined transfers from Imperial Irrigation District to San Diego (200,000 acre-feet), Imperial to Metropolitan Water District of Southern California and Coachella Valley Water District (100,000 acre-feet), and Palo Verde Irrigation District to MWDSC (111,000 acre-feet)—achieved through a combination of land fallowing and efficiency gains—represent over 30 percent of the amount traded in 2001. This

shift of activity by water users in Imperial County, which has an export ordinance, is bound to alter the statistical relationship between trades and county restrictions in the statewide market.[7]

For counties in the Central Valley, the other main source of market supply, nothing on the immediate horizon suggests a weakening of the effect of export restrictions. Some Sacramento Valley observers have suggested, however, that the restrictions could loosen under another major and prolonged drought. With external pressure to make water available, counties may have little choice.

A more positive impetus for change lies in the possibility that counties will move beyond export restrictions to a wider groundwater management system, thereby ensuring protection of local users without discouraging market activity. The Glenn County experience in 2001 indicates how this might work. That year, several of the county's CVP settlement contractors participated in a program to send water to Westlands Water District, using a combination of fallowing and groundwater substitution to free up surface water supplies. The potential groundwater effects of the transfer were monitored through the county's new basin management objectives system as part of the more general monitoring program being established by the county's water users. In conjunction with the export, Glenn-Colusa Irrigation District also made surface water available to some water-short entities within the area, at a lower price.

Summing Up

Have county-level groundwater export restrictions had an effect on the water market? The record on permitting suggests that they have. The very low number of permit applications supports the view that this process is more useful as a deterrent than as a screening mechanism.

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[7]As an indication, we incorporated all pending long-term transfers listed in Table A.5 to the sales and export data for 2001 and reran the regressions for the 34-county sample. With just one year of the new Colorado River Project trades (assumed at full volume), the estimated effect of county restrictions diminishes in size and statistical significance.

High up-front costs and the likelihood of negative public opinion guiding the decision process are factors discouraging parties from filing.

As the recent experience in Butte County demonstrates, a lack of groundwater permits will not necessarily block transfers if alternatives such as fallowing are available and acceptable to farmers. In the aggregate, however, there is likely to be a market effect, both in reducing total sales and in shifting some water to in-county users (who will typically be willing to pay less than outsiders). We find evidence of both effects in a statistical analysis of county trading behavior from 1990 to 2001. In any given year, the presence of an export restriction reduced a county's trades by 14,300 acre-feet and shifted 2,640 acre-feet to in-county buyers. In aggregate terms, this reduced out-of-county sales by 932,000 acre-feet, or 19 percent, and total sales by 787,000 acre-feet, or 14 percent, since 1996. Overall, the negative effect of county restrictions cancelled out the positive effect of a generally improved trading environment resulting from state and federal regulatory changes.

Looking ahead, the key question is whether communities can move beyond an export restriction mode to one combining protection of local users with the flexibility to allow water trading where feasible. In areas where the groundwater effects of trade are the concern, this means establishing systems for monitoring, mitigation, and actively managing the aquifer. Land fallowing, a key alternative source of water for the market, also raises questions of harm to local communities. As the economics of the water market make this an increasingly attractive option for some farmers, there is a need to consider how and when economic mitigation programs will be a necessary component of water transfers. The following chapter addresses this issue.

6. Mitigating the Economic Effects of Land Fallowing

Land fallowing has been the basis for several major water transfer programs in California since the early 1990s and is an integral feature of the active agricultural water market within the San Joaquin Valley. Noncontroversial in some situations, the concept of idling farmland to sell water has generated tremendous conflict in others. At issue are both equity questions and the potential aggregate consequences of fallowing. In this chapter, we address the economic, legal, and institutional issues that fallowing for the water market raises, with a focus on the following questions. Under what circumstances is it important to address the distributional consequences of the transaction? What do we know about the conditions under which fallowing would cause harm to the local economy, and what policy alternatives are available to minimize negative effects? We begin with a review of California's recent experiences with land fallowing for the water market.

California's Recent Experiences with Land Fallowing

DWR's Dry-Year Programs

Fallowing was a major component of the 1991 drought water bank, accounting for 415,000 acre-feet of the 821,000 acre-feet purchased. Most of the contracts were negotiated directly with individual farmers, who were paid not to irrigate and were compensated on the basis of the imputed water savings. In Yolo County, where a substantial part of the fallowing occurred, the board of supervisors took the view that the state, as purchaser, should indemnify the county for the losses it incurred as a result of the decreased economic activity. Notably, the county observed an increase in demands for unemployment-related social services as a consequence of lower farm labor employment. Challenging both the

legality of the claim and the facts on which it was premised, DWR declined to pay the county the modest amount requested.[1] It also cut the fallowing program short. In the 1992 and 1994 banks, water was purchased entirely from surface storage and groundwater exchange.

Over time, however, the Yolo episode has led DWR to approach the fallowing question somewhat differently. When it launched a new trial run with fallowing during its 2001 dry-year program, DWR made arrangements to pay a 5 percent fee ($3.75 per acre-foot) to Butte County to handle the associated mitigation costs of the transfer by Western Canal Water District. As we will discuss below, this raised both practical and legal issues at the county level that are still being worked through. It nevertheless appears that the state's current default position is to compensate for third-party effects of fallowing for its own water purchases. Mitigating the effects of fallowing is also a central focus of the programmatic environmental impact review now under way for the Environmental Water Account, a joint state-federal program.

Long-Term Fallowing Along the Colorado River

The year following the drought water bank experience, MWDSC launched a two-year fallowing program with the Palo Verde Irrigation District (PVID). Under the trial program, the district idled land to free up 93,000 acre-feet of water per year for MWDSC. Encouraged by the outcome, the two parties then developed a long-term transfer arrangement, under which PVID farmers will fallow up to 29 percent of their 91,000 irrigated acres of land, to send up to 111,000 acre-feet annually to the coast. The 35-year transfer was in the final stages of approval by the boards of both agencies in late 2002 and should get under way in 2003. Both the PVID board and area farmers regard the transfer as an opportunity for the area's economy on the grounds that it helps stabilize farm incomes.[2] A $6 million fund has been set aside to

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[1]The bill submitted by the Yolo County Board of Supervisors was for $129,305 to cover general assistance and Aid to Families with Dependent Children entitlements for 450 persons deemed to have lost their employment because of the water transfers (Gray, 1994b).

[2]See "Rural Palo Verde Valley Agrees to Colorado River Pact" (2002) and Lyn Johnson (2002).

compensate the community for potential income losses from lower agricultural activity.

At the same time that Palo Verde farmers and the PVID board were lauding the forthcoming fallowing program in the local press, representatives of the neighboring Imperial Irrigation District (IID) were going on record with their doubts over whether they would vote for a similar program for sending Colorado River water to San Diego. Unlike the Palo Verde deal, the Imperial deal with San Diego has been one of the biggest water controversies in recent California history. Palo Verde's transfer was premised on land fallowing, but this method was essentially imposed on Imperial because environmental constraints precluded the preferred option of conserving water through more efficient irrigation practices. Like some other local agencies, IID had a policy disallowing fallowing as a source for water transfers.

Accordingly, the initial transfer deal, agreed to in 1998 by the IID and San Diego County Water Authority boards, explicitly ruled out fallowing. It was not until early 2002, during the environmental review phase of the transfer, that objections were raised to the efficiency-based method. By reducing the district's agricultural runoff, the irrigation improvements would hasten the increase in salinity levels in the Salton Sea, a major aquatic bird sanctuary along the Pacific flyway. By this time, the transfer had become a linchpin of California's 4.4 Plan to reduce its use of Colorado River water over a 15-year period. Under the threat that the U.S. Secretary of the Interior would immediately reduce California's annual supplies from 5.2 to 4.4 million acre-feet if parties within the state did not reach an agreement by the end of 2002, IID was pressured to consider land fallowing as an alternative means of conserving water for the transfer.[3]

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[3]Technically, the agreement that needed to be reached among California's Colorado River contractors by the end of 2002 is the "Quantification Settlement Agreement," under which the senior agricultural contractors—Palo Verde, Imperial, and Coachella Valley Water District—agree to "quantify" their water rights to a specified amount. Up to now, in the order of seniority, these districts have had the right to any amount of water they can put to beneficial use, within the overall allocation available to the state. The lack of a firm upper limit on use has meant that any transfer deals concluded between any one of the parties and a more junior rights-holder (notably Metropolitan Water District of Southern California and San Diego) would not necessarily result in a reduction of water

Negotiations over this transfer have been extremely complex, in part because the fate of the Salton Sea is uncertain, even without the loss of runoff from Imperial's farms. Created in 1905 when massive river flooding broke through a canal erected by area farmers, the sea has relied on agricultural runoff from the district ever since as its primary source of replenishment. Even without the transfer, the sea is predicted to become too saline to support the fish and other marine life on which the birds feed within one to two decades unless extraordinary actions are taken.[4] So far, the science of the problem has proven elusive, with uncertain proposals involving price tags of about $1 billion or more. As a consequence, one of IID's major concerns in the transfer talks has been to bind its liability limits with respect to the sea's future health.

The other major sticking point has been the fallowing question. Once fallowing became the suggested means of achieving the water savings for the transfer, the deal switched from one that was "win-win" for the district to one involving winners and losers. An efficiency-based transfer program would involve keeping all the land in production while creating local jobs to carry out conservation investments. A fallowing program implies some job losses. The debate over just how many and over what time horizon has been central to the negotiation process. Under the terms of a proposed deal negotiated in October 2002, the new per-acre-foot price to be paid by San Diego includes enough additional money to cover up to $20 million in mitigation funds over 15 years. The maximum annual acreage to be fallowed is 30,000 (of a total of 450,000 irrigable acres in the district). Imperial would be free to switch from fallowing to efficiency-based methods of water savings beginning in year 16. San Diego would agree to cover any excess costs of third-party effects beyond those provided for in the $20 million.[5]

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use by the agricultural contractors. This problem arose with the initial transfer of 110,000 acre-feet from IID to MWDSC begun in 1988 and noted in Chapter 2. The transfer was based on efficiency gains in IID's network, financed by MWDSC. Although the gains were realized (and allocated to MWDSC), IID actually increased its water use in the subsequent period.

[4]See Imperial Irrigation District and U.S. Bureau of Reclamation (2002).

[5]For details of the proposal as per the October 15, 2002, agreement, which has remained the basis of the proposals on fallowing, see "Summary of Water Agreement,"

In sharp contrast to the Palo Verde case, no one in the Imperial Valley has gone on record to praise the deal, except to say that it was the best the negotiators could do in a difficult situation. In the months leading up to the October negotiations, both federal and state authorities had made it clear that the district risked having its water rights challenged in the absence of a successful transfer agreement.[6] In December 2002, IID's board voted 3-2 against the terms of the deal brokered in October. Although the effects of fallowing were cited as one of Imperial's Board's concerns, the "deal-breaker" in the end appeared to be the lack of adequate guarantees against possible lawsuits over environmental effects to the Salton Sea.[7] The fate of the transfer remains uncertain at the time of this writing (May 2003), but the latest proposal brokered by the state involves an additional $200 million in state funds directed to mitigating effects to the Salton Sea.

Fallowing in the San Joaquin Valley

The planned Palo Verde transfer and the possible sale by Imperial are the state's first large long-term water transfers based on land fallowing, but they are not the only places where this is taking place. Fallowing has been a regular feature of the temporary agricultural water market within the San Joaquin Valley since the early 1990s. The district-to-district transfers of this type mainly involve moving water from land owned or leased by the same farmer to more productive, water-short land elsewhere in the valley, notably within Westlands Water District and several neighboring CVP contracting districts.[8] Fallowing, in these contexts, is accepted as part of the farmers' overall land management plans. Water districts allowing this activity do vary, however, in the extent to which they impose conditions on the transfer. In some districts, once the land is leased there are no restrictions on transfers to other lands farmed by the

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October 17, 2002. The maximum amount to be fallowed is not explicitly mentioned in the agreement but has been cited elsewhere by IID directors and others (Vogel, 2002).

[6]See statements by U.S. Interior Department Assistant Secretary Bennett Raley in Kasindorf (2002). For a discussion of state policy, see Kasler (2002).

[7]See Conaughton (2002).

[8]Drainage problems, which are reducing the productivity of some areas within Westlands, have also encouraged land fallowing for water sales within the district.

lessee. For farmers within the Kern County Water Agency service area, a casual lease is not sufficient for gaining the right to transfer the water.

Land retirement was also the basis for the permanent transfer of up to 130,000 acre-feet of State Water Project entitlement from Kern County farmers to municipal users under the Monterey Agreement. Importantly, however, this proposal came about as a way of reallocating water from land that had already come out of production because of marginal economic conditions; it did not precipitate crop idling. Two recent sales of SWP entitlement by Kings County farmers, one to other farmers and one for municipal uses, were also predicated on removing water rights from lands that are becoming unprofitable to farm.[9] Recent proposals by some water users in Kern County would involve a multiyear, rotational fallowing scheme to free up water for municipal users outside the county.[10] Whether and under what conditions such programs are acceptable to the wider community is one of the subjects currently on the table in a countywide review of water transfer policy launched by the Kern County Water Agency.

In the eastern part of the San Francisco Bay Area and in San Joaquin County, several long-term, local agriculture-to-urban transfers also derive some of the water savings from land fallowing or land retirement.[11] Such

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[9]Sales by Tulare Lake Basin Water Storage District to Dudley Ridge Water District (for agriculture) and Antelope Valley–East Kern Water Agency (AVEKWA) (for municipal uses). For details, see Table A.6. Technically, there is no explicit fallowing requirement under the terms of the transfer; rather, lands for which SWP entitlement is sold are permanently disallowed from receiving future SWP entitlements. The transfer to Dudley Ridge involved lands owned by the same farmer; the water will be used in Dudley Ridge where the land is more productive. The transfer to AVEKWA involved lands being taken out of production by a large ranch, which is scaling back operations.

[10]See Semitropic Water Storage District (2002).

[11]This includes the ongoing transfer from Byron-Bethany Irrigation District to Alameda County Flood Control and Water Conservation District, Zone 7 (for which water is made available through temporary fallowing of approximately 600 acres and water savings from 300 acres of land already retired) and the proposed transfer of contract entitlement from the Westside Irrigation District and Banta Carbona Irrigation District to the City of Tracy (made possible by preexisting land retirement). See Tables A.5 and A.6 and the environmental documentation for these transfers (Alameda Flood Control and Water Conservation District Zone-7, 1994, and CH2MHill, 2002a, 2002b).

transfers raise somewhat different issues from the cases where fallowing involves sending water to a distant destination. The selling districts defend the action on the grounds that residential development is in all events encroaching on the area's farmland; the transfers provide a way of lessening costs for the remaining farmers while moving water locally to new uses. Objections, when raised, relate to concerns over the consequences of development within the area, not to an outflow of economic opportunity.[12]

Future Trends?

Recent developments in the Sacramento Valley suggest that fallowing for transfers to points south of the Delta will be an increasingly important component of the water market. As noted, DWR purchased water conserved through fallowing from farmers in Butte County for its 2001 dry-year program. Fallowing was also the primary source of the water for the transfer from CVP settlement contractors in the Sacramento Valley to Westlands in that year.[13] As the fate of the Imperial–San Diego transfer remained uncertain in late 2002, officials of Metropolitan Water District of Southern California—the agency that stands to lose the most water if the state fails to meet the deadline for the 4.4 Agreement—unveiled a plan to purchase 205,000 acre-feet from this same group of senior water-rights-holders in 2003. For this transfer, again primarily based on land fallowing, Metropolitan has proposed to include a $5 per acre into a mitigation fund (5 percent of the $100 per acre-foot price negotiated for the water). Once the details of this one-year deal are worked out, the water districts intend to discuss possible longer-term arrangements combining fallowing and groundwater

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[12]For instance, the Sierra Club has taken issue with the pending sales to Tracy on grounds that they encourage sprawl (Cooper, 2002).

[13]Participants in the program included Glenn-Colusa Irrigation District, Princeton-Codora-Glenn Irrigation District, Provident Irrigation District, Reclamation Districts 108 and 1004, several mutual water companies, and private farms with individual CVP contracts. Of a total of 160,000 acre-feet, 91,000 acre-feet were made available through fallowing, corresponding to approximately 27,500 acres.

substitution. The fallowing is concentrated on acreage planted to rice, for which prices are at historical lows.[14]

Thus, we see diverse local reactions to the prospect of fallowing and to mitigation. So far, the only substantial mitigation programs envisaged are for the two large long-term transfers of Colorado River water and for temporary purchases by two big buyers—the state itself and the largest urban water agency. There is, as yet, no real track record on either the consequences of a long-term fallowing program or the "how-to" of mitigation. Before turning to some of the practical questions of designing programs to limit negative effects, we examine briefly the economic and legal issues of fallowing for water transfers.

Economic and Legal Issues of Land Fallowing for Water Sales

Economic Incentives and Third-Party Effects

From the seller's standpoint, fallowing to free up water for the market is likely to be most attractive, the higher the sale price of water and the lower the value of the water in agricultural uses. This is why short-term land fallowing is often seen as flexible tool for coping with drought conditions. At such times, water will fetch a better market price, thus compensating farmers for forgoing their own use. It is also why longer-term fallowing programs for sale to municipal users may be appealing to some farmers, because the municipal market can generally afford to pay a higher price than can other agricultural users.

The incentive structure for individual farmers will depend critically on the rules established by the local water district. In some situations, the bulk of the proceeds will go directly to the farmer who is idling land. In a surprising number of cases, however, the proceeds remain at the district level and go toward keeping down costs to other users. This was

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[14]See Economic Research Service (2002). Changes in the U.S. farm support programs since the second half of the 1990s have also made it more attractive to fallow when farm prices are low. Under current programs, farmers of commodities eligible for price support (notably rice and cotton in California) are paid on the basis of historical acreage rather than current acreage. As a result, they are not penalized for idling the land to make the water available for the market.

the procedure for the Monterey Agreement transfers in Kern County, as well as the transfer in the Bay Area noted above. Without a change in operating rules, this redistribution would also occur in the many districts that do not attribute specific contract amounts to individual landowners but rather deliver water on the basis of annual requests.[15] The attraction of "farming water" instead of farming land is clearly greater when individuals, and not districts, stand to benefit from the sale.

