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TRANSFERRING WATER IN THE AMERICAN WEST: 1987–2005

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Rising urban and environmental demand for water has created growing pressure to re-allocate water from traditional agricultural uses. Water markets are powerful institutions for facilitating this re-allocation, yet the evolution of water markets has been more complicated than those for other resources. In this paper, we set the context for water marketing with an overview of western water law that highlights unique aspects of water law that affect how or whether a water market can develop. Second, we present new, comprehensive data on the extent, nature, and timing of water transfers across 12 western states from 1987–2005. We describe the methodology and decision rules used to collect water transfer information. Third, we identify water market trends and movements to provide a greater understanding of the institutional structure and the mechanisms by which water is transferred in the American West.

INTRODUCTION

In the United States, we use a huge amount of water to grow heavily subsidized cotton and alfalfa feed.[1] Irrigation systems, often primitive earthen canals, may lose forty to fifty percent of the water

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1. *See* Robert Glennon, *Water Scarcity, Marketing, and Privatization*, 83 TEX. L. REV. 1873, 1884–85 (2005).

diverted into them through seepage into the ground.[2] Once the water reaches farms, many farmers use highly inefficient flood irrigation or sprinkler systems that direct water into the air, where much of it evaporates. In California's Imperial Valley, almost one million acre-feet ("maf") of the three maf diverted by the Imperial Irrigation District ends up as wastewater flowing into the Salton Sea.[3] Farmers irrigate millions of acres of marginal land despite the lack of high value crops or substantial profit yields because the farmers have the right to irrigate and may not have the right to do anything else with the water. Under the doctrine of salvage, a farmer who conserves water may lose the right to it,[4] and a farmer who does not use the water may lose the right to it through the doctrines of abandonment or forfeiture.[5]

As a result, farmers continue to use roughly eighty percent of each state's water,[6] even though other users might find a significantly more profitable use for it. In California, an acre-foot used in the semiconductor industry produces $980,000 in gross state revenue; that same acre-foot used to grow cotton and alfalfa generates sixty dollars.[7] Such disparities of value in the use of a resource beckon calls for the reallocation of water from lower-value to higher-value activities through water marketing—voluntary agreements between willing sellers and buyers.[8] The quickest way to

2. *See id.* at 1884.

3. *Id.* at 1884–85.

4. *See* S.E. Colo. Water Conservancy Dist. v. Shelton Farms, Inc., 529 P.2d 1321, 1325–27 (Colo. 1974). Other states may allow the farmer to keep the salvaged water. *See* JOSEPH L. SAX ET AL., LEGAL CONTROL OF WATER RESOURCES 186–90 (4th ed. 2006).

5. SAX ET AL., *supra* note 4, at 247–56.

6. *See id.* at 17.

7. *See* Peter Gleick, *Pending Deal Would Undermine State's Water Solutions*, SACRAMENTO BEE, Feb. 25, 2005, at B7.

8. There is a large body of literature on water marketing. *See, e.g.*, TERRY L. ANDERSON & PAMELA SNYDER, WATER MARKETS: PRIMING THE INVISIBLE PUMP (1997); EDUARDO BAUTISTA ET AL., SHARING SCARCITY: GAINERS & LOSERS IN WATER MARKETING (Harold O. Carter et al. eds., 1994); BRENT M HADDAD, RIVERS OF GOLD: DESIGNING MARKETS TO ALLOCATE WATER IN CALIFORNIA (2000); ELLEN HANAK, WHO SHOULD BE ALLOWED TO SELL WATER IN CALIFORNIA?: THIRD-PARTY ISSUES AND THE WATER MARKET (2003); CHARLES MEYERS & RICHARD POSNER, MARKET TRANSFERS OF WATER RIGHTS: TOWARD AN IMPROVED MARKET IN WATER RESOURCES (1971); NAT'L RESEARCH COUNCIL, WATER TRANSFERS IN THE WEST: EFFICIENCY, EQUITY AND THE ENVIRONMENT (1992); BONNIE C. SALIBA & DAVID BUSH, WATER MARKETS IN THEORY AND PRACTICE: MARKET TRANSFERS, WATER VALUES, AND PUBLIC POLICY (1987); Thomas C. Brown, *Trends in Water Market Activity and Price in the Western United States*, 42 WATER RES. RESEARCH., W09402 (2006); Janis M. Carey & David L. Sunding, *Emerging Markets in Water: A Comparative Institutional Analysis of the Central Valley and Colorado-Big Thompson Projects*, 41 NAT. RESOURCES J. 283 (2001); Joseph W. Dellappena, *The Importance of Getting Names Right: The Myth of Markets for Water*, 25 WM. & MARY ENVTL. L. & POL'Y REV. 317 (2000); Eric T. Freyfogle, *Water Rights and the Common Wealth*, 26 ENVTL. L. 27 (1996); Robert J. Glennon, *"Because That's Where the Water Is": Retiring Current Water Uses to Achieve the Safe-Yield Objective of the Arizona Groundwater Management Act*, 33 ARIZ. L. REV. 89

reform agricultural water use in the United States is to give farmers a financial incentive to use less: that is, let them sell the water to thirsty cities.

Water marketing is of more than academic interest. The reality is that the United States is facing a water crisis.[9] There is a disconnect between supply and demand, as population surges upward and our water supplies remain finite.[10] In the past when we needed more water, we diverted a river, built a dam or drilled a well. With a few exceptions, these options are no longer viable due to engineering, economic, and environmental objections.[11] Our options for obtaining new supplies of water are limited, and we must recognize that we are entering an era of water reallocation, a time when new supplies will necessarily be met by existing users using less. If we want to save our environment from further degradation, we should embrace water marketing.

In theory, it should be easy to achieve this reallocation. The value to and the price paid by municipal and industrial users dwarfs that paid by farmers. For instance, groundwater for farming near Marana, Pima County, Arizona costs approximately twenty-seven dollars per acre-foot (approximately 325,000 gallons), whereas the same water supplied by Tucson Water, with an increasing block rate structure, will cost customers from $479 to $3,267 per acre-foot.[12] In recent efforts to secure Imperial Irrigation District water, San Diego offered $258 per acre-foot for water that farmers in the Imperial Irrigation District paid fifteen or twenty

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(1991); Thomas J. Graff & David Yardas, *Reforming Western Water Policy: Markets and Regulation*, 12 NAT. RESOURCES & ENV'T 165 (1998); Brian E. Gray, *The Shape of Transfers to Come: A Model Water Transfer Act for California*, 4 HASTINGS W.-NW. J. ENVTL. L. & POL'Y 23 (1996); Charles W. Howe, Commentary, *Protecting Public Values in a Water Market Setting: Improving Water Markets to Increase Economic Efficiency and Equity*, 3 U. DENV. WATER L. REV. 357 (2000); Richard E. Howitt, *Empirical Analysis of Water Market Institutions: The 1991 California Water Market*, 16 RESOURCE & ENERGY ECON. 357 (1994); Richard Howitt & Kristina Hansen, *The Evolving Western Water Markets*, CHOICES, 1st Quarter 2005, at 59, http://www.choicesmagazine.org/2005-1/environment/2005-1-12.pdf; Janet C. Neuman & Cheyenne Chapman, *Wading into the Water Market: The First Five Years of the Oregon Water Trust* 14 ENVTL. L. & LITIG. 135 (1999); Carol M. Rose, *Rethinking Environmental Controls: Management Strategies for Common Resources*, 1991 DUKE L.J. 1 (1991); Joseph L. Sax, *Understanding Transfers: Community Rights and the Privatization of Water*, 1 HASTINGS W.-NW. J. ENVTL. L. & POL'Y 13 (1994); Barton H. Thompson, Jr., *Institutional Perspective on Water Policy and Markets*, 81 CAL. L. REV. 671 (1993).

9. *See* Glennon, *supra* note 1, at 1873–74.

10. *See id.* at 1874–75.

11. *See id.* at 1873–79.

12. Interview with Paul Wilson, Professor of Agricultural Economics, University of Arizona; Ken Seasholes, Director, Arizona Department of Water Resources, Tucson Active Management Area; and Christopher Avery, Esq., Assistant City Attorney, Tucson City Attorney's Office, in Tucson, Ariz. (Jan. 2007) [hereinafter Interviews]; *see also* TUCSON, ARIZ., CITY CODE § 27.33 (1965).

dollars.[13] Even more dramatically, while farmers in the Imperial Irrigation District paid $13.50 per acre-foot in 2001, a development near the South Rim of Grand Canyon National Park was prepared to spend $20,000 per acre-foot for the same Colorado River water.[14]

The economic theory of institutional change suggests that with such opportunities for trade, water law and related legal institutions will respond by lowering the transaction costs of transferring water from agriculture.[15] In this process, property rights institutions are particularly important. Most economists agree that an efficient system of property rights requires three elements: a complete definition; exclusivity; and transferability.[16] Despite these theoretical predictions, however, water markets appear to be developing more slowly than theory would suggest.

The gap between theory and reality raises several questions. First, how much water marketing is taking place? Second, are some states more receptive to water marketing than are others? If so, what variables—economic, social, or legal—account for differences between and among the states? Third, has the legal system responded as the economics literature predicts to lower the transaction costs to transferring water? If not, why not? Finally, might empirical analysis shed light on these questions?

In 2003, we received a National Science Foundation grant to begin work on these questions.[17] Our study is the most ambitious and comprehensive study of water transfers ever undertaken. It attempts to test basic economic theory using an empirical study of water transfers in the American West.

