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SAND2013-3556
Unlimited Release
April 2013

Designing a Water Leasing Market for the Mimbres River, New Mexico

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Abstract

The objective of this study is to develop a conceptual framework for establishing water leasing markets in New Mexico using the Mimbres River as a test case. Given the past and growing stress over water in New Mexico and the Mimbres River in particular, this work will develop a mechanism for the short term, efficient, temporary transfer of water from one user to another while avoiding adverse effects on any user not directly involved in the transaction (i.e., third party effects). Toward establishing a water leasing market, five basic tasks were performed, (1) a series of stakeholder meetings were conducted to identify and address concerns and interests of basin residents, (2) several gauges were installed on irrigation ditches to aid in the monitoring and management of water resources in the basin, (3) the hydrologic/market model and decision support interface was extended to include the Middle and Lower reaches of the Mimbres River, (4) experiments were conducted to aid in design of the water leasing market, and (5) a set of rules governing a water leasing market was drafted for future adoption by basin residents and the New Mexico Office of the State Engineer.

Acknowledgments
Support for this project was derived through the Bureau of Reclamations Water Smart Program with matching funding from the New Mexico Office of the State Engineer. Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Contents

Executive Summary

The objective of this study is to develop a conceptual framework for establishing water leasing markets in New Mexico using the Mimbres River as a test case. Given the past and growing stress over water in New Mexico and the Mimbres River in particular, this work will develop a mechanism for the short term, efficient, temporary transfer of water from one user to another while avoiding adverse effects on any user not directly involved in the transaction (i.e., third party effects). Toward establishing a water leasing market, five basic tasks were performed, (1) two stakeholder meetings were conducted to identify and address concerns and interests of basin residents, (2) nine new gauges were installed on irrigation ditches to aid in the monitoring and management of water resources in the basin, (3) the hydrologic/market model and decision support interface were extended to include the Middle and Lower reaches of the Mimbres River, (4) experiments were conducted to aid in design of the water leasing market, and (5) a set of rules governing a water leasing market was drafted for future adoption by basin residents and the New Mexico Office of the State Engineer.

The proposed approach involved the use of a virtual market to aid in the design of the of a fully functional water leasing market in the Mimbres. Our hypothesis is that a water leasing market is best designed if it were first constructed as a virtual water leasing market in which decision makers and stakeholders can explore alternative institutional and regulatory frameworks for governing a voluntary water leasing market. This virtual environment provides a vehicle for educating and familiarizing the stakeholder with how the market will function, allowing stakeholders to ―try out” the market prior to any real financial or resource investment while also engaging the stakeholder and decision maker together in the design of the market-enhancing communication and thus improving the chances of developing a market that meets everyone‘s needs. The ultimate goal of the virtual market is to not only to lay the foundation for the execution of temporary trades of water as described above, but also avoid restrictive pitfalls such as lack of activity in the market due to distrust or confusion among participants, prohibitive institutional structures, waste and/or inequitable distribution of burdens to [direct or implied] market participants.

In two meetings conducted with basin stakeholders a clear indication of disinterest in a market and lack of trust in any project involving water was expressed. Based on this feedback it was decided to continue with the project but without strong stakeholder involvement. The goal of the effort being to develop a template that could be replicated in other basins in New Mexico. Also, efforts on the Mimbres would not be wasted as stakeholders would likely be interested in the market when a priority call is actually made on the river.

According to this modified virtual market approach, experiments were conducted to evaluate the proposed market. Several key findings that reflect on the efficacy and potential operations of a water leasing market in the Mimbres are as follows:

1. Participants in the experiment were able to quickly understand how a water leasing market works and were able to participate with little instruction.
2. Positive welfare gains were recorded for each experiment, which means participants in the market benefited from their transactions.
3. Operation of the market resulted in fewer days under a call.

The Mimbres water leasing market model was exercised to explore potential leases in terms of the difficulty of delivering leased water, impacts that the leases might have on neighboring water users (3rd party effects), and impacts that trading might have on overall system performance. Key results include:

1. Under priority call conditions and no leases, most ditches experience some shortage of delivery and many ditches realize critically-short days (days irrigator fails to receive at least 75% of normal delivery). Conditions worsen as one moves downstream. These delivery problems are just a characteristic of the limited water in the basin.
2. Leasing of water tends to help reduce shortages but not critically short days by the ditch leasing the water. In most cases, the ditch leasing the water sees the entire amount that it has leased, less efficiency losses. However, the ditch is not receiving the water when it really needs it as reflected in no change in critically short days.
3. There are some cases when critically-short days are reduced for a ditch not involved in a trade simply because more water is flowing by that ditch (see scenario 11 where Swartz leases to Tigner).
4. Only two of the 12 trading scenarios explored left the entire basin worse off (scenarios 6 and 7); both of these trades involved movement of water downstream across different AWRMs, San Lorenzo leasing to Goforth (Upper to Middle) and King (Upper to Lower).
5. All leases tend to impact other ditches not involved in the trade; the –best” trades (those columns that are more green than orange) seem to be those conducted between the Middle and the Lower Mimbres, regardless of whether the trade is from upstream to downstream or downstream to upstream; the –worst” trades seem to be those conducted with an Upper Mimbres ditch as the leasor, particularly when the leasee is in a different AWRM (i.e., the Middle or the Lower Mimbres).
6. Only trades 4 and 7 result in measureable shortage impacts over the course of a year; that is, results in shortages that exceed 10% of their deliveries in the baseline year.
7. Only a single trade transactions of the 12 explored did not harm any ditch in the basin and benefited several indirectly: this is a lease from Nan to King, both ditches in the Lower Mimbres with King being the last ditch in the system with the most junior priority date and the greatest shortage no matter how the river is administered.

Ultimately, this analysis points to several difficulties in administering a water leasing market in the Mimbres. First, are the lack of current interest in a market and a lack of willingness of many ditches to participate in the metering program. Although third party effects do not appear to be an important issue, delivery of water in times of drought is a problem (high shortages of water for most ditches). Thus, if efforts were made to institute leases it is likely that non-participating farmers would claim injury even though the shortage is unrelated. One opportunity would be to consider re-operation of Bear Canyon Reservoir to store and deliver leased water.

Introduction

Physical and Hydrologic Setting

The Mimbres Basin is a closed and partially drained watershed with an area of about 5,140mi² (Figure 1). Most of the basin is located in southwestern New Mexico with the southern boundary extending into northern Chihuahua. The Mimbres River is the largest stream in the basin with its headwaters originating in the Black Range which forms the northern most boundary of the basin. Mimbres River stream flow originates as snow melt and rainfall runoff from a 184mi² portion of the upland watershed. Only the upper reach of the Mimbres River is perennial.

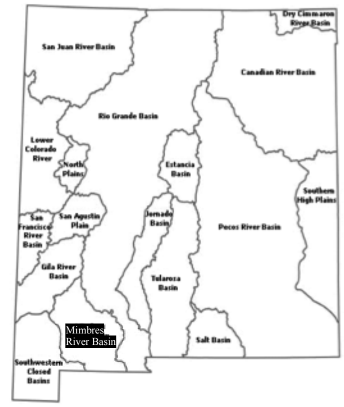

Figure 1: Map of New Mexico Mimbres Basin comprises 3.3 million acres in the southwest corner of the state.

Throughout the river basin there are 33 ditches serving 2594.3 acres of irrigated land divided roughly into 158 farms. Irrigation from the Mimbres River is predominately by means of flood irrigation. Only one ditch (San Lorenzo) has an improved diversion and distribution structure. Most irrigation water is diverted by simple push-up dams conveying water to unlined ditches. Limited off stream storage is available in Bear Canyon Reservoir. The reservoir holds roughly 550 acre-feet of water, half of which is for irrigation storage the other half for recreational purposes. Discharge from the reservoir enters the river just below the second ditch in the Upper Mimbres Basin.

In efforts to administer the adjudicated water rights in the basin, the New Mexico Office of the State Engineer (NMOSE) declared three Active Water Resource Management (AWRM)[1]areas in the basin designated as the Upper, Middle and Lower reaches. The AWRM establish a framework for the State Engineer to carry out his responsibility to supervise the physical distribution of water, to protect senior water rights owners, to assure compliance with interstate stream compacts, and to prevent waste caused by administration of water rights. AWRM encourages the development of replacement plans that prevent serious and imminent economic harm in times of priority administration. Specifically, these replacement plans provide a mechanism by which junior water rights holders, that would otherwise be curtailed, would be able to temporarily acquire senior water rights in an expedited manner.

Problem Statement

The Mimbres River Basin has experienced stress over growing water demands in the form of expanded domestic well production exasperated by frequent periods of drought. Additionally, growing concerns over the environment have prompted interest in allocating more water for in-stream uses. As such, the Mimbres Basin water users share the prospect of a future with times of insufficient supply to meet current demand. So how might the adverse impacts of water shortage be ameliorated when virtually all water supplies are allocated? One obvious answer is improved management of this scarce resource.

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[1]See the NM OSE website at http://www.ose.state.nm.us/water_info_awrm.html for more on rules and regulations associated with AWRM, and the principles and policies associated with its administration.

One mechanism that might allow for improved resource management is a water leasing market. Water leasing is an approach that allows the short-term reallocation of water rights, or more specifically the temporary use of the water associated with the water right, among water users, much as conventional banking allows the short-term reallocation of money among users. Water leasing can be valuable in a system which is fully allocated, but in which the greatest utility of the water is not being achieved. A water leasing system allows a water rights holder to lease his or her water rights within a water market. As in financial markets, there are varying levels of regulatory control that can be placed on water leasing. For this reason, it is important for policy makers and stakeholders to be able to evaluate the advantages and disadvantages of different regulatory structures. Additional details on how water leasing markets function can be found in Appendix 1: A Look at Current Markets in the Western States and Issues in Establishing Water Leasing Markets.

In eight western American states, water reallocation through market leasing does occur on a very limited scale; however, this reallocation process can hardly be characterized as a genuine water leasing market (see Appendix 1). In these cases, water prices are often fixed in advance by an administrator, trading volumes are trivial, and water can only be reallocated over long (usually yearly) time horizons. More importantly, the trading systems currently used have scant attention paid to how trades may affect and interact with the hydrological system, creating the potential for third party effects (i.e., adverse impacts on any water rights holder not directly involved in the trade). As such, additional effort is required to understand how best to integrate such institutions into complex and often contentious water management problems.

Given a future of increasing demand and frequent drought, the NMOSE, the body governing the appropriation and use of water in the Mimbres Basin, is faced with the prospect of a priority call (when junior water users in the basin must forego use to allow senior water users to receive their full allocation of water) on the river and as such is interested in the possibility of a water leasing system in the basin to abate the potential negative consequences of a priority call. The Mimbres Basin presents an ideal setting for further efforts in developing water-leasing models, as the river is fully adjudicated and associated property rights are not only completely defined, but also accurately represented within a GIS system. Furthermore, the area of interest is small and the existing farming operations are relatively homogenous. Within the sub-basins of the Mimbres, the one prominent and relevant challenge is that all sub-basins are not equally metered, where the Upper Mimbres ditches are more heavily equipped with metering/monitoring equipment relative to the Middle and Lower Mimbres; this situation is acknowledged by the Mimbres Water Masters (an authoritative extension of the NMOSE and the local governing/administrative body in the Mimbres Basin) and a plan is in place to address the implementation of monitoring technology and methods in the Middle and Lower Mimbres. A complete description of the physical and institutional challenges surrounding the creation and implementation of a voluntary water leasing market can be found in Appendix 1: A Look at Current Markets in the Western States and Issues in Establishing Water Leasing Markets.

Project Approach

A voluntary, short-term, efficient, temporary transfer of water could occur if a carefully designed and implemented water leasing market existed, and such a water leasing market might be best designed if it were first constructed as a virtual water leasing market in which decision makers and stakeholders can explore alternative institutional and regulatory frameworks for governing a voluntary water leasing market. This virtual environment provides a vehicle for educating and familiarizing the stakeholder with how the market will function, allowing stakeholders to ―try out" the market prior to any real financial or resource investment while also engaging the stakeholder and decision maker together in the design of the market-enhancing communication and thus improving the chances of developing a market that meets everyone‘s needs. The ultimate goal of the virtual market is to not only to lay the foundation for the execution of temporary trades of water as described above, but also avoid restrictive pitfalls such as lack of activity in the market due to distrust or confusion among participants, prohibitive institutional structures, waste and/or inequitable distribution of burdens to [direct or implied] market participants.