From the standpoint of the surrounding community, the effects of a fallowing operation will depend on the interaction of two types of effects. On the one hand, there are the effects of the changes in land use on on-farm and farm-related employment, tax revenues, and, indirectly, the wider economic activity of the area. On the other hand, there are the proceeds of the water sale, which, if spent locally, contribute to job and revenue creation. Thus the aggregate effect of a water sale achieved through a reduction in cropland is not necessarily negative, even in the short run. If, as is typically assumed, farmers elect to fallow the low-value crops—which produce less profit per unit of water used and which require relatively lower labor inputs—the associated employment and revenue reductions will be limited. If, at the same time, they reinvest proceeds of the water sales into farming operations, for instance, by re-leveling the land or making upgrades in equipment, this reinvestment can have a positive effect on employment and revenues.

Typically, however, there are some losers from land fallowing, even in a generally positive scenario such as the one described. The new investments in land leveling or other farm improvements will give a boost to those sectors, whereas the fall in crop output will reduce the demand for specialized services such as harvesting and processing and, in all likelihood, some farm labor. This is why the notion of mitigation enters the equation. Mitigation is envisaged both as a short-term compensation for income losses and as a means of assisting those who may be permanently affected by a long-term water transfer to adjust to the new economic circumstances.

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[15]For instance, Yolo County Flood Control and Water Conservation District and Madera Irrigation District.

Nevertheless, mitigation for land fallowing poses some distinct economic, legal, and policy questions. The negative effect on those who lose out is an economic spillover effect, or what economists sometimes refer to as a "pecuniary externality"—the effect of one person's business decision on someone else's financial outcome. This stands in contrast to a "physical externality," which occurs when a water transfer negatively affects the quantity or quality of the physical resource available to other users. From the standpoint of economic theory, a transfer that results in a negative physical externality requires compensation. Compensation helps to ensure a socially efficient outcome by preventing overuse of the resource. By contrast, there are no efficiency grounds for compensating those affected by a pecuniary externality. Rather, the issue is one of equitable distribution of the benefits (Howe et al., 1990, Howitt, 1994).

Lack of Legal Provisions for Mitigation

The legal issues raised by the two types of effects are also quite distinct. There is a legal tradition for protecting third parties from the negative physical externalities associated with business decisions. In California, the no-injury provisions of state water law, established in case law as early as 1862, specifically aim to prevent negative physical effects on other water users, including wildlife.[16] However, there is no clear legal tradition for protecting individuals from the effects on their livelihood of a change in other people's business decisions—and this is what compensation for the economic effects of land fallowing implies.

At the federal level, exceptions arise when a region or sector is negatively affected by a policy change considered beneficial for society as a whole. Notably, national programs have been available since the early 1960s to assist workers in industries affected by trade liberalization, and special regional programs were introduced in the 1970s to assist forestry workers affected by the expansion of national park areas in the western states.[17] More generally, federal, state, and local governments provide

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[16]The no-injury rule was established in the court case *Butte T. M. Co. v. Morgan,* 19 Cal. 609 (Gray, 1994a). The environmental protections for fish, wildlife, and instream beneficial uses were codified in Cal. Water Code Section 1738 in 1980.

[17]See Appendix F in Illingworth et al. (2002).

transitional assistance to workers facing negative economic conditions through unemployment insurance and other social programs.

In California, the only legal provision for protecting communities from the economic effects of water transfers is found in the wheeling statute of the Water Code (Sections 1810–12), introduced in 1986. Under this statute, the transport of water through public conveyance facilities must be done "without unreasonably affecting the overall economy of the environment of the county from which the water is being transferred." To date, these protections have not been invoked. In effect, it is difficult to demonstrate that fallowing programs pass the (admittedly vague) unreasonable effect test. Available studies suggest that fallowing programs would need to be considerably more extensive than those in recent years to have significant negative county-level effects (Table 6.1).

The studies, which examine the effects of fallowing anywhere from 6 to 25 percent of a county's irrigated farmland, find that it is likely to have no more than a 1 percent effect on overall county economic activity, even when the payments to farmers for the water transfers are excluded. This level was exceeded in only two counties—Colusa and Glenn—in a study simulating the effects of a 25 percent cut in surface water supplies (with no revenues for water sold). A 22 percent reduction in land farmed in the Palo Verde area under the test program had insignificant effects on income within that limited region, a result that is also anticipated even if farmers engage in maximum fallowing (29 percent of total acreage) under the upcoming long-term program.

However, the same studies also demonstrate that there can be significant localized negative effects on individual farm workers and businesses and on local public agencies such as school districts. Thus, there may be ethical grounds for devising mitigation programs, even when a transfer does not trigger the legal requirement to do so. The case for mitigation is stronger when the transfer has negative distributional implications—a concentration of losses to low-income farm workers and processing plant laborers and accrual of most benefits to the relatively wealthy members of the community (or, in the case of absentee landlords, nonmembers). Given the structure of California's agricultural economy, where wages are low, unemployment rates high, and large

Table 6.1

Study Estimates of the Overall Economic Effect of Land Fallowing

Study Area and Subject	Authors	Acres and % of County Farmland Fallowed	County Job Losses	Regional or Sectoral Income Losses	Overall County Income Losses
1991 drought water bank (11 counties)	Dixon et al. (1993)			2–3% of agricultural income	<1%
1991 drought water bank (Yolo and Solano)	Howitt (1994)	Solano: 23,500 acres (13%) Yolo: 45,700 acres (13%)	4.7% (model) 1.5% (survey) (farm job loss, both counties)	Solano: 3.2% gross agricultural income Yolo: 5% gross agricultural income	<1%[a]
1992–1993 Palo Verde Test Fallowing Program	M. Cubed (1994)	20,215 acres (22% of region's farmland)	1.3% regional job loss	Negligible regional income effects	Negligible
2003–2038 Palo Verde Long-Term Program	M. Cubed (2002)	26,500 acres (29% of region's farmland (program maximum)	<2% regional job loss	<1% regional income	Negligible
Irrigation water cuts in Sacramento Valley (8 counties)[b]	Lee et al. (1999)	25% surface supply cut, no replacement with groundwater (4.5% to 6.2% fall in acreage)	305 jobs (8 counties)		Colusa: 5% Glenn: 2.5% 5 other counties: 0.5% Sacramento: negligible
Proposed Westlands land retirement	Illingworth et al. (2002)	100,000 acres (6%)	<1% (Fresno and Kings)		<1% (Fresno and Kings)

[a]Value was estimated by author, using Bureau of Economic Analysis data on agriculture's share in total county income.

[b]This study assumed no payments for water transferred, only a cut in supply.

proportions of the workforce belong to minority groups, it has become common to consider this question under the general rubric of "environmental justice."

Because water is a public resource, and water marketing a policy tool of the state, some scholars have argued that mitigation of the distributional consequences of fallowing should be an integral part of the transfer process (Sax, 1994; Howe, 2000). In this spirit, legislation to provide mitigation funds for third-party effects of water transfers has been introduced on three occasions since 1998 and most recently in the 2002 session. The first, AB 2027, proposed a task force to review third-party effects of long-term water transfers and provide specific recommendations for partial or full mitigation. AB 732, introduced in February 1999, provided, in addition, for the creation of county water transfer management plans to be used to identify and mitigate effects of water transfers of any duration. The most recent bill, SB 1993, returned the focus to long-term transfers. It proposed requiring an economic analysis report for effects on the county of origin and a binding letter of commitment for a community mitigation fee ($1 per acre-foot or $5 per acre-foot if fallowing is involved) and the establishment of an independent board to distribute mitigation funds. Although a diverse set of groups has lent support to the idea of institutionalizing treatment of third-party effects—including the California Farm Bureau, the United Farm Workers, and Metropolitan Water District of Southern California—there has as yet been insufficient legislative backing.

Whether or not communities have a legal right to it, some form of mitigation may be the only way to make a transfer program acceptable to them. A substantial mitigation program would no doubt have been required for the county to accept continued fallowing-based purchases in Yolo after 1991. The mitigation fund has become a cornerstone of the negotiations for the transfer from Imperial Irrigation District to San Diego.

Are Landowner-Run Water Districts More Likely to Fallow (and Less Likely to Propose Mitigation)?

Water districts appear to differ in both fallowing policies and mitigation demands, depending on their governance structure. In California, these special districts have two basic forms of governance. In

popular-vote districts, the entire community residing within the service area elects the board of directors. In landowner-run districts, voting is restricted to landowners, usually in proportion to assessed land values. Most of the fallowing-based transfers on record to date have been agreed to by landowner-run water districts, privately run mutual water companies, or individual farmers.

The notable exception is Imperial Irrigation District's pending transfer to San Diego. Districts such as Imperial, whose boards are elected by popular vote, appear less likely to entertain fallowing as an option. If the recent experience with Imperial is indicative, such districts may also devote more attention to the community effects if encouraged or pressured to fallow.[18] In landowner-run Palo Verde, for a similar level of acreage set-asides, over 35 years instead of 15, the fund is considerably more modest ($6 million compared to $20 million-plus).[19] It was the buyer, Metropolitan Water District, that made the initial offer to establish the fund.

This is not to suggest that landowner-run districts are uninterested in maintaining the health of the agricultural economy. Indeed, a statistical analysis of the likelihood of water transfers by Central Valley water districts and mutual water companies, not reported here, suggests that overall, landowner-run districts have been less likely to transfer water (from any source) than popularly run districts. However, these districts may be less constrained by community opinion if fallowing makes economic sense for the farmers. By virtue of their governance structure, landowner-run districts will not have a built-in pressure to consider mitigation of the third-party effects of fallowing.

These different reactions go to the heart of the policy debate concerning mitigation. By historical accident, water rights and

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[18]In Imperial, area farmers have become concerned that the board does not sufficiently take their views on the transfer into account and have formed their own group to make their voice heard—the Imperial Valley Water Users Association.

[19]For Palo Verde, where the total amount transferred over 35 years will range from 875,000 to 3.9 million acre-feet, this translates to somewhere between $1.50 and $6.80 per acre-foot for the fund. For Imperial, the comparable figure is $14 per acre-foot, for 1 million acre-feet transferred to San Diego, plus 400,000–500,000 acre-feet of flows into the Salton Sea.

entitlements are held in community trust in some areas, in landowner hands in others. Should it be left entirely to the discretion of local agencies to decide whether to deal with the third-party effects of land fallowing? Or should a principle be established whereby communities as a whole are assured of deriving some benefit from a water sale, regardless of how the water rights are held?

Underlying the debate is a nexus of legal and practical questions concerning the appropriateness and the feasibility of mitigation. Farmers correctly point out that they are entirely free to reduce crop acreage for business reasons; many are loathe to see the rules of the game completely altered just because they receive compensation for the unused water instead of simply abandoning it. There is also a concern that institutionalizing mitigation may create unreasonable expectations on the part of the community: Once the principle of mitigation is established, some parties will claim damages, even if the actual effect of the transfer is negligible. In this respect, some point to the IID–San Diego negotiations as an example of community control gone haywire, where exaggerated fears about negative third-party effects may end up blocking a deal that could benefit residents of Imperial County and the state as a whole.

In considering policy alternatives, two sets of issues must be kept in mind. The first concerns the design of the fallowing program itself. Both the scale of a program and its content will influence the extent of effects on the local economy: how many acres fallowed, which crops, in which locations? The second concerns the design of mitigation programs to benefit the community. Here, too, there are questions of size and content: How much is enough, who should benefit, who should manage the funds?

Limiting the Aggregate Negative Effects of Land Fallowing

One key objection to fallowing is that the sheer size of the program could provoke a general economic decline in the region. The concerns stem from two characteristics of most agricultural economies. Agriculture benefits from what economists call "network externalities"—

the average costs of running input services and output marketing systems tend to be lower the greater the number of market participants. If substantial quantities of land go out of production in conjunction with a water sale, this can drive up the costs of doing business for everyone else and eventually drive them out. Agriculture also tends to have assets that are not easily converted to other economic uses. If agriculture moves out, it is not clear that some other business will move in quickly to take advantage of the assets.

These reasons highlight why local transfers of water from agriculture to urban uses are less problematic than transfers to distant destinations. If the transfer is responding to local economic growth, the concerns will be with the details of that process rather than with the potential aggregate consequences for the region's economic well-being.

The oft-cited example of the economy-killing transfer is the Owens Valley deal with Los Angeles in the early 20th century. Although technically a land sale rather than a land fallowing program, this transfer had precisely the kind of spiraling cost implications that drove nonsellers out of business (Hundley, 2001). Remote and with few assets to attract alternative business activities, the economy virtually shut down when agriculture departed. The area's more recent incarnation as a natural-resource-based resort area for coastal urban dwellers offers little consolation to those in active agricultural regions who fear the consequences of "farming water" instead of farming land.

The potential for a fallowing program to be oversized is well recognized, even though there are no hard and fast rules for identifying the threshold points. Since 1992, the state has applied a legal rule of thumb. Section 1745.05 of the California Water Code contains a provision limiting fallowing-based transfers to 20 percent of the total water supply in the seller's area in any given year. Before exceeding this amount, the contracting agency must conduct a public hearing. This threshold falls within the range of actual and proposed fallowing programs (Table 6.1), which have been estimated not to generate significant negative consequences for the local economies.

In part, this conclusion derives from the way fallowing is undertaken. For a given program size (measured in number of acres or percentage of total cropland), the content of the program matters. Crop

choice affects local employment and revenues. Whether land is kept in rotation or simply retired affects the ability to recover the land for agricultural uses in the future. To a large extent, the economics of fallowing will naturally encourage farmers to make the choices that are simultaneously best for themselves and the local economy. Notably, the incentives will generally be to maintain higher-value crops, which generate higher returns per unit of water used.[20] Such crops also have higher labor requirements and frequently higher potential for value-added activities through processing and handling. Likewise, farmers who wish to maintain their land capital will automatically choose to protect the resource by rotating idled land.

It is, nevertheless, reasonable to expect that fallowing programs should impose some rules to minimize the negative effects on the local economy. This can include incentives to maintain economic ties to the land, such as limits on total amount fallowed by any individual farmer, rotation requirements, and upkeep requirements for idled land. Such provisions now appear to be a standard element of long-term fallowing programs, as evidenced by the terms of the Palo Verde agreement as well as proposals currently on the table in Kern County. Likewise, districts that will be involved in intermittent fallowing in the Sacramento Valley plan to rotate the participating lands and farmers from one year to the next, while keeping overall levels fallowed within historical variations in irrigated acreage.

A more contentious issue, from a farmer's standpoint, is whether fallowing programs should also include guidelines on cropping choices. In the draft agreement for the Imperial to San Diego transfer, where significant differences in damage assessment are linked to assumptions about crop choice, IID would undertake to "exercise best efforts to minimize socioeconomic effects attributable to land that will be fallowed."[21] In principle, this could include some form of cropping guidelines.

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[20]Under both the drought water bank and the Palo Verde test program, most crops retired were low-value, high water users: rice, corn, alfalfa, wheat, and sudan grass (Howitt, 1994; M. Cubed, 1994). The fallowing programs in the Sacramento Valley in 2001 and proposed for 2003 mainly concern rice.

[21]Summary term sheet, October 15, 2002.

Putting Together a Viable Mitigation Program

Whether motivated on grounds of fairness or pragmatism, the practical issues of putting a mitigation program in place may determine what is feasible. In theory, the gains from trade make it possible to compensate those who lose out with part of the proceeds of a transaction. In practice, it can be difficult to determine the level of losses, to identify those affected, and to set up a cost-effective system for providing appropriate benefits. Economists refer to these information- and administration-related costs as "transactions costs." Finding ways to keep transactions costs down is a key design challenge for mitigation programs.

Determining the Scale of Losses

Abstracting for the moment from the question of actual program administration, consider the issues involved in establishing levels of loss and identifying potential program beneficiaries. Costs of a fallowing program can be broken down into three categories: the "direct" effects, the "indirect" effects, and the "induced" effects. The direct effects are, as the name implies, the reductions in employment and revenues directly associated with the reduction in farm activity: reduced incomes for the farmers themselves and farm workers. The indirect effects capture the lost income for those who do business with the farm community, as a result of decreased purchases of goods and services for farming. These include both specialized suppliers (e.g., farm equipment suppliers and agro-processing units) and general suppliers (e.g., gas stations and transporters). Finally, the induced or spillover effects capture the general effects on the local economy of reduced expenditures by households and other institutions that have lost farm income or income from related goods and services. The effects at this stage are the most widespread—touching general-purpose businesses and the government sector (local public agencies)—as spending is reduced and tax revenues decline. The combination of all three effects reflects the "multiplier effect," whereby the overall effect of a change in economic activity is greater than the initial effect.[22]

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[22]Depending on the crop and the structure of the local economy, county-level multiplier effects for agriculture are estimated to range from a low of 1.5 to a high of 2.5 (Lee et al., 1999).

Attaching numbers to these categories can be done only with an economic model, drawing on a combination of statistical information and assumptions about how farmers and other agents behave. Key assumptions include which crops farmers will chose to idle (affecting both direct on-farm employment and indirect crop-related services), a function of expectations of future commodity prices and input costs. As noted above, the extent to which farmers reinvest the proceeds of the water sale locally is also vital to the net economic effect, and this level cannot be known with certainty ahead of time. As a result, there is room for debate over the economic effects of a land fallowing operation.

In the absence of an objective price tag, determining the size of a mitigation program may be a matter for negotiation; witness the IID–San Diego transfer. When asked to account for the different views of the two parties on the economic costs of fallowing, the General Manager of the San Diego County Water Authority explained that this arose because, "IID and SDCWA use different economists" (Mitchell, 2002). For smaller or temporary transfers, the question is whether it makes sense to invest in the estimation of economic models or to apply some rules of thumb, such as the "5 percent" rule that served as a basis for DWR's payments to Butte County for fallowing purchases in 2001 and by MWDSC in the upcoming Sacramento Valley deal.