In this Essay, we answer the first question: How much water marketing is taking place?[18] This Essay proceeds in three steps. First, we set the context for water marketing with an overview of western

13. Interviews, *supra* note 12.

14. *See* ROBERT GLENNON, WATER FOLLIES: GROUNDWATER PUMPING AND THE FATE OF AMERICA'S FRESH WATERS 207 (2002).

15. *See* GARY LIBECAP, CONTRACTING FOR PROPERTY RIGHTS 1–8 (1989). Yet, recent work on institutional change reveals that the process is complex and can be derailed by information problems, distributional concerns, entrenched political constituencies, and third-party effects that cannot be completely determined. *See id.* at 19–28.

16. *See* Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. (PAPERS & PROC.) 347–59 (1967) (providing a general discussion of the characteristics and emergence of property rights and linking the development of property rights to changes in resource values); Richard A. Posner, *The Law and Economics Movement*, 77 AM. ECON. REV. (PAPERS & PROC.) 1–13 (1987) (providing a general overview of the law and economics movement, including property rights analysis). Although the theory of property rights outlined by Demsetz suggests that that rights will become more definite as the value of the resources rise, this has not happened with water rights quickly, as the above anomalies suggest.

17. National Science Foundation Grant No. 0317375.

18. *See* Brown, *supra* note 8, at W09402; Howitt & Hansen, *supra* note 8, at 59–63 (addressing this issue but with different approaches and a more narrow data set).

water law that highlights unique aspects of water law that affect how or whether a water market can develop. Second, we describe the methodology and decision rules used to collect water transfer information. As will become clear, compiling a comprehensive dataset of transfers in the American West was not always straightforward. We had to make several assumptions and apply rules of thumb. Third, we present an overview and discussion of the compiled data. Finally, we identify water market trends and movements to provide a greater understanding of the institutional structure and the mechanisms by which water is transferred in the American West.

I. WESTERN WATER LAW AND WATER MARKETS

A. *Water rights*

For a water market to develop, water law must securely establish rights to a particular quantity of water, and the rights must be transferable. For most markets, such as computers or real estate, establishing secure property rights poses no problem, as legal rules can easily set boundaries to protect essential characteristics of property, such as exclusivity. Water has two complications that impede the development of a sophisticated market: water moves and water is reused. Most water rights are only partially consumptive. For farmers who irrigate, crops typically consume thirty to fifty percent of the water the farmer diverted from the river.[19] The other fifty to seventy percent usually flows off the land and back into the river directly or percolates into the ground and moves subsurface, eventually rejoining the river downstream.[20] Once the water has rejoined the stream, it is subject to second and subsequent diversions by downstream users.[21] The important point for water marketing is that water rights are not exclusive, but interdependent, so that a change in one user's method of irrigation, timing, or point of diversion might interfere with the rights of downstream users who have come to rely on the upstream diverters' existing method of irrigation, timing of irrigation, purpose of irrigation, or point of diversion.

19. *See* THOMAS V. CECH, PRINCIPLES OF WATER RESOURCES: HISTORY, DEVELOPMENT, MANAGEMENT, AND POLICY 137 (2003).

20. *See id.*

21. *See* SAX ET AL., *supra* note 4, at 126–31.

B. *State Policies and Water Rights*

An important characteristic of water rights in most western states is that they are not absolute ownership rights but instead usufructuary rights—rights to use the resource. Water is owned by the state that permits its citizens to make use of the resource.[22] Water is thus a public resource regulated by the state that allows residents to use the water if they put the water to a beneficial use. Most western states require the state's water agency to determine whether proposals for new diversions of surface water are in the "public interest."[23] Most states also have a regulatory review proceeding for proposed transfers of water rights from one user to another or from one use to another that insures that the proposed changes not harm other water rights holders.[24]

Western water law, because it is largely state-based, may vary from state to state. For surface water rights, the prior appropriation doctrine prevails in every western state.[25] This first-in-time is first-in-right rule divides diverters into senior and junior appropriators depending on the date at which the first diversion was made.[26] The senior rights are most secure, and during drought conditions, more junior users may be cut off.[27] Even though the system is heavily regulated today through administrative agencies, its genesis in the nineteenth century means that anecdotal evidence forms the basis for many of the most senior rights. While the prior appropriation doctrine is often understood as a system that allots each user a fixed quantity of water with a particular priority date and a particular point of diversion with a specified purpose, there are many conflicts between and among the large number of users on major western rivers. Indeed in some states, claims by users exceed the amount of water that is actually in the river leading to the curious dichotomy between "paper rights" and "wet water."[28]

In an effort to eliminate this uncertainty and give more predictability to water rights, states have set up complicated procedures, called general adjudications. General adjudications bring all claimants in a particular river system into a single court to have

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22. *See* DAVID H. GETCHES, WATER LAW 82 (3d ed. 1997). Texas continues to adhere to the "right of capture," a quaint rule that gives landowners actual ownership of the groundwater beneath their property. *See* GLENNON, *supra* note 14, at 87–97.

23. *See* SAX ET AL., *supra* note 4, at 220–34.

24. *See, e.g.*, ARIZ. REV. STAT. ANN. § 45-172 (2006).

25. *See* CECH, *supra* note 19, at 203. California also retains a carryover of riparian rules from the American East. *See* GETCHES, *supra* note 22, at 72.

26. *See* GETCHES, *supra* note 22, at 74.

27. *See id.*

28. *See* SAX ET AL., *supra* note 4, at 132–33.

their competing claims sorted out and eventually adjudicated.[29] Once the adjudication is complete, the court issues a decree specifying the respective water rights of all users. But for purposes of water marketing, until such a decree establishes the nature of a particular water right, those interested in buying water rights may be deterred because they are not exactly sure what they will be buying. In many western states, prior appropriators have *claims* to water that have not been tested in court to determine whether the claims are valid and, even if valid, to what quantity of water they are entitled.[30] Once adjudicated, the senior priority rights are the most secure and the most sought after in water marketing.[31] Water rights are also less secure due to the principle in western water law that requires all water to be used for a beneficial purpose. If the water is not used for such a purpose, the right may be abandoned or forfeited.[32]

If it is unclear whether a rancher has annually used the full amount of his water right, a cloud of uncertainty is cast over the rancher's right. The beneficial use doctrine adds another impediment to the development of water markets. The doctrine creates incentives for the rancher to use water in inefficient ways simply to rebut potential claims that he has not used the water beneficially. These low-valued uses are the most likely candidates for transfers through water marketing if the rancher can sell his unneeded water, which is a great uncertainty.

State law also controls rights to pump groundwater, and groundwater law has more variety between and among western states than does surface water law.[33] For groundwater, some western states have a priority system that ranks pumpers as junior or senior to each other, depending on when they commenced pumping, and some western states also integrate the surface water priority system with the groundwater system, lending a measure of coherence and hydrologic soundness to the legal system.[34] Other western states, including Arizona, California, and Texas, have no such

29. *See id.* at 314–20. *See generally* John Thorson et al., *Dividing Western Waters: A Century of Adjudicating Rivers and Streams*, 8 U. DENVER WATER L. REV. 355 (2005).

30. For example, in Arizona, the Gila River General Adjudication was filed in the 1970s, but has adjudicated only a handful of water rights. *See* Christopher Avery et al., *Good Intentions, Unintended Consequences: The Central Arizona Groundwater Replenishment District*, ARIZ. L. REV. (forthcoming 2007).

31. *See* GETCHES, *supra* note 22, at 75. The first-in-time is first-in-right principle of prior appropriation gives the greatest protection to the most senior rights. *Id.*

32. *See* SAX ET AL., *supra* note 4, at 247–56.

33. *See* GLENNON, *supra* note 14, at 30–31.

34. *See id.*

integration.[35] In Texas, the law governing groundwater use is the right of capture—a right to pump a limitless amount of water.[36] Arizona and California have adopted the reasonable use doctrine, which is an oxymoron. One may pump an infinite quantity of water so long as the water is applied for a beneficial purpose, which is essentially any use.[37]

These groundwater rules have two major problems, one environmental, the other economic. The environmental consequence is that the failure to integrate ground and surface water has exposed our rivers to dewatering through the invidious and indirect means of groundwater pumping. Pumping water that is hydrologically connected to surface flows has done tremendous damage to rivers around the United States.[38] The economic consequence is that, although some people think that these doctrines protect private property by recognizing the right of landowners to drill wells on their property, on closer inspection, the doctrines offer no protection to the person who has drilled such a well. If an essential characteristic of a property right is the ability to exclude others from using your property, then the right of capture and reasonable use doctrines are not property rights at all. The right of capture and reasonable use doctrines epitomize what Garrett Hardin calls the "tragedy of the commons"—limitless access to a common pool of resources.[39] These doctrines create an economic incentive to exploit the resource because each pumper obtains 100% of the benefits from her pumping while the costs are spread among all who use the resource. This unrestricted system of access with its incentives for overuse will eventually result in degradation and exhaustion of the resource. For water marketing purposes, these groundwater doctrines impede a market from developing because no one who wishes to use groundwater would ever pay another groundwater user for her rights, as the person could simply drill her own well. Arizona, and to a lesser extent Texas, have begun to break this relentless cycle.[40]

The 1980 Arizona Groundwater Management Act ended the unfettered right to drill wells in the heavily populated areas of the state, areas called active management areas.[41] New wells require a

35. *See* Robert Glennon & Thomas Maddock, III, *The Concept of Capture: The Hydrology and Law of Stream/Aquifer Interactions*, 43 ROCKY MTN. MIN. L. INST. §§ 22.1, 22.16 (1997).