Earlier Work

From 2006 to 2009, a cooperative effort between the NMOSE, Sandia National Laboratories (SNL), the University of New Mexico (UNM), and the University of Chicago (UC) was undertaken to design a voluntary water leasing market on the Upper Mimbres. Three activities were pursued as a result of this cooperative effort including (1) organization and administration of a series of stakeholder workshops to engage water users in the design of a water leasing market, (2) development of a hydrologic and market model for the Upper Mimbres, integrated within a decision support system (DSS) which provides a virtual environment for market design, and (3) completion of baseline experiments to evaluate consequences of a water leasing market in the Upper Mimbres. Full documentation of this work is available in Broadbent and others (2009).[2]

This original effort was funded through a Federal earmark sponsored by Senator Pete Domenici. With the purpose of extending this work, a proposal was submitted to the Bureau of Reclamation‘s Water Challenge program in the Spring of 2009. The proposal was subsequently funded allowing the water leasing study to be extended to the rest of the Mimbres Basin. This report focuses on the results of this later study.

Project Objective

The objective of this study is to develop a conceptual framework for establishing water leasing markets in New Mexico using the Mimbres River as a test case. Given the past and growing stress over water in New Mexico and the Mimbres River in particular, this work will develop a mechanism for the short term, efficient, temporary transfer of water from one user to another while avoiding adverse effects on any user not directly involved in the transaction (i.e., third party effects). Toward establishing a water leasing market, five basic tasks were performed, (1) a series of stakeholder meetings were conducted to identify and address concerns and interests of basin residents, (2) several gauges were installed on irrigation ditches to aid in the monitoring and management of water resources in the basin, (3) the hydrologic/market model and decision support interface was extended to include the Middle and Lower reaches of the Mimbres River, (4) experiments were conducted to aid in design of the water leasing market, and (5) a set of rules governing a water leasing market was drafted for future adoption by basin residents and the NMOSE. Below a description of each task and associated results are given.

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[2] Broadbent C.B., D.S. Brookshire, W. Cain, D. Coursey, M. McIntosh, V.C. Tidwell and A.A. Williams, 2009. Progress Report on the Mimbres Basin: Establishing a Proto-Type Water Leasing Market, University of New Mexico, March 3, 2009.

Table 1 summarizes the major tasks that comprised this project and a simple, concise summation of the work that was completed.

Table 1: Tasks descriptions and status.

Task	Task Description	Task Status
Task 1.4.1a	Develop a preliminary set of rules governing the administration of a water leasing market in the Upper Mimbres.	Complete. See *Water Leasing Market Rule Set Development* and Appendix 7.
Task 1.4.1b	▪ Hold a series of workshops to gather feedback on the proposed rules and iterate on the governing framework. ▪ Allow participants to lease water in a virtual market to test the efficacy of the proposed rules and to explore alternative rule sets. ▪ As new rules are defined, perform a limited set of numerical and physical experiments to evaluate the potential for third party effects.	▪ Complete. See *Stakeholder Interactions* and Appendix 2. ▪ Incomplete. Project team unable to convene group of willing Mimbres Valley stakeholders. ▪ Complete. See *Evaluating the Potential for Third Party Effects* and Appendices 4, 5 and 6.
Task 1.4.1c	Design the Market Institution.	Complete. Basic elements of the institution identified and reported on in the context of the Mimbres Basin (see *Water Market Rule Set* and Appendix 7).
Task 1.4.2a	Hold a preliminary workshop for Middle and Lower Mimbres stakeholders.	See *Stakeholder Interactions* and Appendix 2.
Task 1.4.2b	Meter and manage the Middle and Lower AWRM ditch diversions like has been done in the Upper.	Completed with limited success due to unwillingness of Middle and Lower ditches to participate in the process. See *Metering*.
Task 1.4.2c	Extend the DSS from the Upper Mimbres into the Middle and Lower reaches.	Complete. See *Evaluating the Potential for Third Party Effects: Hydrologic Model and DSS* and Appendices 4, 5 and 6.
Task 1.4.2d	Produce a framework for integrated management of the three AWRMs as well as a mechanism to allow leasing of water within and across them.	Complete. As described in this report.

Stakeholder Interactions

This project was devised with the intention to actively engage stakeholders in the Mimbres Basin, as this is believed to be one of the key design features of a successful Water Leasing Market: a market created with all impacted stakeholders‘ water requirements acknowledged and accounted. With this intention in mind, two stakeholder meetings were organized and conducted throughout the duration of this project. These meetings are listed here along with their primary objective, most significant insights gained, and stakeholder desires not possible given physical and/or political constraints (termed ―Constraints" below, and follow-on actions undertaken. Documentation of stakeholder interactions occurring between November 2011 and April 2012 is provided in Appendix 2: Notes from 11/3/2011 and 4/9/2012 Stakeholder Meetings in the Mimbres Valley. For reference stakeholder interactions occurring between July 2006 and May 2007 are documented Broadbent and others (2009).

<u>November 3, 2011</u>

Primary objective: Reintroduced basin stakeholders to the project after a 3.5-year hiatus and clearly reiterated the value to be gained from and concerns with a voluntary water leasing market.
Insights gained: Stakeholders reiterated many of the same desires as were elucidated during the 2006-2007 project: feasibility of intra-ditch leases, use of supplemental wells, avoiding 3rd Party Effects. New issues that were brought to light concerned increasing efficiency, using the Market as a leveraging/bargaining tool with the NMOSE, and the benefits of a new market structure over the existing management scheme(s), in terms of deliveries and conflict abatement.
Constraints: Stacking[3] and extra-AWRM transfers not allowed within current operating policies. The stakeholders expressed the lack of any real economic driver for them to lease water among them; however, the possibility exists for water leasing by domestic well owners.
Follow-on: Refine Market Rules to account for all stakeholder desires communicated to date and develop hydrologic model to clearly demonstrate impacts of trades on all ditches within the basin.

<u>April 9, 2012</u>

Primary objective: Demonstrate hydrologic model and emphasize that this tool will be used to minimize adverse impacts [of temporary trades] on Basin Stakeholders.
Insights gained: Stakeholders seem satisfied that modeling tool could predict ―bad" trades and thereby provide justification for not allowing them; however, the only way that a temporary Water Leasing Market could work is if the Market structure/institution is clearly defined and accepted by all Basin Stakeholder, and if the Market itself is administered efficiently and consistently, and includes monitoring and enforcement (of no discrepancy between allowed diversion and actual diversion). Last, stakeholders insisted that there is not and will not be for many years enough buy-in within the Basin to allow a temporary Water Leasing Market.
Constraints: No new constraints identified.
Follow-on: Present Water Leasing Market and all insights gained from this project to Basin Stakeholders utilizing a far reaching medium (e.g., radio, newspaper).

In two meetings conducted with basin stakeholders a clear indication of disinterest in a market and lack of trust in any project involving water was expressed. Based on this feedback it was decided to continue with the project but without strong stakeholder involvement. The goal of the effort being to develop a template that could be replicated in other basins in New Mexico. Also, efforts on the Mimbres would not be wasted as stakeholders would likely be interested in the market when a priority call is actually made on the river.

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[3] Water applied to a particular parcel of land that is above the currently approved Crop Irrigation Requirement but still meets the definition of beneficial use.

Metering and Monitoring

Active Water Resource Management (AWRM) calls for the direct supervision and distribution of waters in the Mimbres River system as part of the overall statewide efforts by the State Engineer to actively administer the waters of New Mexico. Successful administration of the Mimbres River in accordance with AWRM rules and regulations includes ensuring that each water user only takes from the river what they have a priority right to, thereby improving opportunities for all users to get their adjudicated allocations. The most predictable, accurate, and reliable way to determine the ratio of diverted water to adjudicated water is by installation and monitoring of meters. In addition to facilitating responsible, compliant management of Mimbres waters, meters that capture ditch diversions as well as instream flows will be important for demonstrating the value added by a voluntary water leasing market (e.g., decrease in delivery shortages, increase in instream flows towards amounts necessary for threatened species to thrive, efficiency gains, conservation gains, decreased reliance on ground water resources, etc.).

The authoritative body responsible for installing, maintaining, and collecting data from meters is the NMOSE; the local extension of the NMOSE tasked with these duties in the field is called a Water Master. Before any metering began in the Mimbres Basin, the Mimbres Water Master prepared a Field Manual[4] that sets forth the Administrative Principles and the Operational Practices of the Water Master. The most important tenants of the Manual are that no federal, state, or local permitting is required for the installation of meters, compliance with the National Environmental Policy Act and National Historic Preservation Act should be pursued through a categorical exclusion checklist, and ditch metering agreements will be pursued with each irrigation ditch in the basin. The ditch metering agreements are a critical component of metering, as they provide the NMOSE with permission to access private land to install the meters and to monitor them as necessary. The agreements also document the NMOSE's responsibility for funding and constructing the metering devices. The metering agreement is given in Appendix 3: Ditch Metering Agreement Mimbres River Basin. To date, the Manual and associated Ditch Metering Agreements have only been fully adopted in the Upper Mimbres.

Table 2: Metered ditches.

Ditch Name	Priority Date
Grijalva	1893
Montoya	1880
Kenly 1	1894
Kenly 2	1894
Heuchling 1	1870
Heuchling 2	1870
Heuchling 3-4	1870
San Lorenzo	1869
Swartz	1884
Kimmick	1889
Nan	1880
King	1912
Tigner	1890
Tustin-McIntosh	1884
Wardwell-Herron	1880
O'Sullivan-McSherry-Pena	1880
Martin	1891

To date, eighteen Metering Agreements have been executed and metering equipment installed in accordance with them; fifteen agreements still need to be agreed upon and executed for remaining ditches in the Middle and Lower Mimbres. For eight ditches in the Upper Mimbres, two ditches in the Middle Mimbres, and seven ditches in the Lower Mimbres, flume structures were constructed in an unlined reach of the ditch and placed such that the primary diversion below the head gate/diversion structure is captured; Table 2 lists these ditches. All construction was performed

[4] New Mexico Office of the State Engineer, Upper Mimbres Water Mater District Water Master Field Manual, August 26, 2006.

outside of the irrigation season to minimize negative impacts on the ditch or water user. The flume structures utilized in each ditch are comprised of a satellite-linked receiver, a stage discharge recorder, a 12-volt gel battery that is charged by a solar panel, all housed within a self-contained metal housing; a stilling well and float mechanism; and a satellite antenna and cables. To record the flood flows and released storage water from Bear Canyon Reservoir in the Upper Mimbres, a much larger unit was constructed as a concrete weir in the channel below Bear Canyon Spillway. Similar to the flume structures, this weir unit is also solar-powered with a 12-volt battery, and comprised of a stage-discharge recorder with satellite-linked receiver; however, rather than utilizing a float mechanism, spillway discharge is measured with a bubbler system. The 2006 and 2007 Water Masters Report document that active metering and management as described here has resulted in increased instream flows, a benefit to the threatened Chihuahua Chub.

Hydrologic Model and DSS

A hydrologic/market model has been developed to assist with the design of the water leasing market. The model has been fitted with a Decision Support System (DSS) to: (1) provide a virtual environment for stakeholders to test proposed aspects of the market and provide feedback to its design, (2) provide an interactive environment for water leasing market managers to evaluate trades, and (3) provide NMOSE with a water management tool. The model represents the first detailed water resource management tool for the basin. The model was developed from the collective knowledge of basin citizens, irrigators and NMOSE water managers. Data supporting the model were derived from a number of sources including USGS stream gauging records, Weather Service temperature and rainfall gage data, water rights/water use data from the NMOSE, and GIS base maps of area topography, land use, and irrigation infrastructure.

The model was developed in the commercial system dynamics software package, Powersim Studio 2009. The model is structured according to four broad sectors: surface water, ground water, water use, and water rights. Simulations are conducted on a daily time step for any desired water-year dating from 1950. The spatial extent of the model matches the boundaries of the three AWRM areas(Upper, Middle, and Lower reaches). Within the modeled boundaries, the system is spatially disaggregated according to river reaches as defined by the 33 irrigation ditches.