Program Content: Targeted or General?

The direct, indirect, and induced effects categories are also useful for thinking about the contents of a mitigation program. The most concentrated effects are likely to be felt at the first two levels: farm workers and certain specialized farm suppliers. Unless the program is implemented with a strong geographical bias—usually avoidable through program design—the induced effects on the local economy are likely to be more spread out.[23]

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[23]Howitt (1994) found that negative economic effects in Yolo during the drought water bank were amplified by the fact that land fallowing was heavily concentrated in certain areas. In the land retirement program being considered for Westlands Water District as a solution to drainage problems, geographically concentrated effects on the local economy are anticipated because of the location of the drainage-affected lands (Illingworth et al., 2002).

The distribution of effects can help guide decisions on the appropriate mix of targeted and general assistance. Elsewhere, targeted assistance programs have included direct income supplements, job search and training programs for laid-off workers, and business support programs for enterprises.[24] General assistance might take the form of measures to improve the economic environment of the area, for example, infrastructure investments or reduced sales taxes, or might support specific projects of benefit to area residents.

The strongest case for targeting is when the fallowing program will result in long-term shifts in the demand for sector-specific labor. Some types of adjustment assistance may be warranted to help affected workers make the transition to other sectors locally (or to other geographical areas where there is more work in their sector). In keeping with the equity objectives of mitigation, targeted assistance would be especially appropriate in situations where the main group is low-income rural workers. The key challenge will be to design effective programs to benefit this population, which generally has limited English-language abilities and low levels of formal education. To help people move into new sectors, these programs are likely to require considerable attention to remedial skill development.

In principle, targeted assistance programs could also be considered for short-term fallowing transfers. In such situations, for which transitional programs are presumably less relevant, the focus naturally turns to the merits of a claims-based system. A mitigation program could, in theory, provide cash compensation to those whose business activity temporarily suffers. However, there are serious practical obstacles to implementing a claims-based program effectively. The costs of administration (establishing decision rules on who can claim and processing the claims) are likely to be high relative to the amounts available for mitigation. Because there is no well-established basis for claims of this sort (in contrast to unemployment benefits, for instance), there is also a risk that the volume of claims would be excessive. From an environmental justice standpoint, concerns have also been raised that a

[24]See Appendix F in Illingworth et al. (2002).

claims process is more likely to favor the more articulate, better-off groups—for instance, fertilizer suppliers and crop-dusting pilots—rather than ordinary workers. As a result, a claims-based program risks sowing more local discontent than harmony. At the same time, introducing a claims process opens a legal can of worms, because it implies liability for economic damage. For these reasons, some form of general assistance is probably more appropriate for temporary mitigation programs.

More generally, development of new economic opportunities within California's rural counties may require attention to improving investment incentives. It is unlikely that the resources available in a transfer mitigation fund would be adequate to this task.[25]

Program Administration: Counties or Special Institutions?

Who should administer mitigation programs? The arrangements for the sizable, high-profile IID–San Diego program are elaborate and involve a large number of players. The agreement negotiated in October 2002 provides that IID establish a "local entity" for this purpose, in consultation with Imperial County and other state and local interests. A team of economists representing both IID and San Diego would establish methods for estimating and monitoring third-party effects. The mitigation plan would be developed in consultation with no less than three state agencies: the Resources Agency, the Technology, Trade and Commerce Agency, and the Department of Finance. Disputes concerning funding, disbursements, or measurements related to socioeconomic effects would be resolved through binding arbitration.

In Palo Verde's case, an ad hoc committee, involving representatives from both water districts (PVID and MWDSC) and community leaders, is developing the arrangements for implementation. It is anticipated that the committee to be established for actual program administration will work with a local nongovernmental community organization.[26] For its

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[25]In the context of the transfer to San Diego, representatives from Imperial Valley have raised questions about more general public investment support, for instance, the location within the county of a cargo airport and a new campus for San Diego State University (Yniguez, 2002).

[26]Personal communication, Ed Smith, Palo Verde Irrigation District, November 2002.

trial run with mitigation for fallowing by a water district located mainly in Butte County, DWR designated the county government to receive the funds and to decide what to do with them. For the pending transfer from Sacramento Valley water districts to Metropolitan, a similar approach is being taken, although some districts have indicated that they prefer to administer the funds themselves rather than turn them over to the county.

Butte County's reaction to DWR's proposal in 2001 highlights some key practical issues that arise regarding the design of mitigation programs. The amount of funds involved is modest—just under $63,000, corresponding to the one-time fallowing of just over 5,000 acres of rice lands (under 3 percent of the county's nonrange farmland). Although not averse to the principle of administering a mitigation fund, the county declined to accept DWR's initial proposal.[27] In effect, the county had no basis for knowing whether the funds would be adequate to cover actual damages and did not want to accept responsibility (and any implied liability) for mitigation under those circumstances. The funds will instead go toward a detailed study of the third-party effects of the fallowing operation by a consultant of the county's choice. The results may establish a basis for handling fallowing-related mitigation in future years.

In this situation, DWR's choice to select the county as the administering entity was probably a good one. The level of resources involved certainly does not justify the creation of a specific local entity, and the county is probably the more appropriate entity for responding to third-party effects than the water district that sold the water, a landowner-run district with no mechanisms in place for community outreach. Likewise, counties are probably an appropriate level of administration within the Sacramento Valley and all but the largest San Joaquin Valley counties. A county-level administration would be problematic in cases such as Palo Verde, where the region is isolated from the county seat.

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[27]Personal communication, Vickie Newlin and Ed Craddock, Butte County Department of Water and Resource Conservation, August 2002.

"Mitigation" or Community Development?

A local administrative capability can, in principle, reduce the transaction costs of mitigation. But the Butte experience—and the current discussions on how to manage a fund in the upcoming transfer from Sacramento Valley water districts to Metropolitan—also highlight the need for clarity on several unresolved practical issues, particularly with respect to short-term transfers. How much mitigation is enough? What guidelines should be adopted for deciding how to use the funds?

Given the practical and legal complexities inherent in instituting a claims-based program, we have argued that it is more appropriate to consider general assistance programs for short-term transfers. This greatly simplifies the process, reducing the need for certainty on actual costs and the administrative burden of handling claims. The question nevertheless remains of how to spend the funds. Water districts are adamant that the funds—which ultimately come off the top of the transfer price they receive—should not simply go into the "black hole" of county coffers to support general operating expenses.

It is also unclear that it would be appropriate to direct the funds to the county's social program budget, which finances general assistance programs and the county's (relatively small) share of state and federal programs for individuals and families in difficulty. Although this was the basis for Yolo County's request for mitigation in the early 1990s, observers in both Butte and Glenn Counties now consider that the current rice fallowing programs are unlikely to increase the caseloads for county social programs. Given the highly mechanized nature of planting and harvesting the crop, and the fact that farmers are generally making improvements on their idled acreage, the primary anticipated effect is a shift in demand for agricultural services (more leveling and less aerial application of seeds and chemicals) rather than a reduction in farm labor. It is possible, of course, that the reduced business in these sectors has generated some layoffs of low-income workers, thereby increasing county social program expenditures. The detailed study of the local effects of fallowing commissioned by Butte County will provide valuable insights on this matter, both for Butte and for neighboring counties.

An alternative proposal that appears to be gaining popularity, at least within water circles, is to earmark the funds for the development of county water management programs. The development of monitoring and evaluation activities generates considerable financial costs, for which local funding sources are limited. Although in some respects this type of program might most directly benefit water districts and their members, this use of funds could also be justified as providing general benefit to the residents of the county.

Of course, other programs of a quite different nature could be selected for support—for instance, adult education, computer literacy, and youth programs. In such cases, the responsibility for program execution could be devolved to the appropriate local entity.

As these examples illustrate, a mitigation fund generated through water transfers can be used for a range of activities that provide general benefit to community residents in addition to more targeted support to individuals in affected sectors. In light of the legal concerns over the introduction of a claims process, as well as the likelihood that such a program may generate expectations that cannot reasonably be met, some observers have suggested a shift in thinking about the concept itself. Instead of "mitigation," which implies economic harm that needs to be redressed, it might be better to think in terms of "community development." From this perspective, there is an opportunity for the wider community to benefit from the proceeds of a fallowing-based water transfer, irrespective of the voting rules of the water agency and without the presumption that farmers are causing harm by participating in the water market.

Summing Up

Water conserved through land fallowing has been an important component of the state's water market since the early 1990s. On a temporary basis, fallowing was used extensively for drought-related transfers in 1991 and has reemerged as a source of supply from the Sacramento Valley since 2001. It is a regular feature of the short-term agricultural water market within the San Joaquin Valley. Increasingly, rotational fallowing is being considered as a basis for long-term transfers

from agriculture to municipal users, with one large program scheduled to begin in 2003 and another under consideration.

Fallowing of low value, water-intensive crops can provide hydrologic flexibility to the state's water system and financial flexibility to farmers. Nonetheless, there are potential negative effects on the wider community in farming areas. State law provides local communities with a safeguard on the scale of fallowing programs by requiring a public review if more than 20 percent of water for a transfer is to come from crop idling. There is no institutionalized mechanism for compensating communities for losses of jobs, incomes, and tax revenues resulting from crop idling. Although these effects appear to be small when viewed in the aggregate—for instance, as a share of county economic activity—they can be important for some groups.

From a policy perspective, there is a need to determine whether mitigation of the community effects of fallowing should remain an ad hoc process—determined strictly on the basis of negotiations between buyer and seller—or should become a legal obligation, as has been proposed in recent bills to the state legislature. The advantage of maintaining the status quo is flexibility. There may well be situations where the likely effects are minimal or where there is little community demand for mitigation. The argument in favor of institutionalizing the process is that it establishes some ground rules to be followed even when the community has no voice in transfer negotiations. It appears that landowner-run districts have been more likely to consider fallowing and less likely to seek out mitigation programs than districts whose boards are popularly elected. To date, the key proponents of mitigation have instead been two large buyers, the state itself and the largest municipal water agency.

Whether the process remains ad hoc or becomes institutionalized, it will be important to clarify the terms and conditions under which mitigation should be provided. For long-term transfers involving significant amounts of fallowing, the potential socioeconomic effects merit specific study and review before the transfer begins, in parallel fashion to the review of potential environmental consequences required under the California Environmental Quality Act. Long-term transfers are also those where some form of adjustment assistance for displaced

workers and affected communities is most warranted. For short-term transfers, the up-front study costs are too great (in time and money) to merit a full socioeconomic impact study each time there is a proposed fallowing arrangement. It may be preferable to establish some rules of thumb on mitigation amounts, based on a broad-level assessment of likely effects.

There are both legal and practical reasons for avoiding a program of direct compensation of individuals or firms, especially with respect to short-term transfers. Costs of administering a claims-based program could quickly mount, and requests are likely to exceed available resources. A claims-based program also implies liability for economic harm caused by a business decision, which is a break with U.S. legal tradition. Indeed, the very use of the term "mitigation" for land fallowing may be somewhat of a red flag, simultaneously suggesting liability and raising unrealistic expectations about the benefits that a community may expect to gain from a transfer. For this reason, it may be preferable to think in terms of transfer-related community development, with funds allocated to programs that benefit local residents.

7. From Groundwater Protection to Groundwater Management

Native groundwater reserves and imported water banked underground are major sources of water for transfers. As we have seen, concerns over the potential for the market to encourage overexploitation of this resource—with negative consequences for both quantity and quality of water available to local users—have been at the origin of the county ordinance movement. However, a policy that restricts exports without encouraging better management of groundwater locally is limited in two respects. It cannot, in most circumstances, protect the resource from overuse, and it does not provide the opportunity for residents to realize the financial and water supply benefits of an actively managed aquifer.

In this chapter, we examine the issues involved in moving from groundwater protection to groundwater management at the local level. The first concerns the development of effective strategies for mitigating the effects of groundwater transfers and the related practice of groundwater banking. The second concerns the wider question of how to develop local groundwater oversight systems that can effectively manage the resource. This discussion addresses the role that different institutional levels can (or should) play, from the local water agency up to the county and the state.

Mitigating the Effects of Groundwater Transfers

Economic and Legal Issues

The economic and legal issues concerning mitigation of groundwater effects are somewhat different from those pertaining to mitigation for land fallowing effects. To recall the discussion of the previous chapter, a transfer or banking operation that has negative effects on either the

quantity or quality of groundwater available to other users constitutes a physical externality. From an economic efficiency standpoint, such an effect requires mitigation by the parties engaging in the transfer. Without mitigation, those parties are not fully taking into account the consequences of their actions on the availability of the resource. They are, in effect, paying too little for the water and thereby have incentives to use too much of it.

The problem arises because of the collective nature of the groundwater resource. In a groundwater basin that is entirely owned or managed by one party, that owner automatically will take into account the full cost of any extractions or, in economists' parlance, "internalize" those costs. In a groundwater basin with collective access, but where the withdrawal rights are fully attributed (for instance, by adjudication), the full cost of the resource is also taken into account in the determination of maximum sustainable yield. The only collective problem in such basins is to ensure adequate monitoring and enforcement of the rules on withdrawal.

In the typical situation in California, neither of these stringent management options applies, and users do not have clear incentives to avoid overexploiting the resource. Of course, overdraft can result strictly from extracting too much water for local uses. But the potential for causing harm to one's neighbors by sending water out of the basin is more problematic, both politically and legally.

Legally, there are both local and state protections for groundwater users with respect to water transfers. As we have seen through the *Baldwin v. Tehama* holding, county authority to establish groundwater protection ordinances derives from its police power to protect public health, safety, and welfare in fields not preempted by the state. The legal protection of local groundwater users is, by this reasoning, a matter of public welfare. Counties can assume this role because of the lack of full protection of groundwater users under the state's water code. Because the state has not exercised full regulatory powers over groundwater, the no-injury provisions of the Water Code—designed to protect water users from the negative effects of transfers—technically apply only to surface water users.

However, a strong case can be made that groundwater users are protected in spirit under the no-injury provisions. This is the interpretation of the two state agencies that have oversight responsibilities for transfers, the State Water Resources Control Board (for transfers of water held in rights established since 1914) and the Department of Water Resources (for transfers among State Water Project contractors, for its own purchases, and for water wheeled through state-owned conveyance facilities).[1] Significantly, the state filed an *amicus* brief in support of counties' right to adopt groundwater protection ordinances during Tehama County's appellate court case in 1994. As noted above, there are partial state-level protections of groundwater users in the Water Code. Notably, Section 1220 limits exports from the Sacramento and Delta-Central Sierra Basins. Case law from the beginning of the last century has also established restrictions on the export of groundwater from an overdrafted basin, since nonoverliers may have access to water only if there is a surplus.[2]

Mitigation Options and Experiences

Surface water transfers that are legally subject to the no-injury provision can either be proscribed by the SWRCB, if there is harm to another water user, or mitigated by means of a "physical solution." Physical solutions involve providing the equivalent amount of water to the affected water-rights-holder, notably through alternative sources of supply. This may involve covering the additional monetary costs incurred to ensure that supply, so that the affected party is "made whole." However, the no-injury law does not provide for purely monetary solutions through which the affected party is financially compensated for the loss of water. In this respect, legal practice departs from economic theory. From an economic standpoint, monetary

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[1]Personal communication, Andy Sawyer, SWRCB general counsel's office, September 2002, and Jerry Johns, Chief of Water Transfer Office, Department of Water Resources, December 2002.

[2]*Katz v. Walkinshaw*, 141 Cal. 116 (California, 1902). Within the Kern County Water Agency service area, this doctrine is explicitly used to guide transfer policy.

compensation for not using the water—if correctly determined—can be equivalent to a physical solution.

For groundwater users, there are only very limited situations in which there is a legal obligation to provide affected parties with a physical solution. Physical solutions have been imposed in court decisions where a basin has been determined to be in overdraft and pumping by junior or nonoverlying groundwater users is causing harm to appropriators with more senior rights.[3] Nevertheless, the principle of making the affected water user whole through physical solutions has guided the design of mitigation systems for groundwater transfers and groundwater banking projects. Mitigation actions include sinking new wells, covering the additional energy costs incurred if pumping costs increase, or providing an alternative supply of surface water. In addition, these systems generally have a built-in process for stopping or adjusting pumping associated with the transfer if groundwater levels decline beyond certain limits. One key component in such systems is the ability to adequately monitor groundwater levels, as well as quality and land levels in some cases.[4]

To date, the most structured mitigation systems for groundwater effects are found in Kern County, in the context of large groundwater banking projects. Both the Semitropic Water Storage District and the Kern Water Bank faced situations where their proposed banking activities had the potential to affect the groundwater supplies of a number of adjacent water districts.[5] The neighboring parties' concerns were taken into account during the project design and review phases. The projects include elaborate monitoring schemes in which all parties participate. Project operation is guided by the "golden rule" principle,

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[3]For instance, this was required by the court in the case of *City of Barstow v. Mojave Water Agency,* 23 Cal. 4th (Cal. 2000).

[4]Excessive pumping can cause land levels to sink, a phenomenon known as "land subsidence."

[5]For detailed case studies, see Thomas (2001). The report also provides a case study of the Arvin-Edison banking project with Metropolitan Water District of Southern California, for which mitigation provisions were greatly simplified by the fact that the project has very limited potential groundwater effect on anyone outside the Arvin-Edison district.

whereby nonparticipants must be at least as well off with the project as without it.[6] In Semitropic's case, a formal groundwater target level was established to provide assurances to local water users. Under the "3 year–15 fifteen feet" rule, Semitropic agreed to cut off pumping activities for its banking operations with outside clients if the groundwater table declines by more than 15 feet in the space of three consecutive years.