36. *See id.* at § 22.03[2][6].

37. *See id.*

38. *See generally* GLENNON, *supra* note 14.

39. *See* Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243, 1243–44 (1968).

40. *See* GLENNON, *supra* note 14, at 92–93, 215.

41. *See* ARIZ. REV. STAT. ANN. §§ 45-401–704 (2006); *see also* GLENNON, *supra* note 8, at 91 (providing an analysis of the Act).

permit from the state, and perhaps, a demonstration that the developer has secured rights to a renewable water supply.[42] At the same time, the Act grandfathered in protection for existing users, quantified their water rights, and most importantly, made their rights transferable.[43] The Act put in place mechanisms by which a water market could potentially develop. In the 1990s, however, the state took the wind out of the sails of a burgeoning market by creating the Central Arizona Groundwater Replenishment District.[44] This organization is charged with obtaining access to renewable supplies to serve new developments.[45] However, in practice, the system has functioned to remove the burden from developers to enter the marketplace and secure water rights that would demonstrate an assured water supply as required under the Act.[46]

Another factor that has impeded the development of markets is the seemingly innocent exemption from regulation of wells for small domestic users.[47] The justification for the exemption is that the amount of water used by an individual homeowner is *de minimis* to the state's regulatory system.[48] But in some states, tens or even hundreds of thousands of exempt wells have been drilled in this fashion.[49] In the State of Washington, developers used multiple exempt wells to furnish water to entire subdivisions.[50] The exemption for domestic wells finesses a demand that new users enter the marketplace to acquire and retire an existing water right.

In most western states, water rights holders are theoretically free to transfer their rights for use by others upstream or downstream on a river.[51] But the reality is more nuanced, particularly under the "no injury" rule that permits transfers only so long as the transfer does not result in harm to other appropriators, including more junior appropriators.[52] A transfer from one place on the river to another may have consequences for other users—third parties who are not involved in the transaction between the seller and buyer of the water right. The factual complications involved in assessing whether a junior has been harmed may substantially add to the

42. *See* Avery et al., *supra* note 30, at 4–7.
43. *See id.* at 3–4.
44. *See id.*
45. *See id.*
46. *See id.*
47. *See e.g.*, ARIZ. REV. STAT. ANN. § 45-454 (2006).
48. *See* Glennon & Maddock, *supra* note 35, at § 22.04.
49. *See id.*
50. *See id.*
51. *See* A. DAN TARLOCK ET AL., WATER RESOURCE MANAGEMENT: A CASEBOOK IN LAW AND PUBLIC POLICY 357 (5th ed. 2002).
52. *See* SAX ET AL., *supra* note 4, at 270–76.

transaction costs, as it requires a fact specific, intensive inquiry into return flows, irrigation ratio efficiencies, consumptive use patterns of various crops, and the like.

One aspect of the legal system where there is a substantial difference across states is the salvaged water doctrine. If a water user takes steps to use water more efficiently, such as by moving from flood to sprinkler irrigation or by lining an earthen ditch with an impermeable material, should the appropriator obtain rights to the water that has been saved? Common sense might dictate that the answer should obviously be "yes," as it encourages water conservation. But given the "no injury" rule and the reality that downstream users may have come to rely on return flows, the case law and legislation about salvaged water is far from uniform. The extreme is represented by Colorado, which prohibits water users from clearing a channel as a basis for expanding the use of water by the appropriator.[53] The Colorado Supreme Court held that the water saved became subject to the appropriation system and could then be used by the next most senior appropriator, not by the person who undertook the water conservation efforts.[54] Other states, led by California, encourage users to conserve water by giving the users the benefit of the water conserved. California law provides that such conservation efforts will not be subject to the forfeiture doctrine and that the water conserved may be sold, leased, or exchanged.[55]

Another complicating feature involving the development of water markets is the question as to who owns the water when it is used by farmers inside irrigation districts. Agricultural water supply organizations in the American West take many forms: from community-based organizations, such as acequias in Northern New Mexico, to mutual water companies in Colorado and Utah and to irrigation districts in most western states.[56] In mutual water companies, each irrigator typically owns stock in the company, often called a "ditch" company.[57] Each share entitles the owner to a specified amount (or proportionate share) of water. All shares are equal, and because the ditch company controls the rights—often to water diverted from a river but stored in a reservoir—the shares

53. *See* S.E. Colo. Water Conservancy Dist. v. Shelton Farms, Inc., 529 P.2d 1321, 1326–27 (Colo. 1974).

54. The Colorado Legislature has approved this result. *See* COLO. REV. STAT. §§ 37-90-103, 37-92-103(9) (2006). *See generally* Eli Feldman, *Death Penalty for Water Thieves*, 8 U. DENV. WATER L. REV. 1 (2004).

55. *See* CAL. WATER CODE §§ 1011, 1244 (Deering 2007).

56. *See* SAX ET AL., *supra* note 4, at 681–87.

57. *See id.* at 684.

are indistinguishable from one another. This fungible quality reduces transaction costs and makes it extremely easy to transfer water between and among members. In mutual companies, voting rights are by share: one share, one vote. In mutual companies, shares are also transferable without the approval of the board. In Colorado, cities have recently found mutual shares worth purchasing, we hypothesize, because their characteristics reduce objections from third-party juniors.[58]

Irrigation districts, by contrast, are political subdivisions of the state with substantial powers, including the ability to levy taxes, exercise the power of eminent domain, issue tax free bonds, and make rules and regulations for the distribution of water within the district.[59] Irrigation districts play a critical role in the lives of all district residents and the political power of these districts is unparalleled. Yet, quite surprisingly, voting rights in irrigation districts vary tremendously. In some districts, any registered voter within the district may vote for the board of directors, but in other districts only property owners may vote for the board.[60] Indeed, in some districts, a weighted system of voting gives one vote per acre of land owned, thus allowing a handful of large farmers to control the election of the board. These differences have substantial consequences for whether, and to what extent, an irrigation district is willing to engage in water marketing for use outside the district by municipal and industrial interests.[61] In short, state law varies tremendously, with some states facilitating the transfer of water from an irrigation district for use outside of a district and other states, such as Arizona, granting the district veto power over such a transfer, regardless of the wishes of the individual farmer who wants to sell the right to use his water.[62]

C. The Role of Federal Law and Institutions in Encouraging or Discouraging Water Marketing

This portrait of western water law and water marketing would be incomplete without briefly considering the role of federal law and institutions. In *Sporhase v. Nebraska*, the U.S. Supreme Court held that the dormant commerce clause precluded states from

58. *See* Brown, *supra* note 8, at 3.

59. *See* SAX ET AL., *supra* note 4, at 685–87.

60. *See* Robert Glennon, Chinatown: In the Era of Water Reallocation, Where Will the Water Come From? (Jan. 10, 2005) (unpublished manuscript, on file with author).

61. *Id.*

62. *See* ARIZ. REV. STAT. ANN. § 45-172(A)(5) (2006).

prohibiting out-of-state transfers of groundwater.[63] That decision paved the way for interstate water sales and federal court challenges to efforts to restrict such sales.[64] Some states have attempted to use *Sporhase* to limit the extent of out-of-state trading of its water. Other states, such as Montana, have established that water leasing would be regulated by a state agency.[65] Efforts to restrict the export of water have taken many forms, including recently in California county ordinances that prohibit the export of groundwater from within the county to other regions of California.[66]

Federal agricultural policy, with its massive subsidies, has encouraged the continuing inefficient use of water and has served as a brake on water marketing. A 2006 Congressional Budget Office report documented how these policies discourage the reallocation of water.[67] The federal government's agricultural marketing loan and price support programs subsidize the production of crops and encourage the use of water for marginal crops that would not be grown but for the subsidies. We think that the same thing might be said about subsidies for water infrastructure, low-cost hydroelectric energy, and federal crop insurance. On the other hand, a recent federal program has encouraged water conservation by irrigators. The Challenge Grant Program initiated by the Department of the Interior provides up to fifty percent of the costs of irrigation efficiency improvements.[68]

Three other aspects of federal law deserve mention. First, the U.S. Bureau of Reclamation has played a critical role in providing water to farmers in the American West.[69] One hundred years after the creation of the Bureau, one might think that courts would have settled the question of who owns the water that is provided through Bureau projects. Instead, a controversy rages about the nature of those water rights.[70] In 2005, the U.S. Supreme Court decided a case that many observers hoped would settle the conflicting claims of farmers and the irrigation districts to which they belong.[71] *Orff v. United States* involved California farmers who,

63. Sporhase v. Nebraska, 458 U.S. 941, 954–58 (1982).

64. *See* CONGRESSIONAL BUDGET OFFICE, HOW FEDERAL POLICIES AFFECT THE ALLOCATION OF WATER 16–20 (2006) [hereinafter CBO REPORT].

65. *See* MONT. CODE ANN. §§ 85-2-141(10), -301(2) (2005).

66. *See generally* Ellen Hanak & Caitlyn Dyckman, *Counties Wresting Control: Local Responses to California's Statewide Water Market*, 6 U. DENVER WATER L. REV. 490 (2003).

67. *See* CBO REPORT, *supra* note 64.