Principle components of the surface water system include the Mimbres River, accompanying tributaries and Bear Canyon Reservoir. Main stem and tributaries inflows are treated as exogenous variables taken from historic gage data. Once stream/tributary flows enter the basin they are simply routed from one river reach to the next by way of a time delay coefficient based on river discharge. Modeled gains to the river include ground water discharge and agricultural return flows, while losses include irrigation diversions and open-water evaporation. Bear Canyon Reservoir is an off-stream reservoir with ~550 acre-feet of storage. The model tracks inflows, evaporative losses, spills, and releases. Evaporative losses are modeled using the Hargreaves Equation subject to daily average temperature data measured in the basin.

Each river reach is accompanied by two ground water elements, one fluvial aquifer and one regional aquifer. Ground water flows are modeled between adjoining reaches, between the fluvial and regional aquifer and between the river and fluvial aquifer. Flows are driven by differences in fluid potential as represented by differences in groundwater head and/or river stage.

Gains to the regional aquifer are limited to distributed recharge while losses include municipal/agricultural pumping and losses to the fluvial aquifer. Fluvial aquifers receive inflow from irrigation seepage, irrigation canal leakage, and the regional aquifer, while losses occur by riparian evapotranspiration and pumping.

Temporally varying water demands are limited to irrigated agriculture and domestic uses. Domestic water use is based on permitting records and is modeled by reach according to population and per capita water use. Agricultural diversions are based on crop type, corresponding Farm Delivery Requirement, irrigated acreage and irrigation system efficiency. Ditch diversions are not assumed to be constant, rather vary from day to day based on the ditch operating schedule. Conveyance and seepage losses (delivered to the fluvial aquifer system) are modeled according to the irrigation diversion and system efficiency. Water is only diverted when flows in the river are sufficient to meet the demand.

The priority administration process is also modeled for the entire Mimbres River. In the model, the system enters priority administration when water users on the senior ditch do not receive their adjudicated allotment. At this point water is released from Bear Canyon Reservoir sufficient to compensate for the undelivered water. Once supply in Bear Canyon is exhausted (~275 acre-feet) domestic well users must discontinue any outdoor water use. Additionally, irrigation ditch deliveries are discontinued according to adjudicated priority until the senior ditch receives their full allotment. Priority administration continues until flows in the river are sufficient to meet all delivery obligations.

Decision Support System

The model of the physical system (described above) is connected to a water leasing market interface. Integrating the model of the physical system with the market interface provides a virtual environment for testing and exploring alternative operational aspects of the water leasing market (see next section). This same integrated DSS provides a general framework for managing the water leasing market once the trading institution is established. Specifically, the DSS allows basin water masters to quickly and easily assess the hydrologic implications of temporary water

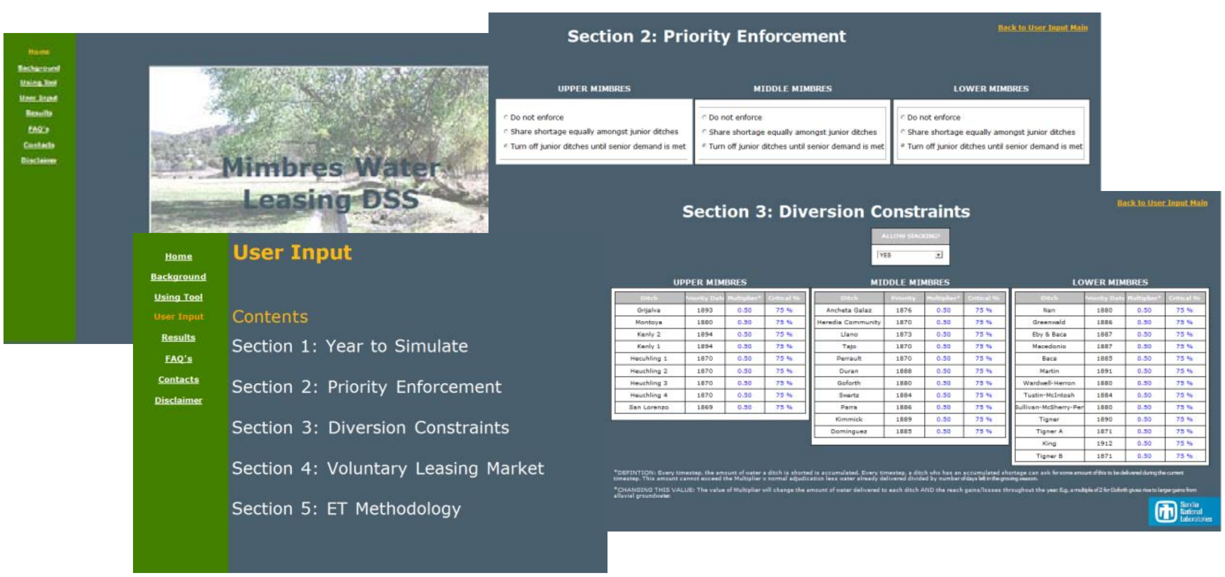

Figure 2: Example screen shots from Mimbres Water Leasing DSS.

transfers. Furthermore, constraints that determine the existence of a Third Party Effect can be quickly identified in real time thus avoiding approval of trades that are likely to go undelivered or will harm non-participating basin residents. Figure 2 gives representative screen shots of the DSS. Additional screen shots and descriptions can be found in Appendix 4: Hydrologic Model and DSS for Mimbres AWRM.

Market Experiments

The water leasing market model and DSS have been exercised to explore how a market might operate in the Mimbres basin and to identify potential consequences of the market. Two sets of activities have been accomplished. The first involves a set of market experiments in which participants representing farmers in the Upper Mimbres engaged in market leasing framework experiments (see Appendix 5: Framework Experiment Instructions). The second includes a series of model simulations investigating potential operations of a water leasing market in all three reaches of the Mimbres River. The purpose of these simulations was to investigate the difficulty of delivering leased water, impacts that leases might have on neighboring water users (3rd party effects), and impacts that trading might have on overall system performance. Here the goal is to avoid trades that will result in injury to a market participant, others not involved in the lease, or the environment.

Below we discuss the approach and results for both the market framework experiments and the model simulations. But first, an overview of 3rd party effects is given.

Third Party Effects

Third party effects have often been proposed as a limiting factor to water market transactions as first described by Gould (1988, 1989). In these two papers, Gould examines how the movement of water between agricultural users could impair an intermediate party from being able to obtain their water right. Because of the possibility of these effects, many have deemed that water transactions cannot occur, as any transaction has the potential for third party effects.

Referring to Figure 3, a 3rd party effect can be present if any user on the left-hand side (―A”, ―B”, or ―C”) trades water to any user on the right-hand side (―D”, ―E”, or ―F”) and the resulting trade impedes the ability of any user not directly involved in the trade to divert their allocated water. For example, if user ―A” leases water to user ―F”, then less water will be diverted into the left-hand side diversion and more into the right-hand side. If any user not involved in this trade (―B”, ―C”, ―D”, or ―E”) sees a harmful impact (e.g., reduced flow or excessively increased flow) because of the deviation from their normal diversion, a Third Party Effect has occurred. This type of effect is that which has limited many water markets from functioning properly.

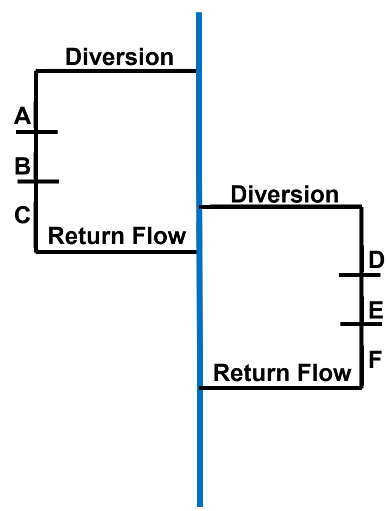

Figure 3: Schematic for describing third party effects.

Market Framework Experiments

Market framework experiments were limited to the

Upper Mimbres River. Use of the hydrologic model and water leasing DSS allowed the identification of the presence or absence of third party effects as water is traded between the nine agricultural ditches in the Upper Mimbres or out of agricultural production towards municipal well use. The Upper Mimbres Basin was modeled on a ditch scale, meaning that all water rights holders within each ditch were aggregated so that they are represented as one user in the marketplace. This means that the majordomo is the representative for each of the users that belong to their ditch. The water rights in the Upper Mimbres are based on the Mimbres Adjudication summarized in Table 3.[5]

Table 3: Ditch Allocations

Ditch Name	Priority Date	Right (Acre-Feet)
Grijalva	1893	132
Montoya	1880	99
Kenly 1	1894	96
Kenly 2	1894	137
Heuchling 1	1870	16
Heuchling 2	1870	11
Heuchling 3	1870	9
Heuchling 4	1870	37
San Lorenzo	1869	789
Casas Adobes	1895	0
Domestic Wells	1895	0

Two non-agricultural users are included in the water rights model: Casas Adobes to represent the mutual domestic in the basin and Domestic Wells to represent domestic ground water pumping in the basin. This structure allows the tracking of how transactions affect each of the ditches on the aggregate level and if trades between ditches end up causing harm to any third parties. The water allocations shown in Table 3 assume the maximum amount of acreage that each ditch can file a TBI (To Be Irrigated) petition for as of 2009 and are the amounts used to evaluate for third party effects. Because each ditch does not file its maximum TBI each year, if third party effects cannot be found to exist at large TBI levels, then one would not expect to see such effects at the smaller TBI levels that are generally filed.

Four economic experiments were conducted over the fall of 2012 at Illinois Wesleyan University (IWU) to investigate the impacts of water transfers under two different scenarios: 1) no call with stacking[3] allowed and 2) a call is placed with stacking not allowed. To conduct these experiments, 13 participants were recruited from a senior seminar course in economics at IWU to represent each of the 12 ditches, keeping an alternate participant in case of an unforeseen problem with a participant‘s availability. These participants were educated through a two-week period on the history of prior appropriations in the western United States and the benefits of participating in market transactions for goods and services (see Appendix 5: Framework Experiment Instructions). This was done through two interactive presentations. Upon arrival at the experimental laboratory, each participant was assigned a priority date based on their arrival time. Once all 13 participants had arrived, 13 candy bars ranging from a ‗king size‘ bar to a ‗fun size‘ bar were laid out on a table in the front of the laboratory. The individual with the first arrival time (i.e. the ‗senior‘ right holder in a prior appropriations setting) was given the opportunity to come up and choose their preferred candy bar; all subsequent participants (i.e., ‗junior‘ right holders) then came up in order of their arrival times, from earliest to latest. This exercise demonstrated to the students how a prior appropriative system gives preference to the earliest arrival time (i.e. a ―senior" rights holder). After this, a multimedia presentation was given that provided context on the Doctrine of Prior Appropriations.

[5] *Mimbres Valley Irrigation Co. v. Salopek et al.*, *Luna County District Court Cause No. 6326,* with a Final Decree entered January 14, 1993 (―the *Mimbres Adjudication*").