Since the banks began activity in the mid-1990s, they have demonstrated the utility of a multiparty monitoring and information-sharing system, but they have not really been tested for their ability to respond to adverse effects. The second half of the 1990s saw a series of very wet years, which made a considerable amount of water available for banking. Withdrawals from the banks were first made in 2001 and to a more limited extent in 2002. So the projects have, for now, been purely a boon to local water users.

Two other mitigation systems worth considering are in the Sacramento Valley. The first of these is in Yuba, where the Yuba County Water Agency has overseen all of the groundwater substitution transfers by its member units. Its policy is to immediately mitigate the effects of groundwater substitution transfers where there is a clear relationship between the effect and the transfer. Mitigation has mainly concerned residential pumpers and has consisted of lowering pumps or deepening wells, at times temporarily discontinuing nearby groundwater substitution pumping until the situation is addressed. Where the relationship is not clear, there is an investigation before mitigation action.

The second system is the BMO program recently established in Glenn County. This program does not yet formally incorporate provisions for mitigating transfers, but it incorporates two essential elements of a mitigation system: a multiparty monitoring framework in which transfer activity can be reviewed and a set of rules for determining whether pumping activity associated with a transfer should be curtailed. Glenn-Colusa Irrigation District, the largest district involved in groundwater substitution transfers in 2001, put in place its own

[6]Economists refer to this as the Pareto Principle.

mitigation funds, to be accessed if needed under the county's review process. As it happened, the system was provided with a test case during this first year of operation.

The case involved the well of an independent agricultural groundwater pumper whose farm is located on the periphery of GCID. The farmer, Marvin Lohse, noticed a sharp decline in the pumping capacity of his well during the summer of 2001, at a point when a neighboring farm within the irrigation district had been pumping extensively as part of the groundwater substitution program. The matter was brought to the Water Advisory Committee (WAC), which has oversight responsibilities for groundwater monitoring and the determination of groundwater target levels. GCID had a policy of immediately mitigating any damages caused by its own pumping but considered that a technical review was needed to determine whether this was the case.

The WAC's Technical Advisory Committee (TAC) was designated to conduct the review. Once the season was over and testing could be conducted, GCID financed extended pumping of the well neighboring the Lohse farm so that potential interactions with the Lohse well could be measured. This and other test data were analyzed by staff members of the Department of Water Resources Northern Area Office, who participate regularly in the TAC. At a recent TAC meeting, DWR presented its final conclusion, confirming its initial finding that there is no direct correlation between water levels in the two wells.[7] Rather, the data suggest that the loss of water in the Lohse well could have resulted either from the higher overall levels of pumping by GCID during the 2001 season (a result of the transfer program) or from water management activities up-gradient, in an area uninvolved in the transfers. The recommendation is to perform focused monitoring on the Lohse well the next time there is a transfer program or a reduction in surface water supplies to up-gradient users.

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[7]Glenn County Water Advisory Committee, minutes of the October 8, 2002, meeting.

Mitigation Design Issues

The Glenn experience highlights many of the issues that are still on the table regarding the design of effective groundwater mitigation systems. The first of these relates to the quality of information on which to base decisions. Knowledge about groundwater basins is by nature inferential. Like economists measuring the effects of fallowing, hydro-geologists can make use of hard data but ultimately must base their conclusions on estimations and simulations of how the system works. Even for aquifers with long and extensive well data, there is room for surprises. Notably, groundwater basins do not always register changes in use in predictable ways. There can be lags in adjustment of the water table to use levels, and the basins themselves are known to shift.

The philosophy behind the Glenn County basin management objective ordinance is one of adaptive management. By this approach, the county's water users intend to improve their knowledge of how the aquifer works, while making use of the resource, including for water transfer projects. Indeed, Glenn's water users argue that the optimal and most sustainable strategy cannot be known without this empirical approach to basin evaluation. Counties such as neighboring Tehama appear to be taking a more conservative approach by aiming to compile as much information as possible before becoming comfortable with potential transfers.

A second, related issue concerns the timing of mitigation. There is a tradeoff between obtaining reliable information and responding quickly to a claim of damage. Unless there is already a clear set of baseline information, immediate mitigation essentially precludes verification of the link between the transfer activity and the decline in well levels of those who claim harm. The distinction is important because, as the Glenn example shows, there can be other reasons why a well would run dry. In counties such as Glenn and Butte, where there are large numbers of independent agricultural pumpers, "over-mitigating" by responding immediately can pose a high financial risk to the parties engaging in transfer activity. Such districts worry that they may be held responsible

for replacing agricultural wells throughout the county, whether or not there is a link to the transfer activity.

On the other hand, failure to respond quickly to a perceived groundwater effect can lead to political pressure to shut down the water transfer system altogether. With the benefit of hindsight, some observers in Butte regret that the districts engaging in groundwater substitution for the 1994 drought water bank did not opt for a liberal, rapid mitigation policy when the first complaints were aired. Failure to do so meant that virtually everyone in the county with a well affected by the drought ended up blaming the transfer, irrespective of his or her location on the gradient. The result has been a restrictive ordinance and a political climate that may make it more difficult to put in place an alternative groundwater management system focusing on active basin management.

GCID's decision to wait for an investigation of the causes of the dry well was made in a quite different context: an isolated complaint, in a county with a process established for technical review. It nevertheless reflects the growing pains associated with an adaptive management approach, since not everyone in Glenn has emerged satisfied by the conclusions. Delaying mitigation also can make it difficult—if not impossible—to make the affected party whole through a physical solution.

A third issue that has arisen in Glenn concerns the practical matter of funding. Glenn's review system has two essential ingredients for handling third-party effects to groundwater users: There is an impartial technical review committee, and this committee—not the injured party—bears the burden of investigating complaints brought forth by the public. Much of the work conducted by the committee is on a pro bono basis, effectively contributed in-kind by the participating institutions and individuals. As the process has unfolded, however, the county office that coordinates TAC and WAC activities has come to the conclusion that it may need funds to cover its own expenses for the reviews. This implies some sort of transfer tax to cover the cost of the process, even if the responsible water district ultimately pays for any actual mitigation that may be warranted.

Discussions of the idea of establishing a groundwater mitigation fund at the county level rather than at the level of the individual water

districts have also started. Some districts object to this idea, arguing that any financial responsibility should remain decentralized. Their concern is that, as water transferors, they may bear the cost of groundwater mitigation unrelated to their own transfer activity or to the more general transfer activity occurring in the county.

Leaving aside the general reluctance for parties to see themselves taxed—a view that may be even stronger in California's rural areas than elsewhere in the state—the debate on a transfer tax raises two key concerns regarding the principles of mitigation for groundwater effects. First, it is clear that the parties in Glenn need to find a way to collectively finance the costs of conducting the review of third-party effects. Without this, the foundation of the basin management objective system is eroded. If this means some sort of assessment in addition to in-kind contributions of participating agencies, so be it. However, it is less clear that establishing a general mitigation fund through a transfer tax is the appropriate response. A tax to mitigate physical effects to water users raises legal issues, because it simultaneously grants implicit legal coverage to parties not currently covered under the no-injury law without ensuring adequate protections. A mitigation fund established ex ante may not contain adequate resources to provide the specific remedies required for affected parties.[8]

The second concern is the problem highlighted by the districts themselves: the risk of commingling mitigation for transfers and remediation of other types of groundwater problems present in the county. The districts have a point in arguing that a tax on transfers is not an appropriate solution to funding more general groundwater management programs. This would amount to discriminating against transferring parties (in this case, parties with more substantial water rights), without holding other parties responsible for actions affecting the health of the aquifer. The debate underscores the fact that ultimately, an effective mitigation system for groundwater transfers must come packaged within a wider groundwater management system.

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[8]These objections were raised to the proposed transfer tax in the "Model Water Act" sponsored by a group of business leaders in the mid-1990s (Gray, 1996).

Ingredients of Effective Groundwater Management Systems

Unlike many of its western neighbors, California does not have a state-regulated system for managing the exploitation of groundwater resources. Looking across the California landscape, one finds a continuum of local management options. At one end, there are fully regulated systems that manage use through a combination of pricing and quantity controls. These include basins with a single managing authority (such as certain special districts) and basins where individual property rights have been attributed through a court-ordered adjudication. As we have seen, such systems tend to be adopted in places with higher population densities or specific technical concerns over the nature of the resource (coastal and desert areas or areas overlying fractured rock where the resource is nonrenewable). Most southern California and coastal counties have such systems in place.

At the other end is the option of complete laissez-faire, where individuals are free to extract groundwater without restrictions on quantity and without fees other than their own pumping costs. Although this has been the preferred local management option in many parts of the state historically—notably in the agricultural heartland—it is becoming an increasingly empty set. Spurred on by a combination of local initiatives and state-level prompting, counties, cities, and water agencies have been putting in place local oversight systems since the mid-1990s.

Because it does not purport to manage the resource in any other way, the local system that most closely resembles the laissez-faire option is the county ordinance restricting exports. Further along the continuum, one finds a range of local groundwater management programs, established under a variety of authorities: the provisions of AB 3030, the 1992 legislation specifically designed to enable the creation of groundwater management plans, general joint powers authority (e.g., Sacramento Regional Groundwater Authority), and, in Glenn's case, the county's police power. To date, the most common form is the AB 3030

groundwater management plan, with over 100 in existence, and with roughly 20 involving multiple parties.[9]

As a group, these systems provide a framework for active, largely voluntary management of the groundwater basin. The focus is on the development of monitoring systems and the organization of basin replenishment activities. There are only limited powers to introduce either quantity controls or pricing mechanisms for limiting access to the resource.[10] Within the group, the county ordinance in Glenn may have the most potential clout, because it provides for pumping restrictions (first for exports, then for local agricultural uses) if target levels for the groundwater basin exceed critical limits.

To a large extent, these local groundwater management systems have yet to be evaluated. In part, this relates to the relative newness of the process. In part, it derives from the fact that before 2002, local agencies were not required to report on the plans.[11] For this reason, there are no precise statewide figures on the number of plans in existence and their membership, let alone information on how well they have been functioning.[12] It is widely recognized that plans sometimes were adopted on paper, with little real management content.[13] Some local agencies did so as a defensive strategy to keep the state from expanding its own authority over groundwater.

It is nevertheless possible to highlight a set of questions about the elements of a successful system. The first question is whether a strictly

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[9]Figures are derived from DWR's database on groundwater management plans.

[10]For instance, a local agency with an AB 3030 plan cannot "limit or suspend extractions unless [it] . . . has determined through study and investigation that groundwater replenishment programs or other alternative sources of water supply have proved insufficient or infeasible to lessen the demand for groundwater" (Cal. Water Code Section 10753.9). Fees can be collected for groundwater management only after holding an election within the affected area (Cal. Water Code Section 10754.3).

[11]The reporting requirement was introduced in 2002 through SB 1938.

[12]DWR officials estimate that they may have about 90 percent of the plans in their database. The information on member agencies of multiparty plans is also incomplete.

[13]The likelihood of relatively inactive AB 3030 plans is highest for individual district plans, although it is also appears that some of the multiparty plans have many passive members.

voluntary system is adequate. A number of management plans appear to focus on recharge and replenishment activities, by bringing in additional surface water when available. This is consistent with the view that if the plan is sufficiently proactive, there will not be a need for sanctions on local users.

A second and related question is whether a plan can be effective without establishing target levels for the water table. Such levels are the essence of the BMO approach—the levels can be adjusted as information on the aquifer improves, but they can also be used to determine critical conditions when pumping restrictions are warranted. Beginning this year, new legislation (SB 1938, Machado) provides local agencies with a strong incentive to adopt such target levels; without them, a groundwater management plan will no longer be eligible to receive state funds administered by DWR for groundwater quality or construction projects.

The third question concerns the appropriate level of jurisdiction for a local groundwater management system. The systems now in place span a wide range of options, from a single water district to multiparty, multicounty arrangements (for instance, the Sacramento Regional Groundwater Authority). Many of the multiparty programs are configured to correspond to the underlying groundwater basin. This is generally not the case for programs adopted by individual districts. By making state funding contingent on the presentation of plans to involve other agencies overlying a basin, SB 1938 also establishes the principle that AB 3030 programs should follow a basin approach whenever possible.

Although it does not specifically address the physical aspects of a groundwater basin or watershed, another bill passed in 2002 to support "integrated regional water management" (SB 1672, Costa) reinforces the notion that local agencies will need to group together to receive state funding for water projects in the future. Under this statute, regional groups associating at least three local agencies will be eligible to receive competitive grants for water management (including, but not limited to, groundwater) under the latest water bond, Proposition 50, which passed in November 2002.

Role of Counties and Local Agencies

The 1990s have seen parallel developments for local groundwater control in California, with on the one hand county-level ordinances and on the other local management plans involving mainly water agencies and rarely coinciding with county boundaries. What interactions have there been between these two developments, and what are the potential roles of counties and local agencies in the future?

Within the San Joaquin Valley, the two approaches appear as alternative paths. In Merced, Kings, Stanislaus, and Tulare, multiparty groundwater management plans provided an acceptable alternative, at the local level, to the option of introducing a county ordinance. This is less the case in the Sacramento Valley, where ordinance adoption got off to an earlier start and is more widespread. In many counties there and further north, the more relevant question is how export ordinances will interact or coexist with more active groundwater management programs as these develop. In Glenn, a county ordinance for local groundwater management has effectively replaced the initial ordinance restricting exports. In Sacramento, the Water Forum process led to a new groundwater management system for the county, which incorporates some out-of-county parties overlying the shared basin. The county's export ordinance remains on the books and can be activated if officials deem it necessary.

As noted, a number of counties in the northern half of the state are currently building on Glenn's experience with basin management objectives. Although it is too early to tell how this will play out, one likely scenario is the adoption of countywide ordinances, as has been done in Glenn. Whether these counties will actively maintain their export restrictions will depend on local factors, including the extent to which the BMO adoption process creates an adequate level of trust among local users and the extent to which the perceived threat of exports is linked more to potential practices of local water agencies or to the potential for private individuals to sell land for groundwater pumping to an outside party.

This analysis suggests that in some places, counties are likely to play an active role in the movement toward more comprehensive groundwater management, by virtue of already having played an active role in establishing an oversight role for exports. In this context, the county will play the role of convener for local water users, whether or not there is a complete overlap between county lines and the contours of the groundwater basin. The Glenn experience demonstrates one advantage of a county-level approach over one affiliating local agencies along basin lines: the ability to readily implicate nonaffiliated parties, such as private pumpers.[14]

In Kern and Yuba, both special cases by virtue of their countywide umbrella agencies, a convening role has been key for county water policy formation. The most recent illustration of this is the public forum launched by the Kern County Water Agency (KCWA) in 2002 to deliberate over future banking and transfer policy. The discussions are focusing on two issues: use of State Water Project water in out-of-county transfers and groundwater basin management in relation to banking and transfers. Whereas the first issue is mainly a matter to be decided between the county, KCWA, and the 13 member agencies that share the SWP entitlement,[15] the forum on groundwater involves all water users overlying the Kern Basin. A key objective is for these parties to come to a consensus on standards and methods for basin measurement.

For the "county" to play a convening role, county administration need not be heavily involved. Most rural counties have limited staff and budget resources to make available on water issues, and water districts are generally wary of being managed by an entity with limited technical expertise. Most rural counties also have some form of consultative group on water issues. The models emerging from such counties as Glenn and Butte demonstrate that these groups can play a significant role in developing local water policy. Indeed, in Glenn, the Water Advisory Committee—composed of water users from throughout the county—is

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[14]In Glenn, private pumpers were organized along county district lines.

[15]The county's involvement is predicated on the fact that county funds help defray the cost of SWP water to local users, by roughly 13 percent.

the county organ for groundwater matters. The county administration provides technical and administrative support to this committee's work.

This experience reflects the core philosophy of local groundwater management—that the policy needs to be developed and adapted through a consultative process among water users. For this reason, active participation of local water agencies is a key component of any multiparty groundwater management plan, whether organization is along county lines or some other principle. When the plan is backed by a county ordinance, as in Glenn, it is useful to consider the respective roles of the county and of the water agencies in groundwater management. The county is responsible for monitoring and evaluation and, ultimately (if necessary), policing water users. Water agencies—together or individually—are responsible for the planning, construction, and operation of groundwater projects. This type of management protocol will generally be the appropriate division of labor, except in the few cases where counties themselves hold substantial surface water rights. Because most counties share basins with their neighbors,[16] county-level management plans will logically need to coordinate with the players on the other side of the border, be they other counties or local water agencies.

In some places, a county-level management plan is less likely, either because viable alternatives already exist or because the local dynamics favor an alternative future path. In light of their oversight responsibilities for land use planning and economic development, the case could be made that county administrations should nevertheless have a "seat at the table" on local water policy. This was, in essence, Fresno County's motivation for adopting an ordinance.

Role of the State

If there is one area on which local entities can easily reach consensus regarding groundwater management, it is that the state should stay out of it. This includes the expansion of regulatory oversight through legislative actions and through the exercise of additional authority by the

[16]Both Yuba and Kern have the added advantage of overlying relatively distinct basins.

SWRCB.[17] As a first reaction, local agencies generally do not even appreciate far meeker forms of intervention, such as the incentive-based system for state funding introduced by SB 1938 and SB 1672. There is, at the same time, a clear preference to avoid going down the road of court-ordered solutions to groundwater management and recognition in many places that some form of local management may be necessary.

A key ingredient of the successful local processes to date has been the hard work, long hours, and initiative of individuals willing to do what it takes to find consensus on local management objectives. That said, the state has played a crucial role in some cases, by providing technical assistance (most notably, through DWR's Northern Area Office) and financial support. Through several different grant and loan windows, DWR is now able to provide seed money to develop groundwater management plans and to help fund the development of monitoring grids and infrastructure for replenishment and banking activities.[18]

State-level funding for local groundwater management initiatives is justified because improved management at the local level benefits the state as a whole, not just the local water users. When sound local systems are in place, this facilitates the active use of the aquifer, enhancing water supply for the wider community. Indeed, there is some evidence to suggest that the strictly local benefits of improved management will often be inadequate to spur users to put in place an oversight system. Modeling exercises show that the annual increases in farmers' pumping costs (a function of declining groundwater levels) in a laissez-faire system are typically not huge if groundwater use is limited to the overlying users (Provencher, 1995). Provencher (1991) and Knapp et al. (forthcoming)

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[17]See, for instance, the public response to the report recently commissioned by the SWRCB on groundwater authority (Sax, 2002).