68. *See id.* at 16 n.50. The CBO Report applauds these federal cost-sharing programs but suggests that they might be even more effective if they targeted larger farms. *Id.* at 18.

69. *See* SAX ET AL., *supra* note 4, at 687–88.

70. *See* Clifford T. Lee et al., A.B.A. Section of Environment, Energy, and Resources, 24th Annual Water Law Conference: Who Owns the Water (Feb. 23–24, 2006).

71. Orff v. United States, 545 U.S. 596 (2005).

as members of the Westlands Water District, claimed that, although they were not parties to the contract between the District and the Bureau, they could enforce the contract as third-party beneficiaries.[72] The court ducked the issue by instead deciding the case on an issue of sovereign immunity.[73] As a result, the extent to which farmers have property rights in Bureau water remains unsettled and may turn on the contractual right they have with their individual districts and on the districts' contracts with the federal government.

Second, the Endangered Species Act [ESA] has encouraged the reallocation of water from agriculture to environmental uses. The ESA not only prohibits the killing or destruction of a listed species but also the destruction of critical habitat of the species.[74] Under the ESA, federal agencies must refrain from taking steps that would harm the habitat of the species.[75] Several recent cases, including the highly publicized case of the Klamath River in southern Oregon and northern California, have involved a decision of a federal agency to withhold water from farmers in an irrigation district in order to protect a species of endangered salmon in the river below.[76] One controversial federal claims court decision held that the decision of the agency was a taking of the property rights of the irrigators and entitled them to compensation under the Fifth Amendment.[77] In contrast, another federal claims court decision held that there was no taking of the property rights of irrigators in a district when the Bureau acted to protect an endangered species.[78] Across the country, the ESA is requiring developers to engage in mitigation for filling in wetlands or destroying critical habitat of listed species. Such mitigation often has required developers to purchase water rights, especially in states such as Idaho and California.[79]

Finally, if the federal government sets aside (reserves) federal land for a particular federal purpose, courts frequently hold that the government intended to reserve water for the primary purpose

72. *See id.* at 597–98.

73. *See id.* at 601–04.

74. *See* 16 U.S.C. §§ 1536(a), 1538(a)(1)(B) (2000); Babbitt v. Sweet Home Chapter, 515 U.S. 687, 687 (1995).

75. 16 U.S.C. § 1538(a)(1)(B) (2000).

76. *See* Tulare Lake Basin Water Storage Dist. v. United States, 49 Fed. Cl. 313 (2001); Klamath Irrigation District v. United States, 67 Fed. Cl. 504 (2005).

77. *See* Tulare Lake, 49 Fed. Cl. at 313.

78. *See* Klamath Irrigation Dist., 67 Fed. Cl. at 505.

79. *See, e.g., Land and Money Mitigation Requirements in Endangered Species Act Enforcement: Oversight Hearing Before the H. Comm. on Resources*, 106th Cong., 1st Sess. 7 (1999) (statement of Richard W. Pombo, Member, House Comm. on Resources), *available at* http://commdocs.house.gov/committees/resources/hii58723.000/hii58723_0f.htm.

of the federal land.[80] The most important example of federal reserved water rights is for Indian reservations. The last thirty years has seen many settlements of tribal water rights. These settlements have frequently been based on congressional enabling legislation and financial support. The legislation has frequently addressed whether the Indian tribes can lease or sell the water off their reservations and/or out of state.[81]

In summary, a wide range of differences between and among the states as to water law, legal institutions, and the presence of federal enclaves or Indian reservations significantly affects how and to what extent water marketing may occur. With this background, we now turn to our data collection and the evidence regarding water markets.

III. THE METHODOLOGY

We documented the annual water transfers that have occurred in the semi-arid West between 1987 and 2005. To collect water transfer data, we used the *Water Strategist ("WS")*, a monthly publication that details transactions, litigation, legislation, and other water marketing activities.[82] It is self-advertised as "the only source of published information on water transactions in the West."[83] Each month, *WS* publishes a "Transactions" section that lists, by state, each water transfer that occurred.[84] From the publication, we can learn all or some subset of the following: the year of the transfer; the acquirer of the water; the supplier; the amount of water transferred; the proposed use of the water; and, if applicable, the terms, such as the price, of the contract. In collecting data on water transfers, we recorded every transfer in the *WS* from January 1987 through December 2005 in twelve western states: Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Texas, Utah, Wyoming, and Washington.

80. *See* Winters v. United States, 207 U.S. 564, 577 (1908).

81. *See generally* BONNIE G. COLBY ET AL., NEGOTIATING TRIBAL WATER RIGHTS 171–76 (2005) (explanatory parenthetical); Robert Glennon, *Coattails of the Past: Using and Financing the Central Arizona Project*, 27 ARIZ. ST. L.J. 677, 733–43 (1995).

82. Water Strategist, http://www.waterstrategist.com/.

83. *Id.*

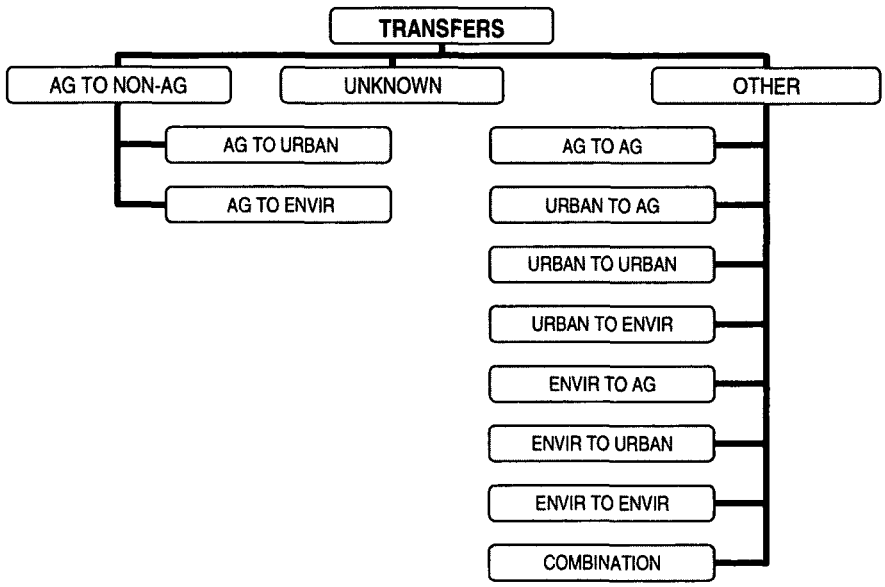
84. *Id.*

A. Transfer Classification

In order to analyze the transaction costs that impede the transfer of water from agricultural uses to uses outside of agriculture, the most important variables for each transfer are the nature of the current use and of the proposed use. Where is water coming from and where is it going? We developed three classifications of original use: An agricultural use, an urban use,[85] or an environmental use. So, too, the destination of the water for the proposed use might be agricultural, urban, or environmental. Because water can originate in one of three uses and can end up in one of three uses, there are nine potential classifications for a transfer.[86]

Figure 1 lists the various classifications of transfers in our dataset. We were primarily interested in the movement of water from agricultural uses to uses outside of agriculture, which we defined as "agricultural to non-agricultural" transfers. We lumped together all other transfers as "Other". These transfers consist of agricultural-to-agricultural transfers; all transfers from urban uses; all transfers from environmental uses; and transfers involving multiple uses, which we labeled "Combination."

FIGURE 1



85. "Urban" includes all municipal and industrial uses.

86. The nine classifications of transfers are: agricultural-to-agricultural, agricultural-to-urban, agricultural-to-environmental, urban-to-agricultural, urban-to-urban, urban-to-environmental, environmental-to-agricultural, environmental-to-urban, and environmental-to-environmental.

For the vast majority of transfers, *WS* explicitly indicated the original and the ultimate purpose of the water and briefly described the details of each transaction. If *WS* did not explicitly note the nature of the original and ultimate use, the brief description usually clarified the origination and destination uses. For a small number of transactions when *WS* did not explicitly state the original and ultimate uses *and* the description of the transaction did not allow us easily to decipher the nature of the uses, we developed rules-of-thumb for classifying the use when other information was sparse or incomplete.[87]

B. General Rules for Classifying Use of Water

By our rules-of-thumb, we classified a use as agricultural if the name of the lessor, lessee, seller, or buyer was an irrigator, an irrigation district, an agricultural user, a farmer, a ranch, a canal company, a ditch company, or an individual.[88] Similarly, we designated a use as agricultural if the description of the transaction stated that the water was used in agriculture, if the water was provided by land fallowing, or if the description discussed widespread farming in the district from which the water was supplied or sent.

We classified a party as an environmental user if it was a state department of fish and wildlife or a nature conservancy. The U.S. Bureau of Reclamation, generally an agricultural water supplier, was classified as an environmental user when it acted to improve or maintain instream flows, to help fish, to preserve water quality levels, or engaged in other similar activities. When a party was a water conservation or conservancy district, we designated the transfer as an agricultural, an urban, or a combination agriculture-and-urban exchange, not as environmental. Most water conservation or conservancy districts are primarily involved in agricultural activities,

87. In select cases where the description of the transfer contained in the *Water Strategist* was ambiguous, we relied on Robert Glennon's knowledge of water institutions in the West (informed by Google searches). These transfers primarily occurred in Arizona and California and consisted of approximately fifty-five of the 3317 transfers in the dataset.