The second educational activity allowed the 13 participants to engage in voluntary market transfers in the production and purchasing of a fictional _widget‘. This activity allowed each participant to understand what the costs of producing a good are and the benefits of owning a good. The activity further demonstrated the positive advantages of engaging in market

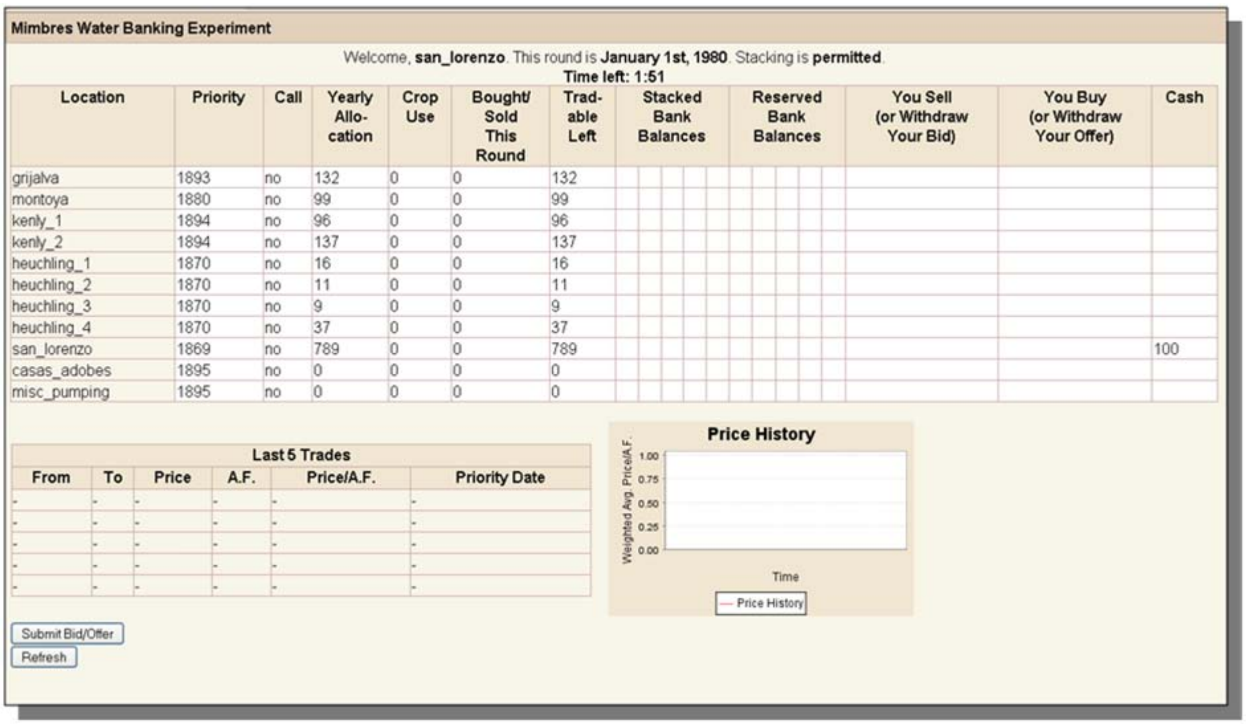

Figure 4: Market Interface.

transactions and how economic welfare could be increased through the trading of _widgets.‘ After the conclusion of these two activities, students were introduced to the water leasing interface (Figure 4). There are three main parts of this interface that provide information to each participant in the marketplace. The first is the middle section that consists of 12 columns and 13 rows, each row representing a different market participant. Column 1 lists participants in order of their location along the river, from upstream to downstream. Column 2 lists the different priority dates of water for each water use while Column 3 designates which users will have their deliveries effectively shut off for any month when a call occurs. Column 4 lists the yearly water allocations from the TBI that is filed at the start of each growing season and Column 5 lists the amount of water used from Column 4 in crop production. Column 6 lists the amount of water that each participant has acquired from leasing water to or from others in the marketplace with Column 7 informing participants how much water they have left to use in crop production or to lease to others during the growing season. Columns 8 and 9 are populated with water allocations that participants have acquired and decided to either use for stacking[3] (Column 8) in an effort to increase crop yields or reserved (Column 9) in case a call is placed upon that user‘s water allocation. Columns 10 and 11 list the array of bids and offers that participants have submitted to the marketplace. Any market participant can click on an existing bid or offer in order to engage in the transactions. Last, Column 12 is an individual bank account that is not public information.

The second area of the interface is the lower left corner where the last 5 transactions that have occurred in the current trading month are listed. The third area is a price graph that is located next to the last 5 transactions. During a trading month, this graph will refresh every time a transaction occurs to show the average price that is being paid for an acre-foot of water. If participants wish to submit bids or offers to the marketplace, this is done by clicking on the submit bid/offer button in the lower left hand corner of the interface. At the conclusion of each month of trading, all bids and offers are run through the hydrologic model prior to the start of the next trading round. This allows the hydrologic model to account for the movement of water and determine if any user is harmed as a result of market transactions (i.e., suffers from third party effects).

Participants were allowed a practice round with the software package and then participated in the two experimental sessions. The results of the experimental session produced data on the total number of transfers, the amount of water that is traded, and the priority date of transfers. In addition, the price that was paid along with the total number of crops that were grown is reported for each participant. This allows for a calculation of economic welfare for each of the participants with and without market transactions. The main results of these data are summarized below while complete analysis is provided in Appendix 6: Framework Experiment Results.

Market Framework Experiment Results

The results of the experimental session produced data on the total number of transfers, the amount of water that is traded and the priority date of transfers. In addition the price that was paid along with the total number of crops that were grown are reported for each participant. This allows for a calculation of economic welfare for each of the participants with and without market transactions. Summary results for the economic impacts of transactions are reported below for five categories:

- Observed Market Prices
- Number of Transactions per Month
- Economic Welfare Effects
- Impacts of Transactions upon a Call
- Third Party Effects from Transactions

Table 4 presents the observed market price per acre foot as a result of trading. The expected price per acre foot in each of these experiments was $3.00. In Table 4 we can see that the observed prices are the highest during the summer months and they are higher during the months when a call was expected (i.e. no stacking call scenarios in June, July and August). A second result from Table 4 is that the observed prices tend to be lower towards the end of a growing season as water becomes less valuable in agricultural producing.

Table 4: Observed Market Prices

	Month											
Treatment	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Stacking No Call #1	4.29	3.96	4.47	4.13	4.24	4.10	4.70	4.32	3.45	3.41	0.00	0.00
Stacking No Call #2	3.59	3.29	3.15	3.75	3.50	3.54	3.97	3.62	3.17	3.42	0.00	0.00
No Stacking Call #1	3.88	3.76	3.10	4.50	4.00	5.50	5.33	5.33	3.81	3.65	5.00	0.00
No Stacking Call #2	4.44	3.92	3.49	3.50	3.13	3.55	2.78	2.89	3.00	3.25	0.00	0.00

Table 5 presents the total number of transactions for each of the four treatments. The main result from this table is that more transactions occur when stacking is not allowed and the market participants are acquiring water in an effort to protect themselves from call. This is especially pronounced during the summer months in the no stacking call scenarios.

Table 5 Total Quantity of Water Sold (acre/ft)

	Trading Month											
Treatment	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Stack / No Call #1	18	5	20	18	13	15	14	9	19	2	0	0
Stack / No Call #2	18	22	20	9	7	9	10	17	4	5	0	0
No Stack / Call #1	18	22	17	2	4	14	4	9	14	18	0	0
No Stack / Call #2	19	11	17	4	6	18	10	5	3	3	0	0

It was expected that we would see an aggregate economic welfare amount for the upper Mimbres Basin to equal $3,978.00 per growing season. This number is obtained by taking the total amount of crops that could be grown in the basin and multiplying them by $3 a ton for experimental purposes. We recognize that this is not a realistic amount per ton, and that crops vary in their value. In order to induce values for the experimental participants it was necessary for us to choose a price per ton and we choose to follow the experimental value that was utilized in previous research we have conducted (see Broadbent et al., 2009). We observed total welfare for each of the four scenarios to always be greater than the expected welfare ranging from a 0.03% gain to an 8.92% gain with the largest gains occurring when a call occurs with small gains when stacking is allowed. While these are not large gains, they are welfare gains demonstrating that the market allows for positive welfare gains as a result of market transactions.

The impact of a call upon transactions explains why we observed larger economic welfare gains during times of a call versus when stacking is allowed. It was expected that we would observe a call during the summer months of July for the 1895, 1894, 1883 and 1880 priority dates. This means that the only two priority dates that would receive deliveries are the 1870 (Heuchling ditches) and the 1869 (San Lorenzo ditch). Further, we expected to see a call in August for the 1895 and 1894 priority dates. This means that only the Kenly ditches would not receive a water allotment in these months and the domestic wells and residential developments (1895 priority) would not receive a water allotment in either month (well use would be restricted to indoor water use). As a result of transactions we only observe a call for the 1895 and 1894 priorities in June and July for one experimental treatment and only June for the other treatment. As a result of trading the impacts of a call were lessened as many participants were able to enter the marketplace and secure water of a higher priority date in case of a call, with less water being called for by the senior users during water scarce times. This led to increased levels of economic welfare as previously described.

The water leasing market model was employed to investigate potential third party effects resulting from the trades for two of the test cases. The model of the full Mimbres Basin was run using the transactions that are summarized in the last two lines of Table 5, which represent water year 1986, a year when several calls occurred and therefore no stacking of water would be allowed. Results of model simulations are summarized in Table 6 where diversion shortages resulting from the experiment transactions can be compared to shortages (amount of water a ditch fails to receive relative to their adjudicated right) when no trades are allowed. All simulations represent a priority administration framework, which would be necessary if trades were to be conducted. Simulations suggest that an overall shortage reduction of 1% is realized in the Upper Mimbres, while a slight shortage increase of 0.23% in Middle Mimbres and 0.006% in the Lower Mimbres occurs. Most important is the result that there is no change in critically short days (days when a ditch is shorted by more than 25% of their normal delivery).

Table 6: Summary diversion shortages for no stacking/call treatments summarized in Table 5.

			Priority Enforcement No Trades		Priority Enforcement No Stacking / Call # 1		Priority Enforcement No Stacking / Call # 2	
Ditch	Priority	Desired Diversion	Shortage	Critically Short Days	Shortage	Critically Short Days	Shortage	Critically Short Days
Grijalva	1893	202.7	2.1	0	1.9	0	1.9	0
Montoya	1880	152.0	<0.1	0	0.0	0	0.0	0
Kenly 1	1894	210.2	147.4	15	147.6	15	145.1	15
Kenly 2	1894	148.3	108.7	15	109.1	15	108.7	15
Heuchling 1	1870	24.1	0.0	0	0.0	0	0.0	0
Heuchling 2	1870	16.2	0.0	0	0.0	0	0.0	0
Heuchling 3	1870	14.5	0.5	1	0.5	1	0.5	1
Heuchling 4	1870	56.5	0.0	0	0.0	0	0.0	0
San Lorenzo	1869	875.8	1.6	0	1.1	0	1.6	0
UPPER TOTALS			260.3	31	260.2	31	257.8	31
Ancheta Galaz	1876	454.0	2.1	0	2.1	0	2.1	0
Heredia Community	1870	430.8	0.0	0	0.0	0	0.0	0
Llano	1873	234.7	1.1	0	1.1	0	1.1	0
Tajo	1870	439.1	7.7	1	7.8	1	7.8	1
Perrault	1870	206.0	17.3	1	17.8	1	17.3	1
Duran	1888	88.5	29.7	24	29.6	24	29.7	24
Goforth	1880	163.2	43.8	24	43.8	24	43.9	24
Swartz	1884	489.9	4.7	0	4.7	0	4.7	0
Parra	1886	98.8	2.3	0	2.3	0	2.3	0
Kimmick	1889	355.8	24.1	0	24.2	0	24.1	0
Dominguez	1885	127.8	1.8	0	1.8	0	1.8	0
MIDDLE TOTALS			134.6	49	135.1	49	134.9	49
Nan	1880	348.9	1.6	0	1.6	0	1.6	0
Greenwald	1886	144.0	3.4	0	3.4	0	3.4	0
Eby & Baca	1887	534.0	17.9	0	18.0	0	18.0	0
Macedonio	1887	323.5	11.0	0	11.1	0	11.1	0
Baca	1885	376.2	5.3	0	5.3	0	5.3	0
Martin	1891	330.9	66.8	18	66.6	18	66.8	18
Wardwell-Herron	1880	510.0	66.1	0	66.1	0	66.1	0
Tustin-McIntosh	1884	550.6	174.1	24	174.0	24	174.2	24
OSullivan-McSherry-Pena	1880	46.2	0.2	0	0.2	0	0.2	0
Tigner	1890	550.2	141.7	0	141.3	0	141.5	0
Tigner A	1871	604.2	433.3	59	433.4	59	433.4	59
King	1912	559.4	514.4	89	516.3	89	514.5	89
Tigner B	1871	394.6	321.2	92	321.2	92	321.2	92
LOWER TOTALS			1,757.2	282	1,758.5	282	1,757.3	282
MIMBRES TOTALS			2,152.1	362	2,153.8	362	2,150.0	362

From this set of framework experiments several key results were obtained that reflect on the efficacy and potential operations of a water leasing market in the Mimbres:

1. Participants in the experiment were able to quickly understand how a water leasing market works and were able to participate with little instruction.
2. Positive welfare gains were recorded for each experiment, which means participants in the market benefited from their transactions.
3. Operation of the market resulted in fewer days under a call.
4. Junior water rights holders were able to obtain water in times of a call with only minor (<0.5%) increases to basin shortages and no increase in critically short days. In other words, this simple set of trades results in no measurable 3rd party effects.