[18]AB 303, the Local Groundwater Management Assistance Act of 2000, has so far made $10 million available for grants to conduct groundwater studies, implement monitoring activities, and undertake groundwater management activities, through annual appropriations of the general fund in 2000–2001 and 2001–2002. Proposition 13 made close to $122 million available for groundwater recharge and storage projects over this period and is slated to make another $85 million available in 2002–2003. Close to 90 percent of this is for grants; the rest is for low-interest loans. Individual amounts are modest (grants range up to $250,000, loans to $1 million). It is anticipated that several hundred million dollars will be available for groundwater projects under Proposition 50.

found that under no-transfer conditions, improved management would generate savings of only 2 to 3 percent in Madera and Kern Counties, respectively.[19] The benefits of management can increase substantially once one considers the opportunity for active conjunctive use, banking, and transfers. In part, the increase in benefits occurs because in an uncontrolled situation, transfers can hasten the speed of overdraft. [20]

This underscores why those water users in a position to organize transfer and banking projects—by virtue of senior surface rights or their location on the aquifer—have every incentive to take a proactive role in local groundwater management. Failure to do so may lead to projects being blocked by communities unwilling to support the risk of exports in an unmanaged aquifer. To some extent, the market opportunities afforded by improved groundwater management also create incentives for private sector support of these initiatives. This will notably be the case for urban supply projects, since municipal users can pay a higher price for the water. Judging from recent experience, the scope for private capital appears greatest for investments to support banking projects (recharge and pumping facilities and upgrades in conveyance).[21]

Before private funding can fill its niche, however, the locals will need to have done the groundwork on putting in place a management system with a protocol for monitoring, evaluation, and mitigation of potential harm from the activities. Not all local programs have required public support for these efforts, but it often appears to provide the grease that keeps the wheels turning. For this reason, the legislative incentive of such bills as SB 1938 and SB 1672, which orient the content of

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[19]These savings are measured in terms of the value of the groundwater per acre of farmland per year. Knapp and his colleagues find, for instance, that the annualized net benefits from groundwater over a 50-year time horizon are $151.48 per acre under laissez-faire management and $153.92 under efficient management, assuming no transfers out of the county ($2.44/acre annualized net gain).

[20]Knapp and his colleagues found that gains from management with transfers (but without banking) rose to $11.09 per acre per year, in part because benefits under laissez-faire fell to $146.03 per acre.

[21]For instance, Semitropic Water Storage District is working with the private sector on a proposed expansion of its banking facilities. Private investors are also considering funding of recharge operations in support of water supply for residential development within the San Joaquin Valley. The proposed transfer from Butte Water District to Madera County is a case in point (see Table A.5).

programs susceptible for state funding, may be a good accompanying measure. For public funds to provide public benefit, they need to support systems that are truly moving in the direction of sound management.

Summing Up

Further expansion of water marketing and water banking activities will require safeguards for the use of groundwater basins. These include measures to protect users and the environment against potential adverse consequences and to ensure the rights of those who bank water underground. Because state laws do not provide adequate protections, mitigation systems for groundwater users must be developed at the local level. Key ingredients of a mitigation system consist of monitoring and information-sharing with all players, an impartial technical review process to investigate potential effects to third parties, and a mechanism for mitigating those effects by measures that may include adjusting or ceasing pumping activity. Such systems are in place in Yuba and Glenn Counties and in the groundwater banking operations in Kern.

The outstanding mitigation design issues are the tradeoff between obtaining reliable information and acting quickly and the mechanism for funding remedies. Whereas a tax on water sales made possible by land fallowing might be an appropriate means for funding social or economic programs, such a tax raises legal issues for the mitigation of groundwater effects. A transfer tax to mitigate groundwater effects simultaneously grants implicit legal coverage to parties not currently protected under the state's no-injury law, without ensuring adequate protections.

Ultimately, an effective mitigation system for groundwater transfers must come packaged within a wider groundwater management system. In California, fully regulated systems that manage use through a combination of pricing and quantity controls tend to be confined to Southern California and coastal areas with historically higher population densities or specific technical concerns over the nature of the resource. Elsewhere, there has been a movement from complete laissez-faire toward local oversight systems. The 1990s have seen parallel developments, with both county-level ordinances and local management plans that rarely coincide with county boundaries. From a basin management

perspective, strong arguments can be made in favor of management systems uniting agencies overlying a common basin. The key question for these systems is whether a strictly voluntary management principle is adequate or whether target levels and pumping restrictions need to be developed for the program to be effective.

By virtue of the institutional history, counties in Northern California will probably play a lead role in developing more active management systems, even if the county lines do not coincide with the basin. The experiences in Glenn, Yuba, and Kern demonstrate that counties (or countywide water agencies) can play an important convening role for local water users. In counties that play an active role in setting up management systems, the "county" need not—and often should not—be the county administration itself but rather a representative group of water users supported by the administration. In places where groundwater management develops along other geographical lines—notably basins or watersheds—county administrations nevertheless deserve a "seat at the table" on water policy development, given their oversight role for land use and economic development.

The state's role in encouraging better groundwater management is three-pronged: providing technical assistance where requested, making funds available to support system development, and encouraging the adoption of programs with sound content by attaching conditions to the release of state funds. Because sound local management of groundwater provides benefits to the state at large, all three measures constitute appropriate support to system development. Once systems are in place, there is also an opportunity for private funding of groundwater infrastructure, especially for municipal supply projects.

8. The Scope for Resolving Third-Party Issues

The ordinances restricting groundwater exports by California's rural counties over the past decade reflect popular concerns about the potential negative effects of the water market on groundwater users and the local economy and the lack of adequate protections afforded by state law. There is statistical evidence that the restrictions have significantly reduced overall market activity, and they may also have encouraged some shifting of sales toward within-county buyers. Local resistance is likely to remain a force to reckon with in market development, especially for long-term, interregional transfers from agricultural to urban users.

This is important because municipal demand—which did not contribute to overall market growth in the second half of the 1990s—can only increase in the years ahead. Demographers forecast an increase in the state's population by 12 million people over the next 20 years, corresponding to an increase in demand of roughly 3 million acre-feet at current patterns of residential use.[1] Meanwhile, roughly 800,000 acre-feet of urban supply (nearly one-tenth of the estimated municipal and industrial water use in the mid-1990s) will be removed at some point over the next 15 years in the context of California's agreement to stop using more than its entitlement of Colorado River water. Cities are already looking to a range of alternatives to meet future needs, through conservation, desalination, recycling, and increases in local reservoir

[1]Calculations are based on the standard rule of thumb for per capita municipal use in California of 250 gallons per day, or four persons/acre-foot/year. The state's last available projections of municipal demand for 2020, including industrial demand, assume a slightly higher consumption rate of 3.8 persons/acre-feet/year (Department of Water Resources, 1998). Per capita averages are merely summary figures, since they depend on a weighted average of use in single-family and multifamily homes (which is lower), as well as differences in use across areas of the state.

capacity. But it is also clear that the water market—where possible in association with groundwater banking operations—will be an element of this portfolio. The need for reliability, reinforced by new legislative requirements to firm up the link between water supply and land use planning, will naturally lead some municipal water agencies to seek long-term contracts to shore up supplies.

There is some scope for augmenting supplies available for transfers through efficiency-based conservation—notably through upgrades to conveyance systems such as canal lining. As long as such transfers do not harm the environment or seriously alter the recharge of the aquifer, they can take place without generating local concern. However, it is likely that the two key sources of water for the market will be those that have given rise to the local resistance movement: groundwater—either direct or in substitution for surface water—and conservation through crop idling. Moreover, the scope for augmenting groundwater banking in the Central Valley—which could potentially increase annual average water supplies by 1 million acre-feet or more[2]—is inextricably linked to local concerns about groundwater-related transfers. Banking can, in principle, be a "win-win" situation for local users, by increasing overall levels of supply while making new resources available for transfer. But local users need to be convinced that the banks are structurally and managerially sound, such that they do not negatively affect either the quality or quantity of native supplies.

Moving forward will require finding solutions that provide communities in source regions with adequate safeguards against the potential negative consequences to local water users and the local economy. What have the experiences to date taught us about the scope for positive resolution of these conflicts, and what role can policy play in this process?

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[2]Estimates are from modeling exercises conducted by the Natural Heritage Institute (see Purkey et al., 1998). NHI concludes that an important new source of water for banking could be obtained through reoperation of some of the state's reservoirs.

Local Groundwater Management as the Linchpin of Water Marketing and Water Banking

The local movement to restrict exports through the exercise of county police powers was a legitimate response to the threat of uncontrolled mining of the aquifers, once the state made it clear that the water market was open for business in the early 1990s. Under the open-access rules for groundwater that have prevailed in California's rural counties, the introduction of an export potential raises the likelihood of exceeding the sustainable yield. Although many of the counties that adopted ordinances were not already in situations of groundwater overdraft, there was generally an inadequate level of knowledge about basin characteristics, including how quickly exports could lead to problems for local users. In Madera County, the ordinance was introduced in response to similar concerns regarding the unknown consequences of uncontrolled groundwater banking.

The ordinances can be interpreted, in this light, as a precautionary response to a policy shift at the state level, which did not provide adequate protections for local groundwater users. This defensive strategy is nevertheless suboptimal from the standpoint of local as well as statewide interests. A policy limited to restricting exports does little to stabilize the aquifer in places subject to overdraft. It also makes it difficult, if not impossible, to make economic use of the underground storage space, through groundwater substitution transfers and banking of imported surface water. Attaining these goals requires a more assertive, comprehensive strategy of groundwater management that protects local users while providing opportunities to address supply and quality problems and allowing those with sound transfer and banking projects to participate in the market.

There is an emerging consensus that this management needs to be done at the local level. To some extent, this conclusion is based on a perceived political reality. The lack of comprehensive state protections for groundwater users is itself a function of a legal status for groundwater

that local users have jealously guarded. In the transition from the traditional open-access model to a regime with some collective authority over groundwater, solutions involving local institutions are more palatable than centralized management by the state. Politics aside, there are also sound efficiency arguments to be made in favor of local control, because both monitoring and the determination of local water demands is best done on a decentralized basis (Provencher and Burt, 1993).

From a limited base, the decade of the rise in the water market has also been a decade of the rise of local awareness of the need for groundwater management in California's rural counties. Where this is working best, one finds proactive, multiparty initiatives that have either preempted the need for restrictive county ordinances or provided alternative models that give water users the confidence to move beyond restrictions already in place.

This shift toward active groundwater management includes a range of "confidence-builders." The first is a concerted effort to increase hydrological understanding, through data-gathering and analysis. This exercise is necessarily both ongoing and participatory. Active management—with experimentation in transfer and banking activity—provides an opportunity to increase levels of knowledge.

The second confidence-builder is the demonstration of an effective mitigation system for transfer and banking projects. Key ingredients include monitoring and information-sharing among all players, impartial technical review of potential third-party effects, and a mechanism for mitigating these that may include adjusting or ceasing pumping activity. Ideally, cases where mitigation is actually necessary will be limited, but it is crucial for water users to have the assurance that it will be available. This also implies a willingness on the part of those engaged in a transfer or banking project to accept new information on the limits of what may be done with the aquifer. Improving understanding of the aquifer can reveal constraints as well as opportunities.

The third confidence-builder is an increased appreciation at the local level that there are more effective and beneficial management approaches that include benefits for those who do not directly participate in transfer or banking projects. These wider benefits can include improved groundwater levels as a result of recharge projects and improved water

quality as an outcome of new management protocols. They can also include improved access to surface supplies, as those directly benefiting from an interregional transfer project "share the wealth" by transferring some water to other local users at a lower price.

Last, but not least, individuals involved in local management initiatives stress the key role of the process itself as a confidence-builder: working together at the local level to craft solutions and getting to know each other through hours and months of meetings aimed at problem-solving. In some cases (Sacramento and Kern), this process has benefited from professional assistance, with mediators or facilitators using guidelines for meeting protocols. The successful experiences elsewhere (Glenn and Merced) show that this is not always necessary.

All levels of government, from special water districts, to municipalities, to counties, to the state, have a role to play in improving local groundwater management. Logically, the most direct roles are for the local institutions, which need to take a leadership role in crafting locally appropriate solutions. Coordination at the local level is a necessity, given the institutional patchwork of local governance on water issues and the frequent mismatch between institutional boundaries and the physical dimensions of basins and watersheds. The onus for moving forward will often be on those water districts whose members stand to gain the most from greater market activity; they need to show they can be team players.

Rural counties have already shown their ability to play a defensive policing role. In many places, the county is also a useful level of organization for more offensive management initiatives. Counties provide a readily available structure for convening water users, and their police powers can be used proactively as a safeguard in groundwater management. Additionally, in areas already experiencing or slated for substantial population growth, there will be an increasing need for both county and municipal governments to ensure the link between water supply and land-use planning.

Some water agencies have suggested that the threat of county intervention has been an impetus for the agencies themselves to move forward with local groundwater management plans. Clearly, the very threat of the state taking on a greater prerogative over groundwater has

been important in this respect as well. But the state also has a positive role to play in fostering local initiative by providing technical assistance and financial support. The public benefits of groundwater management justify state support to local initiatives, and it is entirely appropriate that access to funding be accompanied by incentives to incorporate sound management principles. Recent bond initiatives have made millions of dollars available for groundwater management, and recent legislation (SB 1938 and SB 1672) has provided appropriate carrots by linking this funding to the adoption of sound management criteria, such as the development of target levels for the groundwater basin and the association of multiple parties overlying the aquifer. More direct input by the state in the form of funding and technical assistance to characterize groundwater basin hydrology and evaluate the potential for conjunctive use projects is also warranted.[3]

Recently, the state has also adopted an incentive-based approach through its own role as a major player on the water market. The policy guidelines for purchases of dry-year water for 2003 indicate that the state expects local parties wishing to sell water to the program to ensure adequate local supplies and minimize third-party effects (Department of Water Resources, 2002c). The guidelines emphasize the development of transfer programs by local agencies through consultation with other local parties. This position is a natural outgrowth of the state's position that groundwater is covered in spirit under the no-injury laws. It also reflects a sensible desire for the people's representative to avoid purchasing water where it may generate local controversy. But the policy is also instructive for the water market more generally. It suggests that buyers can play a positive role in stimulating sounder local water management by insisting that potential sellers work through these controversies preemptively.

Land Fallowing and Community Development

Fallowing of land to make water available for the market raises quite different policy issues. The problem is not one of efficiently managing a collective resource but rather one of determining ground rules under

[3]This was a principal point of consensus of the Water Transfer Workgroup (2002).

which those with access to water rights may forgo their use by taking land out of production and selling the water to others. The potential effects on the community are not losses in water availability (a physical effect) but losses in the economic activity associated with the fallowed land. There is no legal tradition for compensating parties affected by this type of transaction, which results from a private business decision to make a different use of resources for which property rights are clear.

As we have seen, water districts differ in their policies with respect to fallowing for transfers, and it appears that landowner-run districts are more willing than popularly run districts to entertain fallowing as an option. This could be expected given the somewhat different nature of property rights associated with the two voting rules: Under popular-vote districts, the district holds the water right in trust for the entire community, whereas in landowner-vote districts the rights are more directly tied to the farming population. The fact that farmer-run boards appear more willing to consider fallowing for the water market is not in and of itself a bad thing. Farmers are the ones best placed to know the value of the water in their agricultural operations, and they will consider selling only if they can earn more for it on the market. This is the essence of an efficiency-enhancing transaction, which augments collective welfare.

The problem is that despite generating overall gains to the economy, such transactions may lead to some losses, as a result of changes in spending patterns of the farmer and others who earn income associated with the idled land. The studies available on this question suggest that the aggregate local effects have been quite small for programs idling anywhere from 6 to 29 percent of acreage, with local gains from the program largely balancing out local losses. But the modern track record is limited, and there is a tendency for popular sentiment in rural areas to target the notorious case study from California's past where fallowing for the market had dire consequences for the local agricultural economy—Owens Valley.

Districts willing to engage in fallowing today argue that they have no intention of harming the local economy. To the contrary, they maintain that including a fallowing component in their operations enhances

financial stability at a time when farm prices are generally low. These districts now operate under a set of rules that makes a full-scale sell-out of the Owens Valley variety highly unlikely, if not impossible. Both state law and locally determined guidelines limit the negative effects of fallowing. Section 1745.05 of the Water Code requires public review of fallowing that exceeds 20 percent of the local water supply. In designing fallowing programs, water districts increasingly include restrictions to maintain the viability of the idled land and to make sure that participating farmers are not just in the business of selling water. The economics of fallowing also plays a natural mitigating role. Farmers have incentives to fallow the crops that generate the least profit per acre-foot, and these tend to be the low-value, highly mechanized commodities that generate the lowest on-farm employment and the least value-added through further processing.

Even with this combination of operating rules and incentives to limit negative effects to the local economy, there remains the question of whether the community should receive something too. At the federal level, there are some precedents for mitigating economic effects when policy changes in the collective interest cause a structural shift in employment and business opportunities for some sectors or regions. With different degrees of success, federal mitigation programs have aimed to assist affected workers and businesses to make a transition to other economic activities.

A parallel case could be made for mitigating the economic effects of sizable, long-term fallowing operations, especially if they generate systematic hardships for low-income groups or local governments responsible for providing public services. The water market is, after all, an instrument of state water policy. In the two long-term deals pending approval, a transfer from the Palo-Verde Irrigation District to Metropolitan Water District of Southern California and one from the Imperial Irrigation District to San Diego, funds have been earmarked for the benefit of the local communities. This will no doubt become a standard component of any future deals of this type, where large volumes of water are sold to distant urban agencies over more than a decade, with expectations of some systematic effects on local employment opportunities affecting low-income immigrant communities.