88. One could potentially argue that an individual should be classified as an urban user instead of an agricultural user, but we concluded that it was far more probable that an individual—not a city, a corporation, or another institution reflecting municipal or industrial use—was an agricultural user. This rule-of-thumb seemed especially sensible as most "individuals" were sellers of water. Individuals, we decided, were most likely farmers. The *Water Strategist* described the seller of water as an individual eighty-eight times and the buyer nine times. The total water that was transferred when either the buyer or the seller was listed as an individual was 22,467 acre-feet. This amount is less than one one-hundredth of a percent of the total water transferred in our dataset. One transfer by an individual accounted for 15,000 acre-feet of the 22,467 acre-feet transferred.

and some districts have urban and/or a combination of agriculture and urban activities.

Lastly, we used rules-of-thumb to classify urban users when the *WS* either did not explicitly say what the water was being used for or the description was too vague to determine the water's use. We classified as urban water used by cities, townships, municipal water districts, developers, companies, golf course irrigators, landscape irrigators, or mining companies.

Despite our attempts to develop classification rules that would reliably identify the nature of the parties, in some cases, the information was simply incomplete. These "unknown" transfers, lacking a clear origin or destination, were relatively rare, accounting for 85 (2.6%) of the 3317 transactions in our data set. They are not included in the tables provided below.[89]

Finally, a single transaction occasionally involved multiple transfers and different sectors. For example, an entry might include an irrigator and a city that transferred a combined 10,000 acre-feet of water to another city. In this case, the destination of the transfer is clearly to an urban use, but the origination came from agriculture and urban. In many instances, the description included a breakdown that allowed us to identify the sectors. For example, if the irrigator and city each transferred 5000 acre-feet, we noted two transactions, one of 5000 acre-feet from agriculture-to-urban and one of 5000 acre-feet from urban-to-urban. In some cases, however, this information was not provided. We classified such transfers as "combination" transfers because there was either a combination of origins or a combination of destinations. Of the 3317 transfers in our dataset, 161 (4.9%) were combination transfers.[90]

IV. THE RESULTS

A. Total Number and Volume of Transfers by Sector.

The data in Table 1 provide a comprehensive description of water marketing in the West between 1987 and 2005.

89. These unknown transfers account for 798,932 acre-feet of water, about 2.5% of the total in our dataset.

90. Combination transfers account for 4,939,997 acre-feet, about 15.5% of the total in our dataset.

TABLE 1
WATER TRANSFERS BY SECTOR, 1987–2005

Classification	Number of Transfers	Frequency	Amount of Water (af)[A]	Frequency	Committed Amount of Water (af)[B]	Frequency
Agricultural to Agricultural	471	15%	7,138,480	23%	16,241,925	12%
Agricultural to Urban	1,825	56%	5,533,394	18%	39,747584	29%
Agricultural to Environmental	233	7%	6,014,228	19%	18,186,143	13%
Urban to Agricultural	38	1%	326,440	1%	2,549,986	2%
Urban to Urban	440	14%	5,657,591	18%	26,600,020	19%
Urban to Environmental	54	2%	1,054,031	3%	8,925,447	6%
Environmental to Agricultural	0	0%	0	0%	0	0%
Environmental to Urban	1	0%	62	0%	62	0%
Environmental to Environmental	6	0%	284,560	1%	4,171,200	3%
Combination	164	5%	4,955,791	16%	21,636,938	16%
Total	3,232	100%	30,964,577	100%	138,059,303	100%

Sources: Water Strategist and Brewer, Glennon, Ker, and Libecap data set.

[A] Water flow during first year of contract as listed in *Water Strategist.*

[B] Total water committed by contract—one-year lease amounts and amounts implied by long-term leases and sales, discounted to year of contract by five percent.

The data represent 3232 water transfers from 1987–2005.[91] Table 1 lists the amount of water transferred in each classification in two ways. Column 3 lists the amount transferred in the first (or only) year of a contract; column 5 lists the total amount of water committed over the full term of the sale or lease.[92] A number of important facts stand out. First, agriculture is the source of most transferred water which is not surprising given that agriculture accounts for approximately eighty percent of consumptive use of water in the

91. As noted above, we identified 3317 water transfers between 1987 and 2005. However, eighty-five transactions did not have enough complete information for us to include in the analysis, leaving 3232 observations. *See* Jedidiah Brewer, Robert Glennon, Alan Ker & Gary Libecap, *Water Markets in the West: Prices, Trading, and Contractual Forms Extent: Property Rights, and Regulatory Issues* 1987–2005, *Economic Inquiry,* (forthcoming 2007) (providing a more technical discussion).

92. This is discounted to the year of the contract by five percent. We discuss the basis for this committed category in more detail below.

West. As shown in Table 1, seventy-seven percent of all exchanges and sixty percent of all water originates in agriculture. Agriculture-to-urban exchanges are the most numerous, with fifty-six percent of transfers and eighteen percent of all water transferred, at 5,533,394 acre–feet. Urban-to-environmental and combination exchanges also involve considerable amounts of water. Urban-to-agriculture, environmental-to-agriculture, environmental-to-urban, and environmental-to-environmental exchanges are comparatively unimportant.

There is considerable activity within sectors. Agriculture-to-agriculture exchanges account for fifteen percent of the number of transactions and twenty-three percent of all water transferred. Urban-to-urban exchanges involve fourteen percent of the number of transactions and eighteen percent of the amount of water traded. Most transferred water remains in the same sector.

Environmental transactions (agriculture–to–environmental and urban–to–environmental) involve significant amounts of water, 6,014,228 acre-feet and 1,054,031 acre-feet respectively. Based on descriptions provided in the *WS*, however, these transfers are somewhat different in character from the others. These transactions generally are initiated by either the federal or state governments, and as shown in Table 2, these transfers are the largest on average. Environmental transactions are aimed at wetlands restoration, fish and wildlife habitat preservation or protection, and augmenting stream flows. The most active parties are the U.S. Fish and Wildlife Service and state departments of fish and game. In contrast, private parties, irrigators, and developers are more prevalent in agriculture-to-agriculture, agriculture-to-urban, and urban-to-urban transactions.

The final and most important fact about Table 1 is the sheer scale of the volume of water. Transfers involved almost thirty-one maf or roughly twice the annual flow of the Colorado River. If we focus on the cumulative effect of all transfers, including sales and long-term leases, parties transacted for 138 maf, almost ten times the annual flow of the Colorado. From this data, we can extrapolate that sales and long-term leases play an important role in agriculture-to-urban transactions.[93] In contrast, agricultural-to-agricultural transactions tend to be one-year leases.[94]

Table 2 outlines the average size of transfers for some of the major trading classifications in Table 1.

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93. The committed amount of water in the agricultural-to-urban category is almost eight times the first-year flow. Compare column 5, line 2 with column 3, line 2.

94. Column 5, line 1 is only slightly more than double column 3, line 1.

TABLE 2
AVERAGE TRANSACTION SIZE

Classification	Avg Transfer Volume (af)[C]	Committed Avg Transfer Volume (af)[D]
Agricultural to Agricultural	15,156	34,484
Agricultural to Urban	3,032	21,780
Agricultural to Environmental	25,812	78,052
Urban to Environmental	19,519	165,286
Urban to Urban	12,858	60,455

Sources: *Water Strategist* and Brewer, Glennon, Ker, and Libecap data set.

[C] Water flow first year of contract as listed in *Water Strategist.*

[D] Total water committed by contract.

Environmental water transfers involve, on average, large volumes of water with agricultural-to-environmental transfers over 25,000 acre-feet per transfer and urban-to-environmental transfers over 19,000 acre-feet. Agricultural-to-agricultural and urban-to-urban transfers average 15,000 and 13,000 acre-feet respectively. The numerous agricultural-to-urban transfers, however, tend to be quite small, averaging about 3000 acre-feet. Understanding the nature and key issues surrounding water market activities provides some insight into this phenomenon. Agricultural-to-urban transfers often involve the physical movement of water from an agricultural region to an urban area. In the American West, water is power, wealth, and opportunity. The Owens Valley legacy has left rural communities antagonistic toward cities that are coming after their water.[95] Furthermore, taking water out of agriculture and putting it into urban uses involves third-party effects and transaction costs. As a result, agricultural-to-urban transfers can become quite contentious. Obviously, the bigger the transfers are, the more likely that third-parties will be affected and the more contentious the transaction becomes. Due to these endemic problems, agricultural-to-urban transfers are generally small. Contention is less likely in agricultural-to-agricultural and urban-to-urban transfers because these transfers are between fairly homogeneous parties. Neverthe-

95. *See* MARC REISNER, CADILLAC DESERT: THE AMERICAN WEST AND ITS DISAPPEARING WATER 61–87 (1986). *But see* GARY LIBECAP, OWENS VALLEY REVISITED: A REASSESSMENT OF THE WEST'S FIRST GREAT WATER TRANSFER (forthcoming 2007). Owens Valley was the first large-scale water transfer in the West from agriculture to urban uses. It made the growth of semi-arid Los Angeles possible, but its legacy is one of the mistrust of water markets. *See* BRENT M. HADDAD, RIVERS OF GOLD: DESIGNING MARKETS TO ALLOCATE WATER IN CALIFORNIA xv (2000).

less, because agricultural-to-urban transfers often involve long-term leases or sales, they commit a large volume of water.[96] Similarly, transfers from urban to environmental uses typically involve a permanent reallocation; as a result the committed volume is almost nine times the average transfer volume.[97]