Model Simulations

The Mimbres water leasing market model was exercised to explore potential trades between ditches in all three AWRMs; Upper, Middle and Lower Reaches. As with the framework experiments, analyses were aimed at investigating potential leases in terms of the difficulty of delivering leased water, impacts that the leases might have on neighboring water users (3rd party effects), and impacts that trading might have on overall system performance. Although for each simulation significant quantities of data are generated and saved (e.g., ground water levels by reach, stream flows, ditch diversions, evaporation), our analysis focus on two summary metrics. The first is the total amount of water that a ditch is shorted over a given year, that amount of water less than the ditch would receive under full water delivery. The second is the number of critically-short days, which is the number of days in which the ditch fails to receive at least 75% of its normal delivery. This critical measure is an estimate of the point at which crops could incur negative impact due to the lack of irrigation.

Simulations are run using a daily timestep over a one year period of time. Each simulation uses the year 1986 for inflows, which is the driest year for which we have complete stream gauge data. Impacts for a given trade are defined as a change in ditch shortage and/or number of critically short days relative to the ―base case", which is simply the simulation year run with no trades.

Twelve unique trades are explored. Trades include leases among ditches of the same AWRM and leases by ditches from different AWRMs. Below, results are given for each hypothetical trade. But before the trade results are reviewed, three no-trade scenarios are investigated for different river management cases: (1) No priority enforcement, (2) Equal sharing of shortages by all juniors, and (3) Priority administration (our base case). Evaluation of these three cases helps set the context for understanding how management of water allocation impacts deliveries.

Scenario (1): This first scenario explores what might happen under the case where there is no management of basin water deliveries, and no leases occur. In this case, three ditches in the Upper Mimbres suffer a shortage but one of these is the senior ditch, San Lorenzo which is shorted 9.7 AF (Table 7). Only Heuchling 3 suffers a critically-short period of one day. The total shortage for the Upper Mimbres is 10.2 AF. Four of 11 ditches in the Middle Mimbres see a shortage ranging from 8.8 to 41.4 AF. Perrault ditch, one of the Middle Mimbres' senior ditches, experiences a shortage of 17.6 AF. Four ditches suffer critical shortages: Tajo with 1 critically-short day; Perrault with 1 critically-short day; Duran with 24 critically-short days; and, Goforth with 24 critically short days. The total shortage for the Middle Mimbres is 88.1 AF with 49 critically-short days. Six of 13 ditches in the Lower Mimbres see a shortage. Among these are:

Wardwell-Herron at 63.8 AF short with no critically-short days; Tustin-McIntosh at 194.3 AF short with 24 critically-short days; Tigner at 144.4 AF short with no critically-short days; Tigner A at 466.44 AF short with 59 critically-short days; King at 453.8 AF short with 88 critically-short days; Tigner B at 324.9 AF short with 92 critically-short days. Tigner A and B are senior ditches on the reach. The total shortage for the Lower Mimbres is 1,647.7 AF with 264 critically-short days. The Mimbres Basin as a whole sees an overall shortage of 1,745.9 AF with 314 critically-short days. This assumes no leases.

Scenario (2): When shortages are shared equally amongst all junior ditches, the basin overall becomes worse off with the shortage increasing from 1,745.9 AF to 2,778.7 AF with 618 critically-short days (up from 314 days). San Lorenzo sees a benefit from this management with their total shortage decreasing from 9.7 AF to 5.5 AF; all other ditches in the Upper Mimbres see an increased shortage. In the Middle Mimbres, all ditches but Heredia Community see an increased shortage with the shortage increasing from 5.8 AF to 128.8 AF. The only ditches that benefit from this management method are those senior ditches at the bottom of the system: Wardwell-Herron (shortage reduced from 63.88 AF to 38.8 AF); Tustin-McIntosh (shortage reduced from 194.3 AF to 188.2 AF); Tigner A (shortage reduced from 466.4 AF to 330.0 AF); King (shortage reduced from 453.8 AF to 428.5 AF); and Tigner B (shortage reduced from 324.9 AF to 283.8 AF). The Lower Mimbres as whole becomes worse off with the shortage increasing from 1,647.7 AF to 1,906.0 AF.

Scenario (3): When the Mimbres is managed according to a priority administration scheme, shortages are reduced from the equal sharing case but still increased from the no priority enforcement case. However, under this case senior ditches receive more of their adjudicated water; specifically, San Lorenzo, Tajo, Perrault, Wardwell-Herron, Tustin-McIntosh, Tigner A, and Tigner B. Compared to scenario 1 where there is no priority enforcement, the total shortage increases from 1,745.9 AF to 2,152.1 AF with 362 critically-short days (up from 314).

Table below summarizes the impacts of the three different management strategies showing shortage and critically short days resulting when priorities are not enforced (1), when all junior ditches share shortages equally (2), and when ditches are cut off by their priority in order of newest to oldest priority dates in attempt to meet shortage requests (3).

Trade Scenarios

All trades described below assume priority administration (last 2 columns in Table 7); these shortages and critically-short days are replicated in Table 8 and Table 9 column (3) for easy comparison to results from trades. Resulting shortages and critically-short days are shown for every trade scenario in Tables 8 (shortages) and 9 (critically-short days). Each table shows color gradations indicating a better (green), same (white), or worse (orange) condition from the case with priority administration and no trades. The model can accommodate any trade of any amount up to a ditches' adjudicated acreage (i.e., a ditch must fallow some amount of acreage, freeing up that acreage multiplied by their crop irrigation requirement for use elsewhere in the system); the trades described here are a small sample with fallowed acreages ranging from 6% to 100% of total adjudicated acreage and leased amounts ranging from as little as 24 AF to as much as 100 AF. The intention of every lease is aimed at reducing ditches' shortages by their entire shortage up to 100 AF. The ditches chosen for trades are those that are currently metered (see Table 2).

Table 7: Summary diversion shortages from three different management methods.

Ditch	Priority	Desired Diversion	(1) No Priority Enforcement		(2) Share Shortages Equally		(3) Priority Enforcement	
			Shortage	Critically Short Days	Shortage	Critically Short Days	Shortage	Critically Short Days
Grijalva	1893	202.7	0.0	0	115.3	91	2.1	0
Montoya	1880	152.0	<0.1	0	16.3	0	<0.1	0
Kenly 2	1894	210.2	0.0	0	63.8	15	147.4	15
Kenly 1	1894	148.3	0.0	0	55.6	15	108.7	15
Heuchling 1	1870	24.1	0.0	0	<0.01	0	0.0	0
Heuchling 2	1870	16.2	0.0	0	<0.1	0	0.0	0
Heuchling 3	1870	14.5	0.5	1	<0.1	0	0.5	1
Heuchling 4	1870	56.5	0.0	0	<0.1	0	0.0	0
San Lorenzo	1869	875.8	9.7	0	5.5	0	1.6	0
UPPER TOTALS			10.2	1	256.4	121	260.3	31
Ancheta Galaz	1876	454.0	0.0	0	106.6	0	2.1	0
Heredia Community	1870	430.8	0.0	0	0.0	0	0.0	0
Llano	1873	234.7	0.0	0	73.0	0	1.1	0
Tajo	1870	439.1	8.8	1	5.8	1	7.7	1
Perrault	1870	206.0	17.6	1	17.4	1	17.3	1
Duran	1888	88.5	20.6	24	73.1	114	29.7	24
Goforth	1880	163.2	41.4	24	55.7	24	43.8	24
Swartz	1884	489.9	0.0	0	62.4	0	4.7	0
Parra	1886	98.8	0.0	0	45.4	32	2.3	0
Kimmick	1889	355.8	0.0	0	128.8	14	24.1	0
Dominguez	1885	127.8	0.0	0	48.1	13	1.2	0
MIDDLE TOTALS			88.1	49	616.3	198	134.6	49
Nan	1880	348.9	0.0	0	24.2	0	1.6	0
Greenwald	1886	144.0	0.0	0	51.1	10	3.4	0
Eby & Baca	1887	534.0	0.0	0	81.3	0	17.9	0
Macedonio	1887	323.5	0.0	0	69.5	0	11.0	0
Baca	1885	376.2	0.0	0	69.9	0	5.3	0
Martin	1891	330.9	0.0	0	144.2	24	66.8	18
Wardwell-Herron	1880	510.0	63.8	0	38.8	0	66.1	0
Tustin-McIntosh	1884	550.6	194.3	24	188.2	24	174.1	24
OSullivan-McSherry-Pena	1880	46.2	0.0	0	13.9	1	0.2	0
Tigner	1890	550.2	144.4	0	182.7	0	141.7	0
Tigner A	1871	604.2	466.4	59	330.0	59	433.3	59
King	1912	559.4	453.8	89	428.5	89	514.4	89
Tigner B	1871	394.6	324.9	92	283.8	92	321.2	92
LOWER TOTALS			1,647.7	264	1,906.0	299	1,757.2	282
MIMBRES TOTALS			1,745.9	314	2,778.7	618	2,152.1	362

Scenario (4)-San Lorenzo leases to Kenly 1 and Kenly 2: This scenario investigates a lease from a senior to junior ditch within the same AWRM. Assuming priority administration, Kenly 2 sees a shortage of 147.4 AF while Kenly 1 sees a shortage of 108.7 AF, while all other Upper Mimbres ditches experience shortages, 2.1 AF or less. In an attempt to mitigate this, San Lorenzo fallows 37.04 acres (13.4% of their adjudicated acreage), freeing up 100 AF for use elsewhere in the system; Kenly 1 and Kenly 2 each request 50 AF from San Lorenzo. As a result of this transaction, both Kenly 1 and Kenly 2 see significant reductions in their shortages, each on the order of 40 AF, which is what the 50 AF that San Lorenzo gave up becomes when you account for ditch efficiencies; neither Kenly 1 or Kenly 2 see a decrease in their critically-short days. Overall, the Upper Mimbres benefits from this transaction with all ditches seeing the same or smaller shortages and critically-short days. Downstream, third party effects are observed as several ditches in the Middle and Lower Mimbres which see increased shortages (17.5 AF total in Middle and 32 AF total in Lower) and change in the number of critically-short days (increased by one in the Middle and decreased by one in the Lower). One Lower Mimbres senior ditch does benefit from the San Lorenzo lease: Tigner A sees a shortage reduction of 0.6 AF and 1 less critically-short day. Overall, the basin shortage decreases by 30 AF, from 2,152 AF to 2,122 AF and experiences 1 less critically-short day.

Scenario (5)-Montoya leases to Kenly 1 and Kenly 2: This lease involves two ditches in the Upper AWRM in which water moves downstream. Another way to ameliorate the shortage experienced by Kenly 1 and Kenly 2, short 110.7 AF and 150 AF respectively when the Mimbres is managed according to priority administration, is for these ditches to temporarily lease water from Montoya who has a senior priority date of 1880 and is directly upstream Kenly 1 and Kenly 2. If Montoya fallows half their acreage, 18.3 acres, 49.41 AF can be leased by Kenly 1 and Kenly 2. Again, Kenly 1 and Kenly 2 see their shortages reduced by the amounts that they lease, but no change to their critically-short days. Overall, the Upper Mimbres again sees a benefit from this transaction and third party effects are observed in the Middle and the Lower Mimbres; however, the number of ditches harmed by the transaction decreases, while those seeing a benefit increases. Comparing scenario 4 and scenario 5 suggests that a trade from an upstream senior ditch is overall less harmful to the system than a trade from a downstream senior ditch.