For temporary or intermittent fallowing operations, such as those undertaken in the Sacramento Valley since 2001, there are greater questions about the appropriateness of mitigation. The question has come up because the two buyers, DWR and Metropolitan, have developed a policy to provide funds for the community when buying water made available through crop idling. Locally, no one is quite sure what to do with the money, because it is not clear what damages, if any, would merit mitigation. Involved water districts and the county administration in Butte are even uncomfortable with this term, if what it implies is direct compensation of affected parties. In part, this stems from an expectation that the fallowing programs are likely to generate little if any hardship to low-income workers, given the highly mechanized nature of crop production and the considerable workload generated by land maintenance and improvement activities on fallowed acreage. In part, it stems from a concern that a direct compensation program would establish a dangerous legal precedent, generate an excessive amount of claims, and ultimately create unrealistic expectations about the potential community benefits from water transfers. For these reasons, it may make more sense to think of such funds as providing opportunities for community development rather than mitigation.

The key policy issues on the table regarding fallowing concern the rules to limit negative community effects: rules on the scale and content of fallowing program design and rules concerning financial mitigation. At present, most of these rules derive from local practice, with the exception of the Water Code's 20 percent trigger for public review, introduced in 1992. Since 1998, the legislature has considered bills proposing to institutionalize mitigation on three occasions, although none has met with approval.

Further legislative actions on the fallowing question should be avoided for the time being, for two reasons. First, there is a limited track record on fallowing and no experience with implementing mitigation funds. Second, in the major short- and long-term fallowing programs slated to occur, the transacting parties themselves have been adopting design measures to limit negative effects and setting up funds to benefit the community. These cases provide the opportunity both to assess the consequences of responsible fallowing and to experiment with the use of

funds for community benefit. If, as the farmers in the Sacramento Valley and Palo Verde argue, the overall effects are not harmful to the local economy, this may help build wider confidence in a new model for fallowing that can displace the ghost of Owens Valley.

Appendix A

Tracking the Water Market: Data Sources and Caveats

This appendix describes the dataset presented in the body of the report and provides detailed tables on different aspects of the market.

Monitoring the statewide water market is facilitated by the fact that many transactions involve state or federal authorities in at least one of two ways: as direct purchasers (as in the drought water bank and the environmental programs) or as approvers of transactions among other water users. Most transfers require approval by at least one of the following three agencies: the SWRCB, DWR, or USBR, which manages both the Central Valley Project and the Colorado River Project. Although these agencies only recently developed a policy to pool data and monitor transactions collectively,[1] it was generally possible to reconstruct past transfer activity.[2] The full range of federal and state sources was tapped. For transactions falling outside state or federal jurisdiction, the primary source used was the private publication, *Water Strategist*, and its forerunner, *Water Intelligence Monthly*, which track water markets in 14 western states. For the early years, an additional source was Lund et al. (1992).

[1]In 2001, the website of CALFED, a joint state and federal program to address water supply and quality issues in the San Francisco Bay-Delta, posted a preliminary database of water transfers compiled from various sources. Known as "On-Tap," this database provides considerable information but still contains many inaccuracies. The participating agencies intend to improve the quality of transfer monitoring for future years.

[2]The one project area with incomplete records was the Friant Unit of the Central Valley Project, a group of contractors in the east side of the San Joaquin Valley, for which internal transactions were either incomplete or missing in some years. For these years (indicated by an asterisk in the appendix tables), we have adjusted the totals, setting internal Friant trades to their average share of the total market (7 percent) in years when data were complete.

Because there are often discrepancies between intended transactions and what is finally achieved, an intensive cross-checking exercise was conducted on the data, comparing sources and contacting the relevant water districts in the event of questions. We also had access to the transfer records of some large water districts in the state: Metropolitan Water District of Southern California, Westlands Water District, Kern County Water Agency, and Yuba County Water Agency. We attempted to retain only transfers that were actually carried out, in the amounts transferred from the point of origin, on a calendar year basis.[3]

The data presented in the report focus on annual flows of water resulting from three types of transactions: temporary transfers (under one year), long-term transfers (more than one year), and what we have termed "deferred exchanges." Whereas transfers typically involve a one-way movement of water for monetary compensation, deferred exchanges refer to a promise that the buyer will return water (in addition, in some cases, to a cash payment) to the seller at a later date. These exchanges often contain some flexibility regarding the year of repayment to allow for conditions of the water year. We have considered an exchange agreement to fall into this category as long as it does not require same or next-year repayment. As with transfers, the agreements on deferred exchanges can be temporary or multiyear. State Water Project contractors make the most use of deferred exchanges, as project operating rules make these preferable to outright transfers in many instances.

The annual flow data do not contain a fourth category, the permanent transfer of water rights or contract entitlements. Such transfers amount to an outright sale of the rights to use the specified amount of water in perpetuity or for the duration of the contract in question. Because the actual amount accessible to the buyer under these rights or entitlements can vary with the conditions of the water year, it is not strictly appropriate to consider an annual flow of water transferred.

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[3]Some inaccuracies in volumes transacted may nevertheless remain. It was not always possible to resolve discrepancies because of differences in record-keeping among agencies and inconsistencies in accounting for carriage losses—the amount of water lost during conveyance. Some inaccuracies in the year of transfer also may remain, especially if a transfer arrangement was initiated late in the calendar year and some of the water actually was moved after December.

We have therefore opted to present the data on permanent transfers separately.

In the interests of consistency, two other types of transaction have been intentionally excluded from the database: short-term exchanges and transfers within certain localized user groups. Short-term exchanges are same- or next-year exchanges of water among users, generally done for purposes of timing or technical convenience. These include, for example, the annual exchanges between the San Benito Water District and the Santa Clara Valley Water District, which temporarily use a certain amount of each other's water to gain flexibility. This practice is also common among the members of the Friant Unit of the Central Valley Project. In the San Joaquin Valley, short-term exchanges are also used to facilitate transfers between districts not hydraulically connected. An intermediate district (or districts) will use the water from the transferor in exchange for letting the transferee use its water. We have opted not to count these types of exchanges for several reasons. First, they are not tracked as well as transfers: frequently, only one of several possible sides of the exchange appears in the records. Second, unlike deferred exchanges, short-term exchanges do not alter the amount of water available to the buyer and seller over the season. Finally, in cases where exchanges are used to facilitate a transfer, counting them would amount to double- (or triple-) counting the volumes being traded.

Each year, a certain number of water districts are active on both sides of the market, selling water to one or more parties and purchasing water from another party or parties. Although some of these transactions may be strictly for plumbing convenience, some represent distinctly separate deals. For instance, a district will sometimes act as an agent for a landowner transferring water to lands held elsewhere and in the same year take advantage of the opportunity to purchase water to use for aquifer recharge. We have opted to include these volumes of "internal" transactions in the data presented on the total transfer market. In total, they represent about 5 percent of the water market.

In several parts of the state, a considerable number of local transactions are not picked up systematically by any of our data sources. These include transfers among users within the same water districts, which some argue have long been a part of farmers' water management

practices. Given the difficulties of tracking these transfers, for which many districts do not maintain records, we have opted to exclude intradistrict transactions from the database and to focus on the activity among parties with separate water rights or contract entitlements. It should be noted that the volumes involved in intradistrict transfers can be substantial. UC Berkeley researchers have estimated that in the Westlands Water District, one of the nation's largest irrigation districts, internal transactions amounted to 300,000–400,000 acre-feet annually in the mid-1990s, or about one-third of the district's total water supply (Sunding, 2000). Much of this activity is linked to the fact that some lands in the district are affected by drainage problems, which reduce agricultural productivity.

There are also some local transactions across districts that we have not been able to track systematically. Within the Kings River Water Association, a 28-member group that shares water rights on the Kings River, transfers can amount to as much as 20,000 acre-feet in some years, depending on river conditions.[4] There is also a substantial amount of transfer and exchange activity—as much as 100,000 acre-feet annually—among the 13 member agencies of the Kern County Water Agency that share a contract entitlement with the State Water Project. According to agency management, these transfers are essentially for convenience, facilitating the joint management of water from different sources (project, river, and groundwater) in different locations within the county. Within the Mojave Basin, where groundwater rights have been adjudicated, there is an active annual market among rights-holders that enables buyers to use more than their allotment. In 2002, these trades were estimated at over 30,000 acre-feet.[5] Permanent transfers of drawing rights also occur within the basin. Although the Mojave Basin is the largest adjudicated area, it is likely that such local markets also are active in other adjudicated basins in Southern California.[6]

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[4]Personal communication, Tim O'Halloran, Kings River Water Association, October 2002.

[5]*Water Strategist* (2002).

[6]For a map of adjudicated basins, see Figure B.2.

Finally, we do not report in detail on the volumes involved in groundwater banking, which, although not technically a transfer, frequently involves the movement of water among parties in manners akin to transfers. Storing, or "banking," water in underground aquifers has been on the rise in California since the early 1990s. A number of users have developed projects to store water on behalf of other rights-holders at a more suitable location. These projects are by nature long-term arrangements that allow the rights-holder to respond to dry years by drawing down on stored reserves.

Our records, limited mainly to the operations of the State Water Project contractors, show that close to 750,000 acre-feet were stored in such projects on behalf of third parties since the mid-1990s in various locations in Kern County. The first drawdowns occurred in 2001, a dry year. In some of the banking projects, a market exists for the permanent sale of storage rights—in effect, for ownership of a share of the bank facilities. Because banked water can be used in transfers, there are also direct links between banking projects and the annual water market. Transfers can involve not only water users with their own on-site banking projects but also those banking at a distant location. A case in point was Santa Clara Valley Water District's transfer of water banked in Kern County to the Environmental Water Account in 2001.

Table A.1

California Short- and Long-Term Water Transfers, by Type of Market

Year	Total	% Long-Term	Direct Government Purchases	Within CVP	Within SWP	Within Colorado River Project	"Open Market"
1985	78,781	0	3,308	52,216	15,489	0	7,768
1986	156,669	0	0	147,447	7,950	0	1,272
1987	168,143	0	0	70,622	6,171	0	91,350
1988	320,872	34	119,031	87,141	300	110,000	4,400
1989	513,731	21	239,000	152,584*	2,691	110,000	9,456
1990	566,633	19	131,409	177,142*	3,561	110,000	144,521
1991	1,139,653	10	864,315	102,202*	2,696	110,000	60,440
1992	565,551	24	217,983	155,786*	4,919	138,301	48,562
1993	547,090	37	1,703	213,782*	197	202,989	128,419
1994	721,916	24	302,852	218,400*	1,726	174,688	24,250
1995	454,095	25	54,090	182,829	4,500	110,000	102,676
1996	825,185	13	69,216	270,282	207,496	110,000	168,191
1997	1,038,980	11	291,500	216,159	66,144	110,000	355,177
1998	653,054	21	60,748	145,026	201,810	110,000	135,470
1999	1,078,299	13	229,059	368,348*	241,390	110,000	129,502
2000	1,281,305	14	276,290	369,759	286,305	110,000	238,951
2001	1,257,118	22	584,349	440,252	18,240	110,000	104,277

NOTE: Asterisks indicate that the volume reported has been adjusted to account for incomplete data on the Friant Unit of the CVP. All water measurements are in acre-feet.

Table A.2

Water Purchases, by Type of End User

Year	Total	Environment	Municipal and Industrial	San Joaquin Valley Farmers	Other Farmers	Mixed Purpose
1985	78,781	3,308	5,000	44,518	3,768	22,187
1986	156,669	0	5,000	69,589	13,740	68,340
1987	168,143	0	44	43,741	10,350	114,008
1988	320,872	119,031	110,500	38,878	12,366	40,097
1989	357,283	39,000	131,043	157,021	30,219	0
1990	453,576	1,500	146,735	260,562	33,779	11,000
1991	703,329	64,612	477,292	104,892	6,863	49,670
1992	530,305	101,726	198,473	188,592	12,163	29,351
1993	546,266	1,703	208,208	293,838	42,517	0
1994	615,397	81,100	203,997	249,215	27,830	53,255
1995	511,904	111,899	112,667	279,331	8,007	0
1996	825,185	72,216	220,308	503,548	29,113	0
1997	1,037,808	293,000	191,402	439,322	14,084	100,000
1998	554,411	61,748	215,956	211,029	65,678	0
1999	1,078,379	229,459	173,988	556,980	72,592	45,360
2000	1,281,305	276,290	169,826	507,841	94,146	233,202
2001	1,257,117	445,543	261,922	388,401	112,776	48,475

NOTE: For discrepancies between total transfer amounts reported in Table A.1 and total purchases by end user listed here, see footnote 2, Chapter 2. All water measurements are in acre-feet.

Table A.3

Transfers, by Region of Origin and Region of Destination

	Sales by Water Users					Purchases by Water Users (Nonenvironmental Water)				
Year	Sacramento Valley	San Joaquin Valley	Southern California	San Francisco Bay Area	Other	Sacramento Valley	San Joaquin Valley	Southern California	San Francisco Bay Area	Other
1985	8,693	55,183	9,887	5,018	0	7,943	61,762	0	5,018	750
1986	13,740	131,682	6,247	5,000	0	13,740	137,929	0	5,000	0
1987	93,450	68,478	6,171	44	0	10,350	74,649	0	44	0
1988	131,397	78,975	110,500	0	0	12,366	78,975	110,500	0	0
1989	301,023	102,708	110,000	0	0	30,219	157,021	110,000	21,043	0
1990	252,328	191,525	110,000	11,700	1,080	34,879	260,562	110,000	35,535	100
1991	700,720	271,572	113,206	53,905	250	6,013	154,562	325,736	152,156	250
1992	218,521	193,659	142,364	11,007	0	12,641	203,089	152,364	45,509	122
1993	17,910	290,446	208,084	5,650	25,000	11,867	293,838	202,989	30,219	5,650
1994	303,038	234,152	176,788	4,933	3,005	27,094	302,870	175,568	28,735	30
1995	22,097	321,331	110,000	667	0	10,007	279,331	110,000	667	0
1996	57,773	459,704	224,078	20,267	63,363	33,113	506,548	215,641	667	0
1997	164,375	721,311	136,958	9,991	6,345	114,084	440,827	190,730	667	0
1998	79,349	257,385	294,778	4,000	17,542	68,378	212,129	207,156	6,000	0
1999	107,251	620,324	305,932	9,650	35,142	75,582	603,348	168,380	2,000	10
2000	105,571	760,142	377,611	6,000	31,981	82,334	771,343	124,926	26,412	0
2001	520,648	574,842	128,240	32,000	1,388	132,011	439,766	217,722	7,092	14,983

NOTE: All water measurements are in acre-feet.

Table A.4

Source Regions for Environmental Water Purchases

Year	Sacramento Valley	San Joaquin Valley	San Francisco Bay Area
1988	119,031	0	0
1989	39,000	0	0
1990	1,500	0	0
1991	64,612	0	0
1992	52,525	20,000	4,736
1993	0	1,703	0
1994	0	81,100	0
1995	69,899	42,000	0
1996	16,660	55,556	0
1997	45,517	247,483	0
1998	10,748	51,000	0
1999	21,559	207,900	0
2000	9,795	266,495	0
2001	80,000	335,543	30,000

NOTE: All water measurements are in acre-feet.

Table A.5
Long-Term Transfers Since 1985

Year	Seller	Buyer	Annual Acre-Feet (Max)	Duration (Years)	Purpose	Region of Origin	Region of Destination	Within Project
1987	Imperial ID	MWDSC	110,000	35	Agr to M&I	So. Cal.	So. Cal.	CO River
1992	Palo Verde ID	MWDSC	93,000	2	Agr to M&I	So. Cal.	So. Cal.	CO River
1994	Byron-Bethany ID	Alameda County FCWCD	5,000	5	Agr to M&I	Bay Area	Bay Area	No
1997	Solano County WA	Mojave WA	10,000	>5	M&I to M&I	Bay Area	So. Cal.	SWP
1998	Westside WD	Colusa County WD	25,000	25	Agr to Agr	Sac Valley	Sac Valley	CVP
1999	Byron–Bethany ID	Alameda County FCWCD	5,000	15	Agr to M&I	Bay Area	Bay Area	No
1999	Oakdale ID	Stockton East WD	15,000	10	Agr to M&I	SJ Valley	SJ Valley	No
1999	South San Joaquin ID	Stockton East WD	15,000	10	Agr to M&I	SJ Valley	SJ Valley	No
2000	Mercy Springs WD	Westlands WD, Santa Clara Valley WD, and Pajaro Valley WMA[a]	6,260	25	Agr to All	SJ Valley	SJ Valley and Bay Area	CVP
2000	Placer County WA	Northridge WD	29,000	25	All to M&I	Sac Valley	Sac Valley	No
2001	Kern County WA	Western Hills WD	8,000	35	Agr to M&I	SJ Valley	SJ Valley	No
2001	Merced ID	U.S. Fish and Wildlife	12,500	12	Agr to Env	SJ Valley	SJ Valley	No
2001	Oakdale ID	U.S. Fish and Wildlife	15,000	12	Agr to Env	SJ Valley	SJ Valley	No
2001	SJ River Group Authority	U.S. Fish and Wildlife	110,000	12	Agr to Env	SJ Valley	SJ Valley	No
2002	San Bernardino Valley MWD	MWDSC	20,000	10	M&I to M&I	So. Cal.	So. Cal.	SWP
2002[b]	Imperial ID	Coachella Valley WD and MWDSC	100,000	75	Agr to All	So. Cal.	So. Cal.	CO River
2002[b]	Imperial ID	San Diego County WA	200,000	75	Agr to M&I	So. Cal.	So. Cal.	CO River
2002[b]	Butte WD	Madera ID and Root Creek WD	15,000	25	Agr to M&I	Sac Valley	SJ Valley	No
2002[b]	Merced ID	U.S. Fish and Wildlife	47,000	10	Agr to Env	SJ Valley	SJ Valley	No
2002[b]	Palo Verde ID	MWDSC	111,000	35	Agr to M&I	So. Cal.	So. Cal.	CO River
2002[b]	South San Joaquin ID	Cities of Tracy, Escalon, Manteca, Lathrop	75,000	25	Agr to M&I	SJ Valley	SJ Valley	No

NOTES: Abbreviations: WA = water agency or water authority; WMA = water management agency; FCWDC = flood control and water conservation district; MWD= municipal water district; M&I = municipal and industrial; Agr = agriculture; Env = environment. "U.S. Fish and Wildlife" as buyer indicates purchase by USBR's Water Acquisition Program for environmental uses; SJ River Group Authority includes Merced ID, Modesto ID, South San Joaquin ID, Oakdale ID, SJ River Exchange Contractors, and Friant Water Users Association.