B. Water Transfers over Time

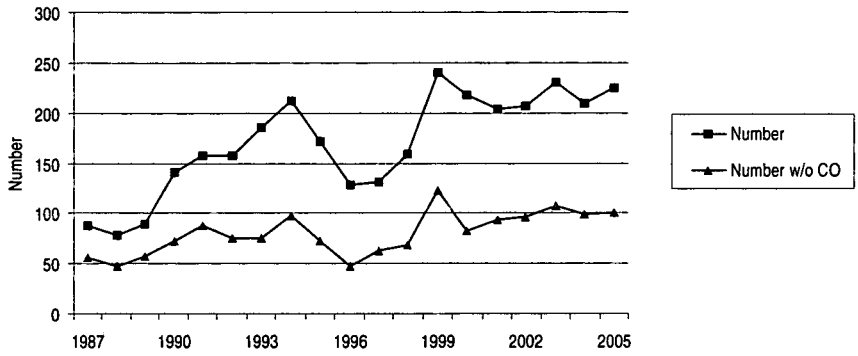
Our dataset covers nineteen years from 1987 through 2005, and this time series allows us to examine how the water market is changing over time, instead of simply providing a snapshot of the market at a given point in time. We had to wrestle with the issue of how to measure the amount of water that was transferred in a given year. At first, this would seem like a fairly easy task, but there are actually several different possible measurements. For example, suppose party A leased 10,000 acre-feet of water to party B for five years starting in 1990. We could record this transaction as a single transfer that occurred in 1990 and that transferred 10,000 acre-feet of water the first year of the contract, which for one-year contracts is the total amount of water involved. Long-term contracts and sales, however, can involve considerable flows of water over time. In our hypothetical, there was a transfer of 10,000 acre-feet *each* year, beginning in 1990 through 1994. This water commitment is quite different than what the initial flow might suggest. To measure this other amount, we projected the annual amounts forward for the length of the lease (or in perpetuity for sales) and then discounted them by five percent to get a "committed" flow as of the year of the contract. Depending on how one records this hypothetical transfer, one will get a different number of transfers, a different quantity of water transferred, and different years when the transfer(s) took place. Is it more interesting to know the number of contracts made, the annual amount contracted for, or the amount committed to be transferred over time? We decided that we wanted answers to all three questions. We measured the number of transfers, the annual amounts of water, and the "committed" amounts over time.

The need to distinguish between the two methodologies becomes clear when considering a sale of water rights as opposed to a lease as in the above example. When a water right is sold, it is essentially a transfer that happens every year in perpetuity. For

96. Compare column 2, line 2 with column 1, line 2.
97. Compare column 1, line 4 with column 2, line 4.

example, suppose party A sells a water right to 5000 acre-feet of water to party B in 1990. Again, there are two ways to measure this transfer. We could measure it as a transfer that took place in 1990 for 5000 acre-feet or as a transfer of 5000 acre-feet in 1990 and in each succeeding years in perpetuity and discount it back to the transaction year, 1990. This measure, a much larger volume than 5000 acre-feet, is our committed amount variable.

FIGURE 2
NUMBER OF WATER TRANSFERS, 1987–2005,
WITH AND WITHOUT COLORADO



Source: *Water Strategist* and Brewer, Glennon, Ker, and Libecap data set.

Figure 2 provides a graph of the number of transfers in each year for the western United States. Starting in 1987 and moving toward 2005, we see a sharp increase in the number of transfers over time. More participants are becoming involved in the market. However, the increasing trend has two distinct humps: one centered on 1994; the other around 1999. There was a decline in the number of transfers in the West between 1994 and 1999. Although our purpose in this paper is to document, rather than explain the observed transfers, we can speculate as to the transfers' causes. One explanation is that 1994 and 1999 were relatively dry years in the West in terms of the historical long-run average.[98] Hence, a

98. The years between 1994 and 1999 were relatively wet years. NATIONAL CLIMATIC DATA CENTER, U.S. CLIMATE AT A GLANCE, http://www.ncdc.noaa.gov/oa/climate/research/cag3/cag3.html.

larger number of transfers take place in dry years and a smaller number in wet years.[99]

Figure 2 presents the number of transfers with or without those from Colorado. Almost half of all transfers in the twelve western states took place in one state—Colorado. The lion's share of these transfers involved the Colorado-Big Thompson Project.[100] This trans-basin diversion of water from the West Slope is considered "developed" water, which is subject to the total control of the developer. As such, the water may be sold or leased without the restriction of the no-harm-to junior rule described above. Colorado-Big Thompson is a mutual water company, which uses shares to represent the interests to water of its members.[101] An active market for these shares has developed because they have a fungible quality that keeps down transaction costs. This example illustrates how important the reforms associated with Colorado-Big Thompson's institutional structure are for promoting transfers.

C. Agricultural to Non-agricultural Transfers

Our research focuses on understanding how water moves from agricultural uses to non-agricultural uses and how the law facilitates or hinders such transfers. Our agricultural to non-agricultural classification combines agricultural-to-urban and agricultural-to-environmental transfers into one category. Figures 3 and 4 demonstrate that the amount of water in this category has increased substantially and relatively steadily over time. Comparing years in the late 1980s to years in the early 2000s reveals that the amount of water transferred has doubled.

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99. A simple correlation of California precipitation data and water transfers in California from 1987 to 2005 is -0.185. The correlation of lagged precipitation and water transfers is -0.239. These measures suggest that transfers and precipitation move opposite of one another, as we would expect. Because we are not controlling for any other factors, the correlations are fairly strong evidence of this relationship.

100. *See* Janis M. Carey & David L. Sunding, *Emerging Markets in Water: A Comparative Institutional Analysis of the Central Valley and Colorado-Big Thompson Projects*, 41 NAT. RESOURCES J. 283, 283–328 (2001) (discussing the importance of the Colorado Big Thompson Project).

101. *See* DANIEL TYLER, THE LAST WATER HOLE IN THE WEST: THE COLORADO-BIG THOMPSON PROJECT AND THE NORTHERN COLORADO WATER CONSERVANCY DISTRICT 456–61 (1992) (describing the structure of the Colorado-Big Thompson).

FIGURE 3
TRANSFER AMOUNTS, FIRST YEAR OF CONTRACT,
AGRICULTURE-TO-NON AGRICULTURE, 1987–2005

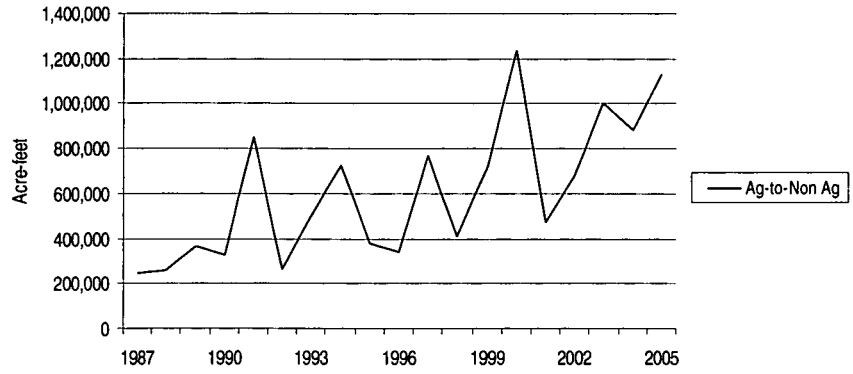
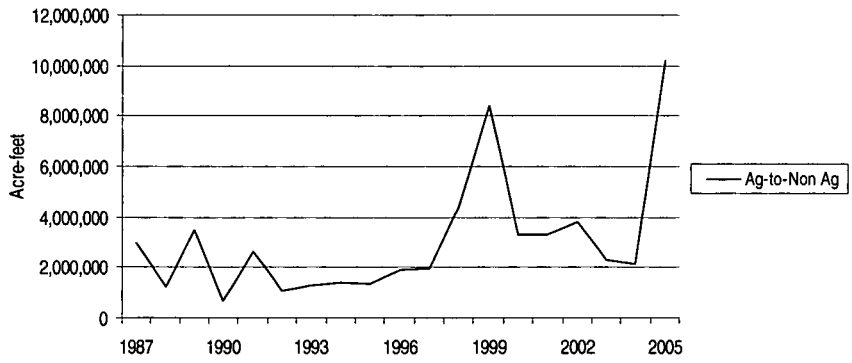


FIGURE 4
TRANSFER AMOUNTS, COMMITTED WATER,
AGRICULTURE-TO-NON AGRICULTURE, 1987–2005



Sources: *Water Strategist* and Brewer, Glennon, Ker, and Libecap data set.

Both Figures reveal increases in agricultural-to-agricultural uses over time. The committed quantity shows a less pronounced trend because of the substantial amounts of water that are involved, especially with some transfers.[102]

In summary, this data offers important observations about water marketing in the western United States. The number of water

102. Notice the difference in the scale for the committed relative to the annual flow. Water markets, however, are expanding in terms of quantities.

transfers, for the most part, has been growing. The amount of water transferred highly correlates with the number of transfers and has generally increased over time.