Scenario (6)-San Lorenzo leases to Goforth: This trade involves movement of water from a senior ditch on the Upper Mimbres to a junior ditch in the Middle Mimbres. Assuming priority administration, Goforth sees a shortage of 43.8 AF (the highest in the Middle Mimbres). In an attempt to abate this, San Lorenzo fallows 16.22 acres (6% of their acreage) making 43.8 AF available for use elsewhere in the system; Goforth requests 43.8 AF and sees their shortage reduced significantly, to 8.2 AF but with critically-short days unchanged. This transaction is projected to have greater third party effects than both previous scenarios with two ditches in the Upper Mimbres seeing increased shortages but the Upper Mimbres overall seeing slightly reduced shortages and no change in critically-short days. Looking to the Middle Mimbres, shortages overall are reduced slightly but increased for many individual ditches and critically-short days increase. The Lower Mimbres sees only negative effects, with all but four ditches seeing an increased shortage; no change in critically-short days is expected. These results suggest that leasing across AWRM‘s might have greater negative impacts than leasing within AWRM‘s.

Scenario (7)-San Lorenzo leases to King: This lease attempts to move water from a senior ditch on the Upper Mimbres to a junior ditch on the Lower Mimbres. Assuming priority administration, King sees a shortage of 514.4 AF (the highest in the Lower Mimbres). In an attempt to abate this, San Lorenzo fallows 37.04 acres (13.4% of their adjudicated acreage), freeing up 100 AF for use elsewhere in the system. With this trade, King reduces their shortage to 465.7 AF but sees no change in critically-short days. This transaction is the first to have a negative impact on the Upper Mimbres overall and the entire basin with the overall shortage increasing from 2,152 AF to 2,167 AF. No change in critically-short days is observed. These results suggest that moving water from a senior ditch near the top of the system to a junior ditch at the very bottom of the system could have relatively greater third party effects than any other transaction might.

Scenario (8)-Dominguez leases to Duran: This lease addresses the upstream lease of water between two ditches in the Middle Mimbres. Assuming priority administration, Duran (1888) sees a shortage of 29.7 AF, while Dominguez is five ditches downstream of Duran with a priority of 1885. In an attempt to get rid of their 29.7-AF short, Duran can lease from Dominguez. Dominguez fallows 9.9 acres (36% of their acreage), freeing up 29.7 AF for diversion by Duran. This transaction gets rid of Duran's short entirely, reduces their critically-short days to 0,and improves conditions in all three sub-basins. Only one ditch suffers a third party effect: Tajo sees an increase in their shortage of 0.1 AF, which is 0.02% of their annual diversion.

Scenario (9)-Swartz leases to Kimmick: Downstream lease between two ditches in the Middle Mimbres. Assuming priority administration, Kimmick (1889) sees a shortage of 24.1 AF. Swartz is two ditches upstream of Kimmick with a priority of 1886. In an attempt to get rid of their 24.1-AF short, Kimmick can lease from Swartz. Swartz fallows 8 acres (7.4% of their acreage), freeing up 24 AF for use by Kimmick. Through this transaction, Kimmick can reduce their shortage to 0.8 AF and as was the case in scenario 8, a similar lease between two Middle Mimbres ditches, only Tajo suffers a third party effect.

Scenario (10)-Swartz leases to Kenly 1, Kenly 2: This lease considers the upstream lease of water from a ditch in the Middle Mimbres to ditches in the Upper Mimbres. As mentioned previously, assuming priority administration, Kenly 1 sees a shortage of 108.7 AF while Kenly 2 sees a shortage of 147.4 AF. In an attempt to mitigate this, Kenly 1 and Kenly 2 can also lease from Swartz instead of San Lorenzo. Swartz fallows 33.33 acres (31% of their acreage), freeing up 100 AF for use elsewhere in the system; Kenly 1 and Kenly 2 each request 50 AF from Swartz and see their shortages reduced by this amount less efficiency losses. Critically-short days go unchanged for every ditch but King who sees 1 less critically short day. Overall, conditions for the basin as a whole improve, with the total shortage decreasing from 2,152 AF to 2,072 AF; however, the Lower Mimbres suffers third party effects in terms shortage increases for many of its ditches and for the first time San Lorenzo sees an increased shortage of 0.2 AF.

Scenario (11)-Swartz leases to Tigner: This lease moves water from the Middle Mimbres to a ditch on the Lower Mimbres. Assuming priority administration, Tigner sees a shortage of 141.7 AF. In an attempt to mitigate this, Swartz fallows 47.23 acres (43.7% of their acreage), making 141.7 AF available for Tigner. As a result, Tigner's short is completely abated and many of the ditches in both the Middle and the Lower Mimbres see reduced shortages. No change in critically-short days is observed. Two ditches in the Middle Mimbres suffer third party effects: Tajo's shortage increases by 1.2% while Perrault's shortage increases by 0.5%.

Scenario (12)-Nan to King: This lease considers a downstream lease between two ditches in the Lower Mimbres. Assuming priority administration, King sees a shortage of 514.4 AF. King looks to reduce their shortage by leasing water from Nan who is 11 ditches upstream of King with a priority of 1880. If Nan fallows 33.33 acres (44% of their acreage), King can request the resulting 100 AF that becomes available and reduce their shortage to 341.5 AF. This transaction, as expected, has no impact on the Upper or Middle Mimbres. In the Lower Mimbres, Tigner B also benefits from the transaction between Nan and King, seeing their shortage reduced by 0.3 AF. Overall, the shortage in the basin decreases from 2,152 AF to 1,978 AF, while critically-short days is reduced by 1 day.

Scenario (13)-O'Sullivan-McSherry-Pena to Martin. In contrast to above, an upstream lease between two ditches in the Lower Mimbres is considered. Assuming priority administration, Martin sees a shortage of 66.8 AF. One way to reduce this shortage is for Martin to lease from O'Sullivan-McSherry-Pena, 3 ditches downstream with a priority date of 1880. O'Sullivan-McSherry-Pena only irrigates 10 acres, so in the instance where O'Sullivan-McSherry-Pena might fallow all of their acreage, 30 AF become available for use by Martin. This lease allows Martin to reduce their shortage by 26.7 AF though critically-short days remain at 18. Results for the rest of the basin are very similar to scenarios 8 and 9, leases from Dominguez to Duran and Swartz to Kimmick, where the only ditch seeing an increased shortage is Tajo at 0.1 AF or 0.02% their annual diversion.

Scenario (14)-Nan to Kenly 1, Kenly 2: Lease upstream for Lower Mimbres to Upper Mimbres. If Nan fallows 33.33 acres (44% of their acreage), 100 AF become available for use elsewhere in the system. Kenly 1 and Kenly 2 can both see their shortages reduced by leasing 50 AF of this water each. This transaction results in several third-party effects across the basin with San Lorenzo seeing its shortage increased by 0.2 AF, the Middle Mimbres seeing a slightly increased overall shortage, and the Lower Mimbres seeing the same overall shortage as the base case. Critically-short days remain unchanged. Comparing the lease of Nan to Kenly 1 and Kenly 2 to the previous leases that involved Kenly 1 and Kenly 2 (scenario 4, San Lorenzo leases to Kenly 1 and Kenly 2; scenario 10, Swartz leases to Kenly 1 and Kenly 2), model results suggest that scenario 4 offers the greatest benefit to the basin as a whole while scenarios 10 and 14 are very similar in their benefit.

Scenario (15)-Nan to Kimmick: This lease considers an upstream trade from the Lower Mimbres to the Middle Mimbres. Assuming priority administration, Kimmick (1889) sees a shortage of 24.1 AF. Nan is two ditches downstream of Kimmick with a priority of 1880. In an attempt to get rid of their 24.1-AF short, Kimmick can lease from Nan. Nan fallows 8 acres (10.6% of their acreage), freeing up 24 AF for use by Kimmick. Kimmick can reduce their shortage to 0.8 AF by leasing from Nan and results for the rest of the basin are very similar as for scenarios 8, 9, and 13 leases from Dominguez to Duran, Swartz to Kimmick, and O'Sullivan-McSherry-Pena to Martin, where the only ditch seeing an increased shortage is Tajo at 0.1 AF or 0.02% their annual diversion.

Table 8: Diversion shortages for simulation with no trades (3) and 12 different trading scenarios (4)-(15).

			Diversion Shortage by Scenario (AF)												
Ditch	**Priority**	**Desired Diversion**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**
Grijalva	1893	202.7	2.1	1.6	1.4	1.7	1.6	2.1	2.1	2.2	2.1	2.1	2.1	2.1	2.1
Montoya	1880	152.0	<0.1	<0.1	0.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Kenly 2	1894	210.2	147.4	107.7	127.4	147.8	149.3	147.0	147.1	106.9	145.3	147.4	147.0	106.9	147.1
Kenly 1	1894	148.3	108.7	70.0	89.4	109.0	110.0	108.5	108.5	69.7	107.8	108.7	108.5	69.7	108.5
Heuchling 1	1870	24.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heuchling 2	1870	16.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heuchling 3	1870	14.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5
Heuchling 4	1870	56.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
San Lorenzo	1869	875.8	1.6	0.7	1.4	1.0	0.5	1.6	1.6	1.8	1.6	1.6	1.6	1.8	1.6
UPPER TOTALS			260.3	180.5	220.1	260.1	261.9	259.7	259.9	181.0	257.3	260.3	259.8	181.1	259.9
Ancheta Galaz	1876	454.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Heredia Community	1870	430.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Llano	1873	234.7	1.1	1.4	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Tajo	1870	439.1	7.7	14.4	9.7	9.9	12.3	7.8	7.8	8.3	7.8	7.7	7.8	8.3	7.8
Perrault	1870	206.0	17.3	18.5	17.5	17.9	19.3	17.3	17.3	17.4	17.4	17.3	17.3	17.4	17.3
Duran	1888	88.5	29.7	33.2	29.3	31.1	36.6	0.0	29.7	29.7	29.7	29.7	29.7	29.7	29.7
Goforth	1880	163.2	43.8	46.7	44.4	8.2	53.4	43.1	43.8	43.8	43.8	43.8	43.8	43.9	43.8
Swartz	1884	489.9	4.7	4.7	4.7	4.7	4.7	4.7	4.3	3.2	2.6	4.7	4.7	4.7	4.7
Parra	1886	98.8	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Kimmick	1889	355.8	24.1	27.0	24.6	24.9	25.6	23.7	0.8	24.1	23.4	24.1	24.0	24.1	0.8
Dominguez	1885	127.8	1.8	1.8	1.8	1.8	1.8	1.2	1.8	1.8	1.8	1.8	1.8	1.8	1.8
MIDDLE TOTALS			134.6	152.1	137.4	104.1	159.3	103.2	110.0	133.8	131.9	134.6	134.5	135.4	111.3
Nan	1880	348.9	1.6	1.6	1.6	1.6	2.5	1.6	1.6	1.6	1.6	0.9	1.6	0.9	1.5
Greenwald	1886	144.0	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Eby & Baca	1887	534.0	17.9	18.8	18.4	19.2	20.0	17.5	17.7	17.9	17.5	17.9	17.6	18.0	17.7
Macedonio	1887	323.5	11.0	11.9	11.5	12.1	12.1	10.7	10.8	11.1	10.6	11.0	10.7	11.1	10.8
Baca	1885	376.2	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Martin	1891	330.9	66.8	67.4	66.2	67.2	67.6	66.6	66.6	66.8	64.8	66.8	40.1	66.9	66.6
Wardwell-Herron	1880	510.0	66.1	70.6	66.6	67.5	78.5	63.8	59.5	66.2	48.0	66.1	57.7	66.3	59.5
Tustin-McIntosh	1884	550.6	174.1	185.2	172.9	178.7	182.2	172.1	172.6	174.3	170.0	174.1	172.2	174.3	172.6
OSullivan-McSherry-Pena	1880	46.2	0.2	0.2	0.2	0.2	0.4	0.2	0.2	0.2	0.2	0.2	0.0	0.2	0.2
Tigner	1890	550.2	141.7	155.8	138.8	147.8	150.4	139.4	139.9	141.9	0.0	141.7	139.6	141.9	139.9
Tigner A	1871	604.2	433.3	432.7	433.1	435.3	436.7	432.5	432.7	433.3	428.9	433.3	432.0	433.3	432.7
King	1912	559.4	514.4	514.6	512.9	517.2	465.7	514.0	513.9	513.5	511.3	341.5	514.0	514.2	514.1
Tigner B	1871	394.6	321.2	321.3	321.4	321.7	320.9	321.2	321.2	321.9	321.2	320.9	321.0	321.2	321.0
LOWER TOTALS			1,757	1,789	1,752	1,777	1,746	1,748	1,746	1,758	1,583	1,583	1,715	1,757	1,745
MIMBRES TOTALS			2,152	2,122	2,110	2,141	2,167	2,111	2,116	2,072	1,972	1,978	2,110	2,073	2,117

Table 9: Critically-short days for simulation with no trades (3) and 12 different trading scenarios (4)-(15).