[a]Westlands WD and Santa Clara Valley WD will receive deliveries until Pajaro Valley WMA completes construction of facilities for the permanent transfer of Mercy Springs WD entitlement. [b]Pending approval in 2002.

Table A.6

Permanent Transfers of Surface Water Since 1985

Year	Seller	Buyer	Annual Acre-Feet (Max)	Purpose	Region of Origin	Region of Destination	Within Project
1998	Corning WD	U.S. Fish and Wildlife	2,300	Agr to Env	Sac Valley	Sac Valley	CVP
1998	Kern County WA	Mojave WA	25,000	Agr to M&I	SJ Valley	So. Cal.	SWP
1998	Proberta WD	U.S. Fish and Wildlife	2,000	Agr to Env	Sac Valley	Sac Valley	CVP
1998	Thomes Creek WD	U.S. Fish and Wildlife	2,000	Agr to Env	Sac Valley	Sac Valley	CVP
2000	Kern County WA	Alameda County FCWCD	15,000	Agr to M&I	SJ Valley	Bay Area	SWP
2000	Kern County WA	Alameda County FCWCD	7,000	Agr to M&I	SJ Valley	Bay Area	SWP
2000	Kern County WA	Castaic Lake WA	41,000	Agr to M&I	SJ Valley	So. Cal.	SWP
2000	Kern County WA	Palmdale WD	4,000	Agr to M&I	SJ Valley	So. Cal.	SWP
2001	Kern County WA	Alameda County FCWCD	10,000	Agr to M&I	SJ Valley	Bay Area	SWP
2001	Kern County WA	Napa County FCWCD	4,025	Agr to M&I	SJ Valley	Bay Area	SWP
2001	Kern County WA	Solano County WA	5,756	Agr to M&I	SJ Valley	Bay Area	SWP
2001	Olcese WD and private ranch	Kern County WA	50,000[b]	Agr to M&I	SJ Valley	SJ Valley	No
2002	Tulare Lake Basin WSD	Antelope Valley–East Kern WA	3,000	Agr to M&I	SJ Valley	So. Cal.	SWP
2002	Tulare Lake Basin WSD	Dudley Ridge WD	3,973	Agr to Agr	SJ Valley	SJ Valley	SWP
2002[a]	Banta Carbona ID	City of Tracy	5,000	Agr to M&I	SJ Valley	SJ Valley	CVP
2002[a]	Lower Tule River ID	City of Orange Cove	2,000	Agr to M&I	SJ Valley	SJ Valley	CVP
2002[a]	Mercy Springs WD	Westlands WD	1,071	Agr to Agr	SJ Valley	SJ Valley	CVP
2002[a]	The Westside ID	City of Tracy	5,000	Agr to M&I	SJ Valley	SJ Valley	CVP

NOTES: Abbreviations: WA = water agency or water authority; WMA = water management agency; FCWDC = flood control and water conservation district; MWD= municipal water district; M&I = municipal and industrial; Agr = agriculture; Env = environment. "U.S. Fish and Wildlife" as buyer indicates purchase by USBR's Water Acquisition Program for environmental uses; SJ River Group Authority includes Merced ID, Modesto ID, South San Joaquin ID, Oakdale ID, SJ River Exchange Contractors, and Friant Water Users Association

[a]Pending approval in 2002.

[b]Average annual volumes.

Appendix B

Groundwater Institutions and Basins

Table B.1

Counties with Groundwater Protection Ordinances, by Region

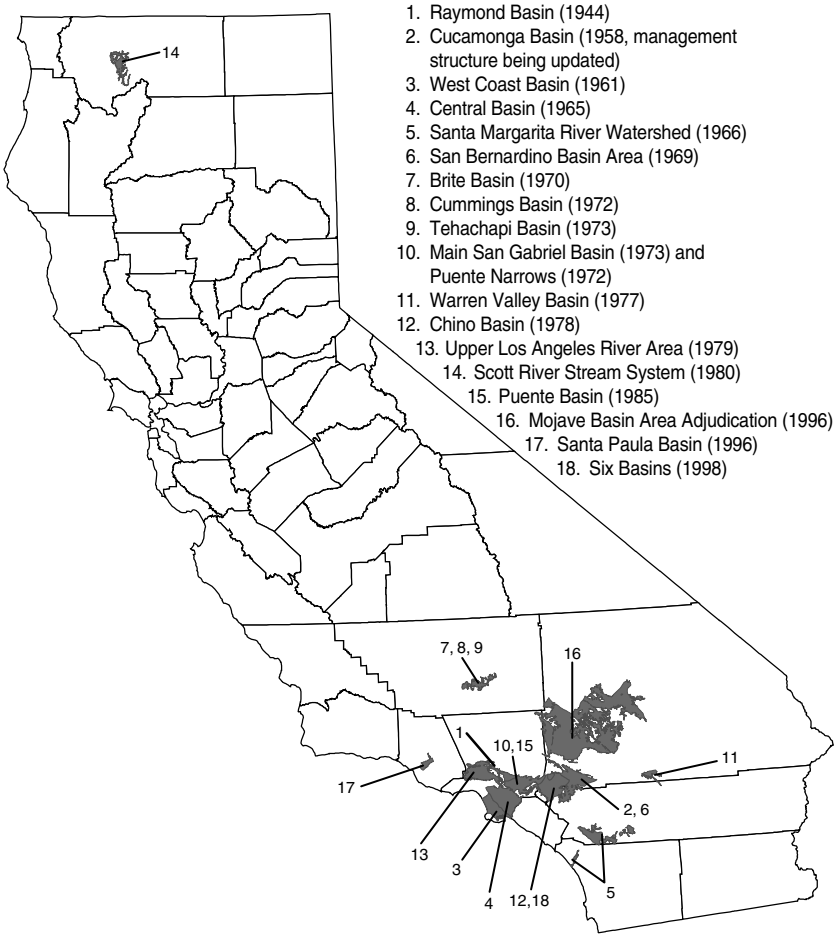
Export Restrictions	On-Site Groundwater Use Restrictions	No Ordinance
Mountain Region		
Calaveras (2002)		Alpine
Inyo (1980)		Amador
Lassen (1999)		El Dorado
Modoc (1978)		Mariposa
Mono (1988; 1998)		Plumas
Nevada (1986–1988 only)		
Sierra (1977; 1997)		
Siskiyou (1998)		
Tuolumne (2001)		
Sacramento Valley		
Butte (1977; 1996)		Placer
Colusa (1998)		Sutter
Glenn (1977; 1990)		Yuba
Sacramento (1980)		
Shasta (1997)		
Tehama (1992)		
Yolo (1996)		
San Joaquin Valley		
Fresno (2000)		Kings
Kern (1998)		Merced
Madera (1999)		Stanislaus
San Joaquin (1996)		Tulare
North Coast		
	Mendocino (1995)	Del Norte
		Humboldt

Table B.1 (continued)

Export Restrictions	On-Site Groundwater Use Restrictions	No Ordinance
San Francisco Bay and Central Coast Regions		
Lake (1999)	Monterey (1993)	Alameda
San Benito (1995)	Napa (1999)	Contra Costa
		Marin
		Santa Barbara
		Santa Clara
		Santa Cruz
		San Francisco
		San Luis Obispo
		San Mateo
		Solano
		Sonoma
Southern California		
Imperial (1996)	San Diego (1991)	Los Angeles
	San Bernardino (2002)	Orange
		Riverside
		Ventura

NOTE: Year in parentheses is year of adoption. If two dates are listed, the first refers to the adoption of an urgency ordinance and the second to the adoption of a regular ordinance. Many ordinances have been revised at least once subsequently. Imperial County adopted an ordinance requiring conditional use permits for some within-county groundwater uses in 1972 and added explicit export restrictions in 1996.

Figure B.1—California's Counties



SOURCES: Adjudication dates—Department of Water Resources (2001). Basin contours—Department of Water Resources (2002a).

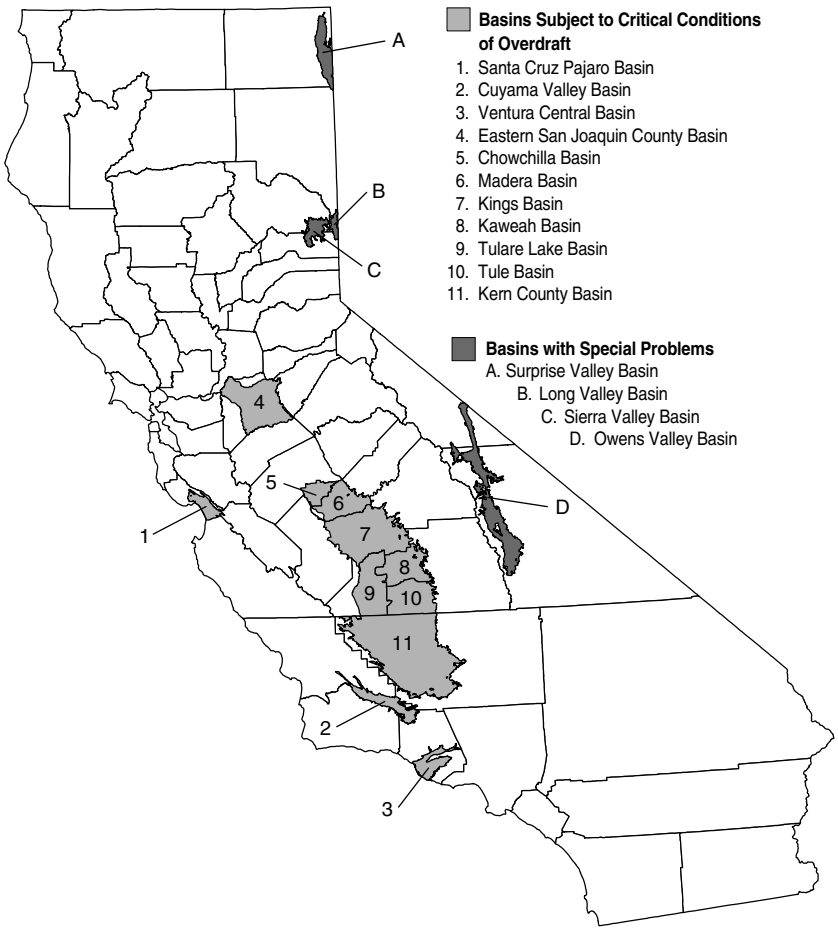
NOTES: The basins illustrated are the full basin boundaries as determined by DWR. Actual adjudicated basin boundaries are defined by the court and are often smaller. The dates indicate the year of final adjudication.

Figure B.2—Adjudicated Groundwater Basins

SOURCES: Agency names and dates are from the Department of Water Resources (1996a); basin contours are from the Department of Water Resources (2002a); agency contours are from the U.S. Bureau of Reclamation (2002).

NOTES: Special Water Districts and Pajaro Valley Water Management Agency are represented by administrative district boundaries (U.S. Bureau of Reclamation, 2002). Other district boundaries are represented by underlying groundwater basin boundaries (Department of Water Resources, 2002a). The following district boundaries were estimated using corresponding basins: Monterey Peninsula Water Management District (Seaside Area subbasin of Salinas Valley and Carmel Valley), Fox Canyon Groundwater Management Agency (Oxnard subbasin of Santa Clara River Valley, Pleasant Valley, Arroyo Santa Rosa Valley, and Las Posas Valley), Mendocino City Community Services District (Fort Bragg Terrace Area), and Tri-Valley Groundwater Management District (Eastern Mono County portion of Owens Valley).

Figure B.3—Special Groundwater Management Districts



NOTES: The basins illustrated are those identified in Bulletin 118-80 (Department of Water Resources,1980), mapped using boundaries appearing in the 2002 Draft Groundwater Map (Department of Water Resources, 2002a). Owing to name or boundary changes, the following 1980 basin boundaries were estimated using the 2002 definitions: Santa Cruz-Pajaro Basin (Santa Cruz Purisima Formation; Pajaro), Ventura Central Basin (Piru, Fillmore, Santa Paula, Mound, and Oxnard subbasins of Santa Clara River Valley; Pleasant Valley; Arroyo Santa Rosa Valley; and Las Posas Valley).

Figure B.4—Critically Overdrafted and Special Problem Groundwater Basins Listed in Bulletin 118-80

Appendix C

Predicting County Adoption of Export Restrictions

This appendix describes the data sources, estimation methods, and results of the statistical analysis of the likelihood of county adoption of export restrictions reported in Chapter 4.

Data Sources

Farm and Agriculture-Related Jobs

The source for farm jobs is the Bureau of Economic Analysis regional accounts data. The source for agriculture-related jobs is the Bureau of the Census "County Business Patterns." Data are from 1995.

Share of Irrigated Agriculture in Total Farmland

This series is derived from results of the 1997 Agricultural Census (U.S. Department of Agriculture and the California Department of Food and Agriculture). 1997 data were preferred over those from 1992, a year with unusually low acreage figures as a consequence of the prolonged drought.

Share of Residential Population Dependent on Groundwater

This series was approximated using information from county environmental health officers and a 1992 survey by the Water Education Foundation (1994).

Other Variables

Membership in the Regional Council of Rural Counties and presence of a critical or specially designated groundwater basin are presented in Chapter 4.

Estimation Methods and Results

Probit regressions were used to estimate the effect on a county's likelihood of adopting an export ordinance of the variables presented above, for which sample characteristics are reported in Table 4.1. The statistical exercise involves considering the effect of each variable on ordinance adoption, while holding the other variables constant.

Table C.1 reports the results of two regressions, one including the full set of variables and one excluding residential groundwater share. The variables used in each model are jointly significant at the 99 percent level of confidence. The second model produces slightly tighter coefficient estimates because groundwater share, itself insignificant, is correlated with the measure of critical basins. This exclusion does not affect overall model fit. Both models slightly underpredict adoption of export restrictions: compared to the 22 actual cases (38 percent), the models predict adoption by 20 counties (34 percent).

Most of the variables are marginally significant (at the 90 percent level of confidence), with coefficients of the expected sign. The effects of each variable on the likelihood of ordinance adoption are presented in Chapter 4.

Because some of the counties in the nonadoption group have other types of more comprehensive groundwater management systems in place—including adjudicated basins, special districts, or groundwater protection ordinances that control local groundwater use—we also performed two tests to see whether the results changed significantly when controlling for this factor: a multinomial logit regression distinguishing among three possible outcomes (export restrictions, comprehensive groundwater management systems, and no groundwater rules), and a binomial probit with a control variable for counties with these types of groundwater systems. The additional "groundwater management" group for the multinomial logit included El Dorado, Los Angeles, Mendocino, Monterey, Napa, Orange, Plumas, Riverside, San Bernardino, Santa Clara, Santa Cruz, San Diego, and Ventura. The groundwater management control variable in the binomial probit included this group plus counties with dual systems: Imperial, Lassen, Modoc, Mono, San Benito, Sierra, and Siskiyou. In neither case was there a substantial

Table C.1

Effects of County Characteristics on the Probability of Adopting an Export Restriction

	Model Including Residential Groundwater	Model Excluding Residential Groundwater
Farm employment (%)	0.045*	0.048*
	(0.026)	(0.025)
Agriculture-related employment (%)	–0.13*	–0.12*
	(0.077)	(0.075)
Irrigated farmland (%)	0.004	0.004
	(0.003)	(0.003)
Residents using groundwater (%)	0.001	—
	(0.003)	
Counties overlying critical/special basin	0.23	0.26*
	(0.17)	(0.16)
RCRC membership	0.27*	0.30*
	(0.16)	(0.15)
Chi-squared test of joint significance of variables in model	20.88***	20.72***
Log-likelihood	–28.06	–28.13
Observed probability	38%	38%
Predicted probability	34%	34%

NOTES: Coefficients are reported as marginal effects. For the binary variables (critical groundwater basins and RCRC membership), the coefficient is the effect of a discrete change from 0 to 1. Standard errors are reported in parentheses.

***Indicates coefficient significantly different from zero at the 99 percent level of confidence.

*Indicates coefficient significantly different from zero at the 90 percent level of confidence.

change in coefficient estimates in relation to those reported in Table C.1, although the loss of degrees of freedom in the multinomial logit reduces levels of significance.

Appendix D

Measuring the Effect of Export Restrictions on County Water Sales

This appendix provides detailed information on the data sources, estimation methods, and results of the statistical analysis of the effect of export restrictions on county water sales and exports presented in Chapter 5.

Data Sources

Annual County Water Sales and Annual County Exports

These series are developed from the water transfer database presented in Chapter 2 and Appendix A. Annual county sales are defined as the sum of all short- and long-term transfers by county water users in a given year. For sales by cross-jurisdictional water districts, the approximate share of the district in each county has been attributed to that county. Annual county exports are the sum of transfers not destined for other water users within the county. Environmental water sales were considered as exports from the county. Although this water is most often used for habitat or instream purposes within the region, it rarely is under control of users in the county of origin. For water districts with multiple jurisdictions, we considered the transaction to be "in-county" if the purchaser was in any of the district's counties. As such, the exports category unambiguously includes only those transfers going from a user within the county to a user somewhere else in the region or state.