D. Contract Types Used in Water Transfers

Understanding how water moves from one use to another requires an understanding of the contractual forms used by the parties. Two primary contractual forms are leases and sales. In general, sales involve the permanent transfer of a water right. Leases do not transfer the water right from one party to another. Leases transfer the water for a stated period of time, but the right to the water remains in the original owner's hands. Leases have the potential to be of different lengths. Certain entities may have an interest in obtaining water for a short period of time. Others may want to procure it for five years or longer. For example, in an area hit with particularly dry weather in a given year, a farmer with avocado trees might save his investment (prevent his trees from dying) by leasing water from a neighboring farm that grows alfalfa. If weather patterns improved the next year, there would be no need to lease water for more than one year. Parties might use long-term leases when the acquiring party wished to purchase water rights but the transferor was only willing to enter into a long-term lease. Some leases in the dataset were for as long as forty years. Most leases, however, were for one year or less with relatively few more than one year in length.

TABLE 3
WATER TRANSACTIONS BY CONTRACT TYPE 1987–2005

	Length	Number of Transfers	Frequency	Amount Transferred (af)[E]	Frequency	Amount Transferred (af)[F]	Frequency
Short-Term Leases	1-year or Less	771	24%	23,450,450	76%	23,450,450	17%
Long-Term Leases	More than 1-year	210	6%	2,395,430	8%	26,759,628	19%
All Leases		981	30%	25,845,880	83%	50,210,078	36%
Sales		2,165	67%	3,974,808	13%	79,496,161	58%
Miscellaneous[G]		86	3%	1,143,890	4%	8,353,065	6%
All Transfers		3,232	100%	30,964,578	100%	138,059,304	100%

Sources: *Water Strategist* and Brewer, Glennon, Ker, and Libecap data set.

Note: "Short-term Sales" as labeled in the *Water Strategist* are included with Short-term leases. There are relatively few of them and

most occur in California. The entries in the Water Strategist describe the nature of the contract, in this case, short-term sales.

[E] Water flow first year of contract, as listed in *Water Strategist.*

[F] Total water committed by contract.

[G] Miscellaneous transfers are listed as "exchanges" and "storages" in the *Water Strategist.* The entries in the Water Strategist describe the nature of the transaction, and in this case, they are labeled as exchanges or storages and not sales or leases. An example of an exchange would be a developer agreeing to give a portion of his water right to the city and in exchange the city would allow the developer to connect his development to city utilities, such as a transfer for taps. Another type of a miscellaneous contractual form is a storage whereby water is stored for future use. Of the 2323 transfers for which we were able to assign classifications eighty-five were neither sales nor leases and hence labeled as miscellaneous contractual forms—exchanges and storages.

Table 3 details the number of leases in the dataset by length. Leases of all types account for thirty percent of transactions and eighty-three percent of the water transferred. Short-term leases of a year or less were eighty percent of all leases and ninety-two percent of all water leased.

The second primary form that a contract could take was a sale. Sales account for sixty-seven percent of all transactions, but just thirteen percent of the water transferred. The miscellaneous transfers shown in Table 3 are those that were not described in *WS* as either sales or leases. Examples of such transactions were exchanges of water between parties for services and storage contracts. These transactions are not of major importance in water markets. These transactions consisted of only three percent of the number of transfers and four percent of the amount of water transferred.

Table 3 offers an important insight into the nature of western water markets. Most transactions (sixty-seven percent) involve sales, but most water (eighty-three percent) is transferred by leases, usually (seventy-six percent) short-term leases. We hypothesize that the legal impediments and political objections discussed in Section I have driven market participants to use short-term leases to transfer large quantities of water precisely because such leases avoid high transaction costs and finesse the controversial issue presented by a permanent reallocation of water from farmers to cities.

FIGURE 5
NUMBER OF TRANSFERS

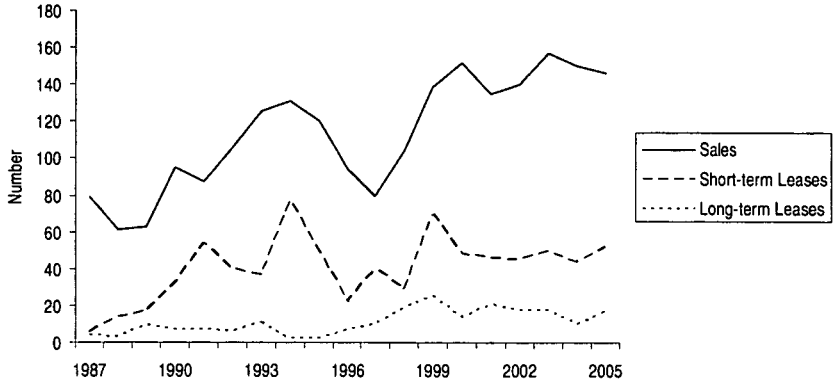
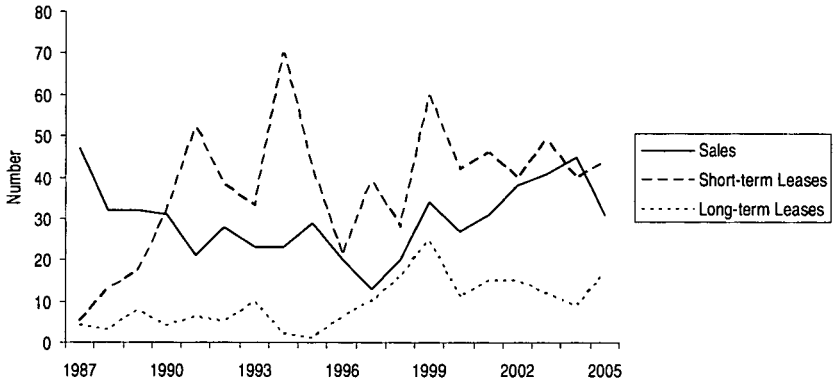


FIGURE 6
NUMBER OF TRANSFERS (CO OMITTED)



Sources: *Water Strategist* and Brewer, Glennon, Ker, and Libecap data set.

For the entire data set, the number of sales is growing over time and is considerably larger than the number of short-term and long-term leases. If we remove Colorado, and hence the Colorado-Big Thompson, then the number of sales drops below the number of short-term leases, but this reflects the fact that large numbers of sales take place routinely in Colorado-Big Thompson. However, the Colorado-Big Thompson sales are for small quantities. Figures 7 and 8 show "committed" water over time by category.

FIGURE 7
AMOUNT OF WATER COMMITTED

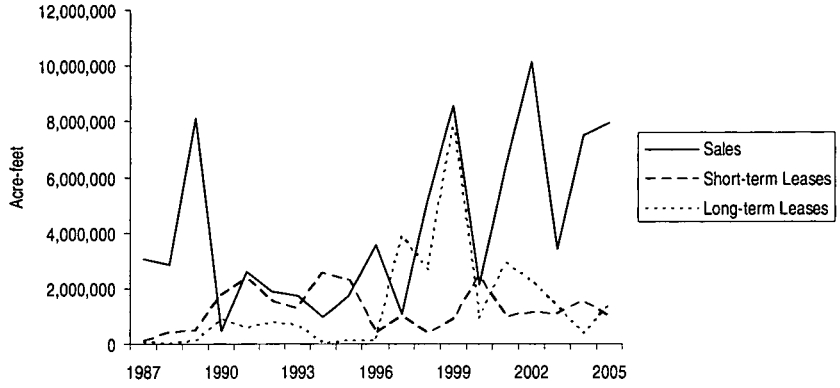
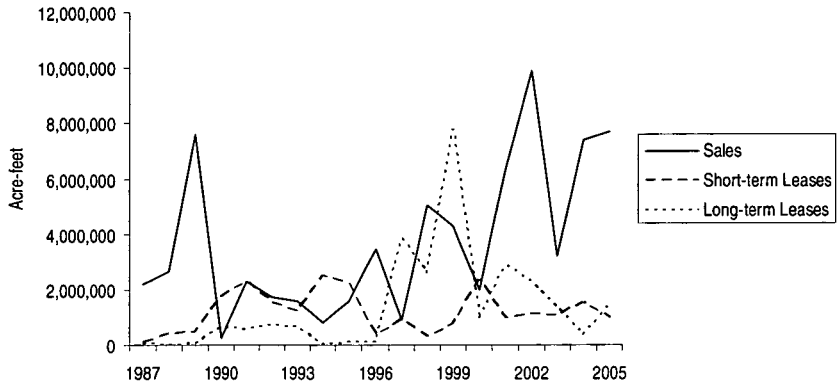


FIGURE 8
AMOUNT OF WATER COMMITTED (CO OMITTED)



Sources: *Water Strategist* and Brewer, Glennon, Ker, and Libecap data set.

With or without Colorado, the amount of water committed by sales and long-term leases is growing over time. In Colorado-Big Thompson, there are many small sales so that the amount committed is limited. The small size of the sales explains why leaving Colorado out has little effect, but it is important to point out. Focusing just on the number of sales would lead to the conclusion that sales are not growing relatively to leases when Colorado is removed, but one would not want to conclude that sales or long-term leases are not important. These sales and long-term leases obligate

substantial amounts of water, suggesting that water markets are expanding in terms of quantities.

E. Contract Types over Time

Table 4 lists the number of transfers for each year as short-term leases, long-term leases, and sales. As in the aggregate data, sales are the most common form of contract, but they involve less water than short-term leases. The number of sales has sharply increased over time; in 1988, there were seventy-nine sales, but by 2005, there were 146, an increase of eighty-five percent. Long-term leases also are more prevalent. Short-term leases reveal a more modest upward trend. The amounts of water transferred by sales and long-term leases have dramatically increased. However, short-term leases account for the most water transferred each year by far, and there is considerable fluctuation, reflecting precipitation levels and other factors.