			Critically Short Days by Scenario												
Ditch	**Priority**	**Desired Diversion**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**
Grijalva	1893	202.7	0	0	0	0	0	0	0	0	0	0	0	0	0
Montoya	1880	152.0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kenly 2	1894	210.2	15	15	15	15	15	15	15	15	15	15	15	15	15
Kenly 1	1894	148.3	15	15	15	15	15	15	15	15	15	15	15	15	15
Heuchling 1	1870	24.1	0	0	0	0	0	0	0	0	0	0	0	0	0
Heuchling 2	1870	16.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Heuchling 3	1870	14.5	1	1	1	1	1	1	1	1	1	1	1	1	1
Heuchling 4	1870	56.5	0	0	0	0	0	0	0	0	0	0	0	0	0
San Lorenzo	1869	875.8	0	0	0	0	0	0	0	0	0	0	0	0	0
UPPER TOTALS			31	31	31	31	31	31	31	31	31	31	31	31	31
Ancheta Galaz	1876	454.0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heredia Community	1870	430.8	0	0	0	0	0	0	0	0	0	0	0	0	0
Llano	1873	234.7	0	0	0	0	0	0	0	0	0	0	0	0	0
Tajo	1870	439.1	1	2	1	2	1	1	1	1	1	1	1	1	1
Perrault	1870	206.0	0	0	0	0	1	0	0	0	0	0	0	0	0
Duran	1888	88.5	24	24	24	24	24	0	24	24	24	24	24	24	24
Goforth	1880	163.2	24	24	24	24	24	24	24	24	24	24	24	24	24
Swartz	1884	489.9	0	0	0	0	0	0	0	0	0	0	0	0	0
Parra	1886	98.8	0	0	0	0	0	0	0	0	0	0	0	0	0
Kimmick	1889	355.8	0	0	0	0	0	0	0	0	0	0	0	0	0
Dominguez	1885	127.8	0	0	0	0	0	0	0	0	0	0	0	0	0
MIDDLE TOTALS			49	50	49	50	49	25	49	49	49	49	49	49	49
Nan	1880	348.9	0	0	0	0	0	0	0	0	0	0	0	0	0
Greenwald	1886	144.0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eby & Baca	1887	534.0	0	0	0	0	0	0	0	0	0	0	0	0	0
Macedonio	1887	323.5	0	0	0	0	0	0	0	0	0	0	0	0	0
Baca	1885	376.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Martin	1891	330.9	18	18	18	18	18	18	18	18	10	18	18	18	18
Wardwell-Herron	1880	510.0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tustin-McIntosh	1884	550.6	24	24	24	24	24	24	24	24	24	24	24	24	24
OSullivan-McSherry-Pena	1880	46.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Tigner	1890	550.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Tigner A	1871	604.2	59	58	58	59	59	59	59	59	58	59	59	59	59
King	1912	559.4	89	88	88	89	89	88	88	88	88	88	88	88	88
Tigner B	1871	394.6	92	92	92	92	92	92	92	92	92	92	92	92	92
LOWER TOTALS			282	280	280	282	282	281	281	281	272	281	281	281	281
MIMBRES TOTALS			362	361	360	363	362	337	361	361	352	361	361	361	361

All of the leases investigated are for the case of low water and priority administration. This is the case of particular concern where leasing is most likely to be of interest to basin farmers. From this analysis several key messages can be derived:

1. Under priority call conditions, most ditches experience some shortage of delivery and many ditches realize critically-short days (this assuming no leases). Conditions worsen as one moves downstream. These delivery problems are just a characteristic of the limited water in the basin.
2. Leasing of water tends to help reduce shortages but not critically short days by the ditch leasing the water. In most cases, the ditch leasing the water sees the entire amount that it has leased, less efficiency losses. However, the ditch is not receiving the water when it really needs it as reflected in no change in critically short days.
3. There are some cases when critically-short days are reduced for a ditch not involved in a trade simply because more water is flowing by that ditch (see scenario 11 where Swartz leases to Tigner).
4. Only two of the 12 trading scenarios explored left the entire basin worse off (scenarios 6 and 7); both of these trades involved movement of water downstream across different AWRMs, San Lorenzo leasing to Goforth (Upper to Middle) and King (Upper to Lower).
5. All leases tend to impact other ditches not involved in the trade; the ―best” trades (those columns that are more green than orange) seem to be those conducted between the Middle and the Lower Mimbres, regardless of whether the trade is from upstream to downstream or downstream to upstream; the ―worst” trades seem to be those conducted with an Upper Mimbres ditch as the leasor, particularly when the leasee is in a different AWRM (i.e., the Middle or the Lower Mimbres).
6. Only trades 4 and 7 result in measureable shortage impacts over the course of a year; that is, results in shortages that exceed 10% of their deliveries in the baseline year.
7. Only a single trade transactions of the 12 explored did not harm any ditch in the basin and benefited several indirectly: this is a lease from Nan to King, both ditches in the Lower Mimbres with King being the last ditch in the system with the most junior priority date and the greatest shortage no matter how the river is administered.

Water Leasing Market Rule Set Development

Establishing an accepted set of rules is the linchpin to a smoothly functioning water leasing market. A codified set of rules is necessary to define such things as: how the inequality in conveyance losses across different ditches is handled relative to a market transaction; the order in which water is consumed relative to owned and leased water with different priority dates; actions when leased water cannot be physically delivered; compensation for parties injured by market transactions; payment of transaction fees; and, defining the structure and authority of the market institution. Beyond such operational rules, the legality of market transactions relative to state water law and the *Mimbres Adjudication* must be established.

While some rules are subject to state and federal law with little latitude on their specification, others deal only with the operations of the market and thus allow more flexibility in how they are defined. Such rules will need to be crafted to meet the disparate needs of basin water users, while providing equitable treatment of all basin parties. Such rules are needed to protect the interest of both those that participate in the market as well as those electing to abstain from the market. Additionally, the rules must balance equity with logistical feasibility; specifically, the rules must lend themselves to measurement, management, and enforcement. See Appendix 1: A Look at Current Markets in the Western States and Issues in Establishing Water Leasing Markets for additional details on water leasing markets and challenges in establishing such markets.

Toward this need an initial set of rules governing the administration of the water leasing market in the Mimbres River Basin was developed. This process began with a review of applicable state law. In principle authority was granted the New Mexico State Engineer in section19.25.13 of the New Mexico Administrative Code to implement Active Water Resources Management, specifically water markets in the State of New Mexico. Implementation of water markets are further governed by Chapter 72-6 of the New Mexico Statutes (2011). Additionally, provisions are made for Water Banking, set forth in Chapter 73-2-55-1 of the 2011 New Mexico Statutes that allows water rights owners on an acequia or community ditch who are temporarily not using some or all of their water rights to benefit by protecting those rights from loss for non-use. The water leasing market provides an alternative for water rights owners to lease rather than bank their rights. Finally, provisions for Expedited Marketing and Leasing in the Mimbres Basin are stipulated in section 19.25.22.516 of the New Mexico Administrative Code.

These codes and statutes provide a general framework for governing a water leasing market. Rules specific to the operations and needs of Mimbres Basin water users are needed. The next step in developing a rule set specific to the Mimbres River was to review rule sets implemented in other water leasing markets/banks across the western U.S. The goal of the review was to learn from others experience. Specific markets reviewed include: Kansas Water Banking Act (2001); Middle Rio Grande Conservancy District Water Bank Rules (2001); Idaho Water Supply Bank Rules (IDAPA 37-Title 02-Chapter 03, 2004); Arkansas River Water Bank Program (2006); Shoshone-Bannock Tribal Water Supply Bank Rules (2004); and, the Kittitas Water Exchange (2012). Using the state code as a framework, concepts for specific rules where adapted from other markets for application to the unique operations and needs of the Mimbres River.

Based on this review a double auction framework that allows each market participant to be both a buyer and seller of a water right was adopted. This structure is commonly used at the Chicago Board of Trade to facilitate the trading of commodities, financial products, precious metals, and electricity. One of the salient features of this market structure is that it allows market participants to have simultaneous offers to sell a water right and bids to buy a water right. In addition, all market transactions are centrally and publically recorded; keeping all information public creates market transparency.

The rule set implements the double action framework within the setting of the Mimbres River. Specifically, the rule set provides a framework for administering the market, establishes the manner with which bids and offers are advertised, defines an approval process for a proposed lease and stipulates how the leased water will be delivered. This rule set is given in Appendix 7: Water Leasing Market Rules for the Mimbres Basin Active Water Resource Management Areas.

This set of rules only represents a starting place as it has not received a full vetting from the legal department within the New Mexico Office of the State Engineer‘s Office.

Appendix 1: A Look at Current Markets in the Western States and Issues in Establishing Water Leasing Markets[6]

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March 4, 2013

[6] This research was supported principally by the Bureau of Reclamation and the Office and the Sate Engineer for New Mexico. Additional support was provided by the U.S.G.S. through the Science Impact Laboratory for Policy and Economics (SILPE) at the University of New Mexico.

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Abstract

Water markets have the ability to play an intricate role in future water demand management. A water market is able to flex with the needs of consumers while also adding the benefit of easily managing variations in water supply from year to year. Markets also have the ability to stimulate economic growth and activity. This report will address the current state of water markets in the western states and discuss considerations when setting up a water market. The report will address the following questions about water markets in the West:

- What is the prevalence of current markets?
- What are the characteristics current markets?
- Are there any futures or ecosystem considerations involved in existing markets?
- What should the ideal water market look like?
- Are the current markets considered robust markets as defined by the definition of a water market in this report?
- Do our current markets comprise the same components of what an ideal water market has as defined by the report?
- How can current and future water markets be changed in order to become an ideal water market?

We find there are few truly robust water markets in the west. Further, we suggest that setting up a water leasing market is not a one size fits all approach, but rather, a market needs an individualized approach based of the needs of the region.

I. Introduction to Water Markets

A. What is a Water Leasing Market[8]?

Water leasing markets are mechanisms that facilitate water transfers for a specific goal between willing buyers or sellers. Thus they are voluntary.

Water banks/leasing programs facilitate the transfer just as any other market might act. The bank/leasing institution is used as a liaison between the buyer and seller of the water right[9]. A water leasing program's main functions may include (Clifford, p.3-4[10]). :

- Determining what rights can be banked;
- Establishing quantity of leasing/bankable water;
- Limiting who can purchase or rent from the bank if necessary;
- Setting contract terms and/or prices;
- Facilitating regulatory requirements.

A leasing program will typically yield least cost efficiency for water users as well as potentially providing a mechanism for regulating the environmental attributes of the region. The goals for setting up water banks or water leasing programs include but are not limited to:

- Create a reliable water supply during dry years.

[8] We focus on water leasing markets as against transfers of property rights. Thus our discussion focuses on voluntary temporary transfers between parties.
[9] The literature does not draw a crisp distinction between banking and leasing. We choose to use them interchangeable, whereby the particular characteristics would be clear in a specifically designed market.
[10] We draw upon this reference for the following discussion.

- Ensure a future water supply for people, farms, and fish.
- Promote water conservation by encouraging right holders to conserve and deposit rights into the bank.
- Act as a market mechanism.
- Resolve issues of inequity between ground water and surface-water users.
- Ensure compliance with intrastate agreements of in stream flow.

B. Market Pricing Mechanism

Water leasing institutions can be set up with various details depending on what the stakeholder's value, activity in the area, and goal of the program. Markets can use a fixed, market, auction, contractual, or possibly futures pricing structure. Below we briefly discuss some of the frameworks.

1. Fixed:

A fixed pricing structure uses a predetermined market price (Colby, p. 8). This method does not capture what the true willingness to pay would occur in a free flowing market. It also does not capture the value of higher priority rights such as senior water rights over junior water rights. Thus water rights holders might be getting paid more for a right that is worth less in a free flowing market and vice versa for a highly valued water right. However, by allowing the central authority to determine the price gives the entity market power and control.