Because the coverage of transfers within the CVP's Friant group was not consistently available in all years, we have excluded internal Friant transactions from the sales data. This concerns five San Joaquin Valley counties: Merced, Madera, Fresno, Tulare, and Kern. Since members of the Friant group are effectively exempted in the counties with ordinances, this should not pose a problem for interpretation of the

results. Trades between Friant members and other water users are included.

County Export Restrictions

We consider that counties have an export ordinance in operation beginning in the year of adoption, as indicated in Table C.1. There are two exceptions. Because Kern County's ordinance applies only to the relatively unimportant desert and foothill region in the southeast, but not to the San Joaquin valley portion of the county where population, agriculture, and surface water entitlements are all concentrated, we have considered Kern to have no ordinance for the purposes of this exercise. The second exception is made for Glenn County, whose export ordinance was effectively removed in 2000, when the new basin management ordinance was adopted.[1] The 2001 season is the first during which Glenn water users worked under the new system.

State and Federal Policy Environment

The general effects of an improved trading environment arising from state and federal policies to facilitate transfers are captured by a time trend.

Agricultural Water Demand

The model uses three measures of agricultural water demand: average county-level prices for annual crops (defined as all field and horticultural crops), the acreage under annual crops, and the share of perennial crops in total nonrange acreage. All three series are constructed using county agricultural statistics from the California Agricultural Statistics Service databases.[2]

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[1]Although the 1990 ordinance remains on the books, the numerous persons interviewed in Glenn, including two county supervisors, considered that the new ordinance has supplanted it for operational purposes.

[2]The annual crop price is calculated using the county's prior year output data, valued at the statewide average price for the current year. This captures the notion that the farmer has an idea of the average market price for the coming season and can calculate what he would earn by farming the same crop mix as in the preceding year. The series is deflated using the western states urban consumer price index, with 1992 as the base year. Ideally, we would measure the value of crops on a per-acre-foot basis to capture the water

In principle, we would expect water sales to be inversely related to the average level of crop prices, which reflect the value of using water in agriculture. On average, real price levels have been relatively flat over the period, hovering around $160 per ton in 1992 prices. The range across counties is quite large, however, with averages over $300 per ton along the south and central coast and $100 per ton or less in parts of the Central Valley.

As with prices, there has been little movement over time in the average level of annual crop acreages, although the cross-county differences are huge, with at least several hundred thousand acres in Imperial County and most San Joaquin Valley counties (and close to 1 million acres in Fresno), and fewer than 50,000 acres along the coast.[3] In part, this range reflects differences in the overall scale of agricultural operations across counties; in part, it reflects a much higher share of perennial crops (fruit trees, nut trees, and vineyards) in some counties. The values span a high of over 90 percent of all nonrange farmland in Napa and over 50 percent in San Diego, Ventura, and Madera, to only 1 percent of cropland in Imperial. Over time, there has been a mild upward trend in tree crops as a share of the total, moving from 22 to 26 percent on average.

Because farmers can make adjustments in annual crop acreages fairly easily as a function of water availability, we would expect water sales to be positively related a county's crop acreage. Conversely, because a higher share of tree crops in total acreage introduces less flexibility in water use, we would expect tree crop share to be negatively related to water sales.

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intensity of the crop mix. This would require making assumptions about the irrigation technology used in each county for each crop, however. If anything, the use of a per-ton measure probably dampens the effect of this variable, since low-value crops also tend to be those with a relatively high level of water use. Annual crop acreage includes all farm acreage except perennials and rangeland (i.e., including irrigated pasture). The share of tree crops is calculated as the share of perennials in total nonrangeland farm acreage. Both acreage measures are valued at the prior year levels to account for the fact that decisions on water sales are generally made before final planting decisions.

[3]San Francisco, the only county in the sample with no commercial agriculture (albeit some fine gardens), has no acreage recorded and no positive crop prices.

Residential Water Demand

County population levels are used to account for residential water demands. The source is the annual population series from the California Department of Finance, based on updates from the 2000 Census (Department of Finance, 2001). Other things equal, we should expect counties with higher populations to be less likely to sell water.

Water Supply Conditions

Annual deliveries of project water from the CVP, the SWP, and the Colorado River Project are captured in two measures: senior rights and junior rights.[4] The senior rights category includes those deliveries with a high degree of reliability, by virtue of the seniority of the contractors. This includes the CVP settlement contractors in the Sacramento Valley and the exchange contractors in the San Joaquin Valley, the SWP's Feather River contractors in Butte and Sutter Counties, and the Colorado River contractors in Southern California. On average, 8.3 million acre-feet are delivered annually to these contractors. Half of this volume is destined to Imperial and Riverside Counties and a quarter to the four main settlement-contracting counties in the Sacramento Valley (Colusa, Butte, Sutter, and Glenn). The only dips in supply occurred during the early 1990s drought, when CVP and SWP contractors' deliveries were reduced by 25 to 50 percent in some years.

The junior-rights category includes the ordinary project contractors of the CVP and the SWP. On average, these projects have delivered just over 6 million acre-feet annually over the 12-year period, to a much larger number of water users. Only two counties in the sample, San Francisco and Yuba, do not have project contractors. Project deliveries have generally been much more variable from one year to the next, particularly for contractors south of the Delta.

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[4]For the Colorado River Project and the SWP, actual delivery data were used. For the CVP, we applied the annual allocation rules by type of project contractor (settlement contractors, north of Delta and south of Delta service contractors, and Friant class 1 and 2 contractors). Because California received surplus deliveries of Colorado River water for the entire time period under consideration, the Metropolitan Water District of Southern California is included as a senior rights-holder. Under California's official allocation of 4.4 million acre-feet, this agency would have its supplies cut back, as the junior rights-holder.

In general, we would expect counties with higher water deliveries to be more active in the water market. By the same token, individual counties should be more likely to sell in years when their deliveries are higher.

Unfortunately, detailed data on other water supplies—from autonomous projects and from groundwater—are not available. We do have a general indicator of the quality of the water year, however, in the form of the state's most important rainfall measure—the Sacramento Valley 40-30-30 index.[5] Since market demands and water prices are likely to be higher in dry years, we would expect this indicator to be negatively related to sales. The period under review contains an equal number of dry and wet years (Figure 2.1).

Sample Characteristics

Table D.1 provides summary statistics for the complete set of variables used for both geographical samples used in the estimations: the 34 water-trading counties[6] and the 18 Central Valley counties.[7] We have excluded 24 nontrading counties from the first group for statistical reasons. Two key econometric models cannot be estimated when these counties are included. The inclusion of counties that never trade adds no information to the estimation of the effects of an export ordinance on trading behavior in a fixed-effects mode. The presence of many counties with all zero trades also complicates the estimation of a random-effects Tobit model. For the state as a whole, the convergence properties of this

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[5]The Sacramento Valley 40-30-30 Index is the main index used by DWR to measure water conditions in the Sacramento Valley, source region for both the CVP and the SWP as well as several large local projects. It is computed as a weighted average of the current water year's April–July unimpaired runoff forecast (40 percent), the current water year's October–March unimpaired runoff forecast (30 percent), and the previous water year's index (30 percent). For details, see DWR's website, http://watsup2.water.ca.gov/hydrologic.cfm.

[6]The sample excludes the 24 counties for which there are no transactions records in any of the 12 years: Alpine, Amador, Calaveras, Del Norte, El Dorado, Humboldt, Inyo, Lake, Lassen, Marin, Mariposa, Mendocino, Modoc, Mono, Monterey, Nevada, Plumas, San Mateo, Santa Cruz, Sierra, Siskiyou, Sonoma, Trinity, and Tuolumne.

[7]Butte, Colusa, Fresno, Glenn, Kern, Kings, Madera, Merced, Placer, Sacramento, San Joaquin, Shasta, Stanislaus, Sutter, Tehama, Tulare, Yolo, and Yuba.

Table D.1

Summary Statistics for Annual County Water Sales and Water Exports, 1990–2001

	34 Trading Counties	18 Central Valley Counties
All sales (acre-feet)	22,734	31,461
	(40,658)	(45,842)
Observed probability of sales	0.69	0.89
Out-of-county exports (acre-feet)	19,465	25,419
	(39,075)	(44,140)
Observed probability of exports	0.61	0.82
Agricultural and residential demand		
Annual crop prices ($/ton)	162	117
	(126)	(51)
Annual crop area (acres)	205,893	294,918
	(226,721)	(230,010)
Tree crop area in total (%)	23.2	22.6
	(19.7)	(13.9)
Population	856,177	286,226
	(1,602,147)	(292,132)
Water supply conditions		
Project deliveries (acre-feet)		
Senior rights	243,826	178,751
	(537,918)	(210,645)
Junior rights	179,474	247,412
	(272,842)	(346,500)
Rainfall index	8.18	8.18
	(3.18)	(3.18)
County export restrictions	0.19	0.30
(1 = restriction)	(0.39)	(0.46)
Number of observations	408	216

NOTE: The table reports mean values with standard deviations in parentheses.

model are not stable. However, regression results on the full state sample are consistent with the findings we report below on the effects of the export ordinances and other key variables for the 34-county sample.

Regression Results

A random-effects Tobit model is the main specification used to account for bunching at zero in the distribution of the dependent variable.[8] Because it is not straightforward to test for fixed effects using this specification (Arellano and Honoré, 2001), we did so with a linear model. Tables D.2 through D.5 present the results for the random-effects Tobit model and the corresponding random- and fixed-effects linear models for all sales and exports for the water-trading counties and Central Valley counties, respectively. Despite the censoring in the dependent variable, the results of the random effects linear model correspond closely to the Tobit model results, suggesting that reliance on the linear model for inferring properties about the Tobit model is reasonable. For all four models, Hausman specification tests of the linear model fail to reject the null hypothesis of no fixed effects at conventional levels of significance, suggesting the absence of cross-sectional omitted variables that would bias the random-effects Tobit results. Consequently, the discussion in Chapter 5 focuses on the results of the random-effects Tobit model.

Overall, the identified variables have the anticipated effects on both sales and exports. Among the control variables, the group capturing the effects of water supply is highly significant. Crop prices and annual crop acreage, two of the agricultural demand variables, are significant for the determination of sales within the full 34-county sample. These factors are not significant for the Central Valley sample, where there is less cross-county variability.

Results pertaining to the key variables of interest—county export restrictions and the time trend used to capture the effect of an improved trading environment—are presented in Chapter 5. The cumulative market effect of ordinances (Figure 5.2) was calculated by multiplying the number of counties affected by the per-county coefficients listed in

[8]For the 34-county sample of water trading counties, 31 percent of all sales and 39 percent of all exports are zero; for the 18-county Central Valley sample, the corresponding values are 11 percent of all sales and 18 percent of all exports.

the left-hand column of Tables D.2 through D.5. For the 34-county sample, the number of counties with ordinances ranges from two in the early 1990s to 12 in 2000. For the 18-county sample, the range is from two in 1990 to 10 in 2000. The cumulative market effect of state and federal policies (Figure 5.3) was calculated by multiplying the total number of counties in the sample (34) by the coefficient on the time trend reported in the left-hand column of Table D.2.

Table D.2

Determinants of Annual County Water Sales in 34 Water-Trading Counties, 1990–2001

	Random-Effects Tobit	Random-Effects Linear Regression	Fixed-Effects Linear Regression
Agricultural and residential demand			
Annual crop prices ($/ton)	–75.8**	–40.8	–55.6
	(33.0)	(25.9)	(52.5)
Annual crop area (1,000 acres)	54.6**	37.0*	143
	(23.1)	(19.7)	(88.4)
Tree crop area in total (%)	–96.1	–10.2	213
	(220)	(176)	(680)
Population (1,000)	–1.5	–1.1	–0.8
	(2.6)	(2.3)	(32.4)
Water supply conditions			
Project deliveries (1,000 acre-feet)			
Senior rights	23.8***	21.5***	–140**
	(7.4)	(7.2)	(56.6)
Junior rights	49.2***	42***	51***
	(13.1)	(10.6)	(12.5)
Rainfall index	–3,529***	–2,160***	–2,099***
	(749)	(549)	(575)
State and local institutional factors			
County export restrictions	–14,308**	–12,671**	–10,770*
	(7,246)	(5,563)	(6,387)
State and federal policy (time trend)	3,828***	2,442***	2,616***
	(681)	(515)	(720)
Log-likelihood; overall R^2	–3,419	0.34	0.00
Hausman specification test			0.33

NOTES: All models are estimated with a constant. Standard errors are in parentheses. The Hausman specification test reports the probability that the difference in coefficients of random-effects and fixed-effects regressions is not systematic.

***Indicates coefficient is significantly different from zero at the 99 percent level of confidence in a two-way test.

**Indicates coefficient is significantly different from zero at the 95 percent level of confidence in a two-way test.

*Indicates coefficient is significantly different from zero at the 90 percent level of confidence in a two-way test.

Table D.3

Determinants of Annual County Water Exports in 34 Water-Trading Counties, 1990–2001

	Random-Effects Tobit	Random-Effects Linear Regression	Fixed-Effects Linear Regression
Agricultural and residential demand			
Annual crop prices ($/ton)	–88.9**	–45.0*	–59.2
	(38.4)	(27.0)	(52.4)
Annual crop area (1,000 acres)	37.6	15.7	97.1
	(27.2)	(20.6)	(88.3)
Tree crop area in total (%)	–113	–17.9	215
	(254)	(185)	(679)
Population (1,000)	–2.0	–1.2	8.0
	(3.0)	(2.5)	(32.4)
Water supply conditions			
Project deliveries (1,000 acre-feet)			
Senior rights	28.3***	24.4***	–160***
	(8.0)	(7.6)	(56.6)
Junior rights	43.2***	34.5***	44.7***
	(14.3)	(11.0)	(12.5)
Rainfall index	–3,235***	–1,909***	–1,796***
	(831)	(551)	(575)
State and local institutional factors			
County export restrictions	–16,948**	–16,276***	–13,875**
	(7,722)	(5,632)	(6,378)
State and federal policy (time trend)	3,729***	2,242***	2,321***
	(761)	(517)	(719)
Log-likelihood; overall R^2	–3,062	0.26	0.05
Hausman specification test			0.15

NOTES: All models are estimated with a constant. Standard errors are in parentheses. The Hausman specification test reports the probability that the difference in coefficients of random-effects and fixed-effects regressions is not systematic.

***Indicates coefficient is significantly different from zero at the 99 percent level of confidence in a two-way test.

**Indicates coefficient is significantly different from zero at the 95 percent level of confidence in a two-way test.

*Indicates coefficient is significantly different from zero at the 90 percent level of confidence in a two-way test.

Table D.4

Determinants of Annual County Water Sales in 18 Central Valley Counties, 1990–2001

	Random-Effects Tobit	Random-Effects Linear Regression	Fixed-Effects Linear Regression
Agricultural and residential demand			
Annual crop prices ($/ton)	–71.8	–57.9	–87.0
	(87.7)	(91.1)	(129.3)
Annual crop area (1,000 acres)	11.0	1.0	224*
	(28.8)	(31.4)	(130)
Tree crop area in total (%)	289	118	–278
	(364)	(421)	(1,659)
Population (1,000)	–18.5	–7.4	163
	(21.6)	(24.2)	(166)
Water supply conditions			
Project deliveries (1,000 acre-feet)			
Senior rights	–7.2	–16.2	–116
	(25.6)	(28.7)	(75.8)
Junior rights	64.0***	60.0***	65.4***
	(15.4)	(15.0)	(17.3)
Rainfall index	–5,410***	–4,482***	–4,639***
	(1,049)	(969)	(1,037)
State and local institutional factors			
County export restrictions	–20,789**	–19,038**	–13,034
	(8,713)	(8,397)	(9,309)
State and federal policy (time trend)	4,645***	4,094***	3,412**
	(977)	(934)	(1,341)
Log-likelihood; overall R^2	–2,321	0.27	0.11
Hausman specification test			0.58

NOTES: All models are estimated with a constant. Standard errors are in parentheses. The Hausman specification test reports the probability that the difference in coefficients of random-effects and fixed-effects regressions is not systematic.

***Indicates coefficient is significantly different from zero at the 99 percent level of confidence in a two-way test.

**Indicates coefficient is significantly different from zero at the 95 percent level of confidence in a two-way test.

*Indicates coefficient is significantly different from zero at the 90 percent level of confidence in a two-way test.

Table D.5

Determinants of Annual County Water Exports in 18 Central Valley Counties, 1990–2001

	Random-Effects Tobit	Random-Effects Linear Regression	Fixed-Effects Linear Regression
Agricultural and residential demand			
Annual crop prices ($/ton)	–139	–77.7	–105.6
	(102)	(92.0)	(130)
Annual crop area (1,000 acres)	–30.7	–26.6	166
	(32.1)	(31.7)	(130)
Tree crop area in total (%)	409	172	–559
	(408)	(427)	(1,665)
Population (1,000)	–10.3	–3.5	245
	(23.7)	(24)	(167)
Water supply conditions			
Project deliveries (1,000 acre-feet)			
Senior rights	–10.9	–26.4	–126*
	(29.0)	(29)	(76)
Junior rights	58.6***	51.5***	54.7***
	(16.4)	(15.1)	(17.4)
Rainfall index	–4,661***	–3,963***	–4,072***
	(1,109)	(975)	(1,041)
State and local institutional factors			
County export restrictions	–26,245***	–23.481***	–16,902*
	(9,350)	(8,450)	(9,343)
State and federal policy (time trend)	4,220***	3,659***	2,699**
	(1,039)	(940)	(1,346)
Log-likelihood; overall R^2	–2,173	0.20	0.04
Hausman specification test			0.52

NOTES: All models are estimated with a constant. Standard errors are in parentheses. The Hausman specification test reports the probability that the difference in coefficients of random-effects and fixed-effects regressions is not systematic.

***Indicates coefficient is significantly different from zero at the 99 percent level of confidence in a two-way test.

**Indicates coefficient is significantly different from zero at the 95 percent level of confidence in a two-way test.

*Indicates coefficient is significantly different from zero at the 90 percent level of confidence in a two-way test.

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