TABLE 4
ANNUAL WATER TRANSFERS BY CONTRACT TYPE AND AMOUNT

	Number of Transfers				Amount Transferred			
	Short-Term Leases	Long-Term Leases	Sales	Total	Short-Term Leases	Long-Term Leases	Sales	Total
1987	6	3	79	88	101,150	1,708	152,674	172,532
1988	15	2	61	77	427,397	24	143,125	448,506
1989	19	7	63	90	454,949	9,002	404,773	778,877
1990	33	6	95	140	1,771,939	27,308	23,304	1,890,082
1991	55	6	87	156	2,359,150	30,750	129,102	2,526,601
1992	40	6	106	154	1,537,700	66,260	95,428	1,723,940
1993	37	11	126	182	1,271,042	177,463	87,867	1,778,591
1994	77	2	131	186	2,554,645	319	49,760	2,421,850
1995	49	2	120	161	2,306,035	6,975	85,761	897,128
1996	22	7	94	117	370,360	19,218	179,735	1,257,717
1997	42	8	80	140	1,123,214	84,274	54,471	1,347,735
1998	31	17	104	155	340,672	187,351	258,417	847,906
1999	70	25	139	238	887,409	487,654	429,508	1,836,965
2000	51	11	152	216	2,465,434	57,918	106,852	2,654,762
2001	48	19	135	202	1,036,533	154,590	318,554	1,359,453
2002	46	17	140	205	1,118,980	173,841	508,848	1,887,212
2003	51	17	157	233	1,097,708	368,813	172,253	1,626,580
2004	44	10	150	207	1,540,868	52,000	374,868	1,978,477
2005	52	17	146	209	993,117	182,107	399,508	1,755,100
Total	788	193	2,165	3,156	23,758,304	2,087,575	3,974,808	29,190,014

Sources: *Water Strategist* and Brewer, Glennon, Ker, and Libecap data set.

F. Analysis of Water Marketing by State

Tables 5 and 6 provide a detailed description of all transfers from agriculture or urban in each of the western states. The tables show the relative percentages of the amount of water exchanged by origination and destination classifications in a single state, in annual amounts and in committed quantities. For example, in Arizona fifteen percent of the water transferred was in agriculture-to-urban trades, while forty-five percent and thirty-nine percent were part of agriculture-to-agriculture and urban-to-urban trades.[103] There were no environmental transactions.

The data allows for informative interstate comparison. From Tables 5 and 6, one is able to determine the types of transfers that dominated in each of the states. For instance, Montana and Idaho were most active in transferring water from agricultural-to-environmental uses; Arizona in agricultural-to-agricultural transfers; and Colorado, Nevada, Texas, and Utah in agricultural-to-urban transfers. Some states had a variety of transactions, notably, California, Colorado, and Washington.

TABLE 5
SHARE OF EACH TRANSFER CLASSIFICATION TO A STATE'S TOTAL TRANSFER AMOUNT (AF), 1987–2005, ANNUAL FLOWS

	Ag to Urban	Ag to Envir	Ag to Ag	Urban to Urban	Urban to Ag	Urban to Envir	Combination	Acre-feet
AZ	15%	0%	45%	39%	0%	0%	0%	8,375,769
CA	19%	25%	15%	12%	1%	4%	24%	11,058,161
CO	25%	19%	15%	10%	5%	4%	7%	1,221,523
ID	12%	45%	18%	2%	0%	0%	22%	4,960,527
MT	19%	64%	16%	0%	0%	0%	1%	67,802
NM	3%	20%	16%	1%	26%	30%	1%	512,134
NV	63%	18%	0%	12%	0%	0%	8%	289,563
OR	0%	43%	10%	0%	0%	39%	8%	954,314
TX	33%	1%	10%	26%	0%	0%	31%	2,559,141
UT	33%	0%	27%	25%	0%	0%	15%	366,577
WA	25%	25%	18%	7%	0%	24%	0%	318,619
WY	13%	0%	22%	0%	1%	0%	64%	280,449

103. The residual classification is made up of environmental-to-agricultural, environmental-to-urban, and environmental-to-environmental transfers.

Sources: *Water Strategist* and Brewer, Glennon, Ker, and Libecap data set.

TABLE 6
SHARE OF EACH TRANSFER CLASSIFICATION TO A STATE'S TOTAL TRANSFER AMOUNT (AF), 1987–2005, COMMITTED QUANTITIES

	Ag to Urban	Ag to Envir	Ag to Ag	Urban to Urban	Urban to Ag	Urban to Envir	Combination	Acre-feet
AZ	31%	0%	37%	32%	0%	0%	0%	21,889,596
CA	25%	13%	11%	10%	4%	2%	34%	36,811,579
CO	30%	29%	3%	7%	1%	1%	4%	14,913,506
ID	8%	56%	19%	1%	1%	1%	13%	8,263,996
MT	42%	53%	2%	0%	0%	0%	3%	492,012
NM	14%	9%	21%	4%	33%	18%	0%	2,350,967
NV	44%	26%	0%	17%	0%	0%	12%	3,879,418
OR	0%	30%	3%	0%	0%	66%	1%	8,841,279
TX	41%	0%	3%	38%	0%	0%	18%	31,144,987
UT	43%	0%	3%	36%	0%	0%	19%	5,004,915
WA	39%	10%	2%	9%	0%	40%	1%	3,917,912
WY	24%	1%	39%	0%	8%	0%	28%	643,874

Sources: *Water Strategist* and Brewer, Glennon, Ker and Libecap data set.

Tables 7 and 8 provide a different cross-state comparison by indicating how much each state contributed to the total amount of water transferred within each classification in all states, in annual amounts and in committed quantities. For example, of the total amount of water transferred from agricultural uses to urban uses, Arizona transferred twenty-three percent of that water, and California transferred thirty-eight percent. As before, there is considerable variation across the states. Arizona accounts for fifty-three percent and fifty-eight percent, respectively, of all agriculture-to-agriculture and urban-to-urban water transactions. California and Idaho contribute most of the agriculture-to-environmental transfer amounts. Lastly, very little water marketing occurs in Montana, Nevada, Utah, Washington, and Wyoming, regardless of transfer classification.

TABLE 7
RELATIVE PERCENTAGE OF STATE TO EACH CLASSIFICATION'S TOTAL TRANSFER AMOUNT (AF), 1987–2005, ANNUAL FLOWS

	Ag to Urban	Ag to Envir	Ag to Ag	Urban to Urban	Urban to Ag	Urban to Envir	Combination
AZ	23%	0%	53%	58%	0%	0%	0%
CA	38%	46%	23%	24%	39%	38%	53%
CO	5%	4%	2%	2%	18%	5%	2%
ID	11%	38%	12%	2%	1%	1%	22%
MT	0%	1%	0%	0%	0%	0%	0%
NM	0%	2%	1%	0%	41%	14%	0%
NV	3%	1%	0%	1%	0%	0%	0%
OR	0%	7%	1%	0%	0%	35%	1%
TX	15%	0%	4%	12%	0%	0%	16%
UT	2%	0%	1%	2%	0%	0%	1%
WA	1%	1%	1%	0%	0%	7%	0%
WY	1%	0%	1%	0%	1%	0%	4%
Acre Feet	5,533,394	6,014,228	7,138,481	5,657,592	326,440	1,054,031	4,955,791

Source: *Water Strategist* and Brewer, Glennon, Ker, Libecap data set.

TABLE 8
RELATIVE PERCENTAGE OF STATE TO EACH CLASSIFICATION'S TOTAL TRANSFER AMOUNT (AF), 1987–2005, COMMITTED QUANTITIES

	Ag to Urban	Ag to Envir	Ag to Ag	Urban to Urban	Urban to Ag	Urban to Envir	Combination
AZ	17%	0%	49%	26%	0%	0%	0%
CA	23%	26%	25%	14%	62%	10%	58%
CO	11%	23%	3%	4%	3%	1%	3%
ID	2%	25%	10%	0%	2%	1%	5%
MT	1%	1%	0%	0%	0%	0%	0%
NM	1%	1%	3%	0%	30%	5%	0%
NV	4%	6%	0%	3%	0%	0%	2%
OR	0%	14%	2%	0%	0%	66%	0%
TX	32%	0%	5%	44%	0%	0%	27%
UT	5%	0%	1%	7%	0%	0%	4%
WA	4%	2%	0%	1%	0%	17%	0%
WY	0%	0%	2%	0%	2%	0%	1%
Acre Feet	39,758,591	18,186,143	16,241,926	26,634,114	2,549,986	8,925,447	21,686,569

Sources: *Water Strategist* and Brewer, Glennon, Ker, Libecap data set.

CONCLUSION

With rapid urban growth, water is becoming increasingly scarce in the West. As a result, cities are searching for water from new sources. This Essay presented the legal context within which marketing occurs, described the methodology used to collect and classify the data, and analyzed the trends in the water market for twelve states in the semi-arid west from 1987–2005. As for the data, the number of water transfers and the amount of water transferred highly correlate over time. However, when we break these transfers down into various components, we note that the number of transfers and the amount of water transferred vary greatly. We find that most transfers are agricultural-to-non-agricultural, yet most water is transferred from agricultural-to-agricultural and from urban-to-urban. We also find that, although most transfers are sales, most water is transferred via short-term leases. Finally, although most transfers are permanent, most water is transferred on a temporary basis.