2. Market:

The clearinghouse is considered the most common method. A clearinghouse allows negotiations to take place between buyers and sellers on the price of a specific water right. This can be done by utilizing a website to post your water right or to buy water rights. This allows easily accessed information by both parties on the clearing market price. The leasing institution should be used for all transactional communication between the two parties. This can also be done using a physical bulletin board in small regions or by phone.

3. Auction:

An auction can be useful in preventing biases in the market. The water right is posted then there is a set timeframe where buyers are allowed to bid (Colby, p. 9). The right then will go to the highest bidder once the time limit for the auction has been reached. Rules can be set up for accepting or denying the bids. This method can also be time consuming and yield no transactions.

4. Contractual:

Contracts may be set up for a period of time between buyers and sellers. A seller might have a contract with a buyer for an amount of time that states they will sell an amount of water a month to the buyer. This helps cut down time of transactions because they are not being made one at a time. They are already set up under contract for deliveries every X times throughout the contract. It also helps with more steady transfers instead of larger deliveries at once. This is because there is not any farther transaction costs for the deliveries. This will require a commitment on both ends and might end up in defaulting on the contract. Participation might decrease and at some point throughout the contract the water use might not be beneficial anymore.

5. Futures:

Futures markets are not currently in existence but a possibility[11]. Futures water markets would work in conjunction with the market pricing mechanisms already discussed. It would work much like that of the futures market for oil. Using an example, if farmer A grows alfalfa and the price has recently plummeted then they might want to cut back on production and thus need less water. However, the price for water is relatively low and they expect the price of alfalfa to rise again in the future. They may be able to find a seller who is expecting less profit from their crop in the future. So one farmer believes they will need water in the future and another farmer is seeing a high price for their crop now but believes that they will see a decrease in the future. These farmers may be able to make a trade for two years for now when they believe that the prices will change. This allows for Farmer A to get water at a cheaper price than it might be in the future and the other farmer is able to sell water at what he believes is a higher rate than he will see in the future.

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[11] We searched and were unable to locate any futures markets. However, there may be some operating that do not appear in the grey literature.

II. The Issues in Designing a Water Leasing Market

Current programs have found success in meeting the current needs for water scarcity, but there is a possibility for future programs to be more robust and provide more services within the market. Depending on the programs goal a number of considerations may be needed to supplement current programs. Figure 1 details the decisions that must be made when setting up a water market. It is important to remember that setting up a water market is not a one size fits all approach. This template serves as a list of possible options for setting up a water market. We discuss each component in turn[12].

A. Goal

The goal of a program can either be environmental or market based (Colby, p. 8). A program with an environmental goal will set its main mission to revive the indigenous habitat or protect indigenous species. A program with a goal of creating a functioning market will make the water users more efficient with their water usage. A program can also be set up with a combination of the two goals in mind allowing for the preferences of the consumers in the area. Each region will be different based on what the participant's value. That is to say, if we decide to have less strict rules for protecting the environment then what are the tradeoffs? The participants should be surveyed to determine the optimal amount of environmental aspects to market aspects.

C. Water Storage

The program can pick from a wet option or a dry option when storing water for use (Colby, p.7). Wet storage is having a physical facility to store and deliver water to the participants in the program. Dry storage is a system of credits and debits, much like todays financial institutions work.

Wet storage makes deliveries easily regulated and means that the transactions are backed by physical water, much like the gold standard. A reservoir or holding tank is used to store the water and a mechanism is built into the facility to hold and release water. These facilities are typically built at higher elevations are a common place where the water gathers and is easily distributed to everyone in the market. This means that there will be loss of water though evaporation and sediment absorption. The infrastructure can also be quite expensive to build, maintain, and monitor.

Environmental attributes need to be kept in mind when using wet storage. This is because more water will be held in the facility instead of going downstream. This can cause damage to the indigenous species and vegetation in the region.

Dry storage uses debits and credits to determine who gets to pull the water from the already flowing supply. This requires little to no infrastructure to be built. There will also be less evaporation and absorption into the sediment. However, dry water storage is hard to regulate and can lead to defaulting on debt by participants. The program should adopt strict regulation guidelines to ensure that this does not happen.

A. Market Players

These are the participants allowed to partake in the market. The program may choose to include whom they want in the market. Who does and does not participate in the market will greatly affect other decisions that the program will have to make.

If the program decides to let everyone into the market, it will have a couple major effects. Opening the program up to everyone means that even people who may not already own a water right can lease water rights now. Doing so might lead to wasting water or at least not putting it toward beneficial use[13]. The program will also see an

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[12] This section draws upon Colby 2009.

[13] Beneficial use: A term that is defined by the program depending on what the programs goals are to yield the greatest gain towards that goal.

Figure 1: Decision Framework for Designing a Leasing Market

Goal
- envirnmental/mitigation
- market

Type of Program
- bank only
- lease
- banking of property rights

Whats Traded
- water
- water rights
- credits/debits

Water Storage
- credits/debits
- physical storage

Market Players
- everyone
- state
- basin only

Market Structure
- fixed
- contractual
- market
- auction
- futures

Managment
- partneership
- non-profit
- public
- private for profit

Fees/Timeframe
- taxes
- application fee
- membership
- percentage
  - progressive
  - flat
- transaction timeframe

Enforcment
- record keeping
- penalty for breaking rules
- how will taken water be monitored within the basin?
- form of accounting for trade

Incentives
- subsidies for consevation
- subsities for new technologies

Insurance Program
- to all
- buy in only
- program buy back rights

increase in the number of transactions made. This being said, as seen in the current programs section, activity and participation in markets is extremely low, so opening the field up to others will provide more options for buyers and sellers in the market.

Another approach is in basin participation only. This is the most common form of operation. This limits the activity in the market but is the most beneficial use of resources. Only the people already using the water are allowed in the market.

B. Market Structure

This has been discussed above in section I.

C. Management

Water markets are more successful when the participants trust the management. This can vary from region to region. The market can be set up using a private, public, partnership, or private for profit (Colby, p.8). All of the options are functional as long as there is open dialog between the participants and management. Choosing the management often will depend on how well the participants trust the government in the region. Using contingent valuation methods can be a good way to get an insight about the perceptions of management in the region.

D. Fees/Timeframe

Once the management has been set up the next major decision will be how to come up with the funds to maintain the program. As seen in the current programs there is use of both taxes and fees, but the market might also benefit from making use of memberships or percentage fees.

1. Taxes

By taxing the region it encourages more participation in the market because people are already going to have to pay for the service. It also allows the amount paid by each person to decrease when compared to other methods because more people must pay. The last benefit of this approach is that the program will know exactly how much money they have for next year's budget, allowing the management to make better decisions about their resources. A drawback to using this approach is that people who do not wish to use the market will be forced to pay. In essence the tax unfairly targets the wrong people.

2. Application Fees

An abundance of programs have decided to use a flat rate application fee that varies from region to region. This method allows for only the people who use the market to pay for it. This can be effective in generating revenues for the program depending on what the fee is set at. The downside is that the program must hypothesize about the rate of the application fee and then hope that it set the price to maximize both demand and revenue. This can be a problem if the program expected to get more money than what they actually received during the year. To help avoid this the management should regularly check to make sure that inflow of revenue is consistent with their forecast for the year. This is not a fix for the problem but the program can change the flat rate price early to try to mitigate the losses for current year. Having a flat rate application fee also encourages larger transactions less frequently so participates avoid having to pay the fee more often than they have to. This can be both advantageous and disadvantageous for the program's success. It cuts down unnecessary transactions, which in turn, cuts down the length it takes to get a transaction processed. Its downside is that the program will have to deal with the effect of larger deliveries on the environment and might have to space them out over time or set a limit on the quantity of water that may be placed on the market.

3. Memberships

Creating a membership to join the market is a hybrid of the tax and flat rate fee systems. Memberships can encourage participation and avoid penalizing non-market users. The management will still run into the problem of having to forecast their revenues for the upcoming year and might get tied down with small or unnecessary transaction that can hurt the turnaround time for the approval process.

4. Percentages

Using a specified percentage to fund the market can be compared to how the tax system is operated in the United States. There can be a progressive, regressive, or flat rate percentage taken off of all trades. Regressive is often heavily disliked and will not be touched on in this paper. Progressive tax is to say that the higher the quantity traded the higher percentage the buyer and seller have to pay. Brackets should be set up as to what quantities of water yield what percentage of fees. This will cause less of an incentive for higher quantity transactions and more of an incentive for lower quantity transactions. A flat percentage fee on transactions might do the opposite. Since all transactions cost the same it provides an incentive for higher quantity transactions.

E. Enforcement

This is an area of concern for most of today's water markets. People are often able to bypass the fees and that may cause environmental degradation or the shutdown of the program. Programs should not provide the contact information for buyers or sellers. Doing this gives them a way to contact each other directly and negotiate. Enforcement depends on the type of program operating in the region. If it is a "wet" storage program then enforcement is often just checking the water levels and monitoring the delivery mechanism. A "dry" storage program will have to make use of random audits to ensure that everyone is complying. This would entail checking water levels on irrigation ditches leading to the participants land or making sure that all physical water rights are accounted for. The program needs to enact a form of accounting[14] for transactions kept on record. This will help the management know what trades they may or may not be able to make depending on environmental factors and total water quantity. A one-time fine is the best way to detour rule breaking. A fine administrated by the bank would also mean that time gets cut down in law suits for taking someone else's water and clears up court proceedings for the state.

F. Incentives

It is more feasible for the program to accomplish its goal if it provides incentives for participants to manage themselves. The best form of this is subsidies/credits for conservation or new technologies. This will encourage conservation in the marketplace. An environmental program should also have a buy back clause[15] to be used for mitigation purposes.

G. Insurance Program

There have been numerous occasions where we see a dry year and people get shorted the water they were expecting for that year. An insurance program should be considered for better stability in the market. The insurance would guarantee a specific quantity of water to the water user for an annual fee. The program should be wary of letting everyone have insurance though. This is because it is impossible to guarantee a quantity of water to users if there is not that specific amount of water for that year. For this reason the price should be set slightly higher than the market price would normally be. The program can also limit the insurance to certain water rights holders (senior or junior rights holders). This is a way to build trust within the market between participants and management as well as raise more funds for the program. The

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[14] Accounting: System used by the program to keep track of transactions

[15] Buy back clause: A legal agreement for the program to buy back water from participants for restoration purposes.

management should also have a form of protection. If there were a sudden decrease in flows then a buy back would be the managements insurance that the water is being used where it is demeaned beneficial. This should not be practiced on a regular basis or the program will lose trust with the participants. It should be avoided when possible and used when there are no other alternatives.

III. Current Programs, Reflections and Thoughts on a Real time Leasing Market

A. Current Programs

Many states have set up a form of water trading. These programs do not have unified characteristics, but rather their own way of making the program work. Looking at our definition of a water market, water markets are a mechanism for facilitating water transfers for a specific goal between willing buyers or sellers. Under this definition most qualify. However, the programs are not robust and are often missing key elements. We can break down the characteristics of the current water markets by looking at the following characteristics:

- Goal
- Geographic Area
- Environmental Impacts
- Funds
- Management
- Operational Policy and Market Creation:
- Timeframe for Trades

Looking at the operational program details in Addenda 1 we can observe some current programs in the west and how they function. Most programs are motivated by environmental issues and are run by public entities. Fees per transaction fund the bulk of the programs. Every time a transaction is made a specific type of fee is collected so the program can continue to run. Some programs must also charge a tax to help with costs. In some cases the tax is applied to everyone in the basin and in other cases the people in the specified region are the only ones being taxed.

We see the most diversity among the programs when we look at the operational policy and market structure. Most programs take advantage of the clearinghouse system as a means of the market mechanism for pricing. However there is also a significant number that use the auctioning, fixed, and contractual methods. There are programs that use a computer database listing the buyers and sellers that only the management is able to see. This means buyers and sellers are matched up by the management and are unable to see other seller's prices. Some programs use a web hosting service that participants can log into and search the listings. There are programs where the buyers and sellers contact each other directly to negotiate and there are programs where the participants may only buy and sell from the bank instead of private buyers and sellers.

One of the problematic factors in current programs is the timeframe of a transaction. How long does it take for the paperwork to go through after a buyer and seller decide they want to enter into an agreement? On average most transactions take 2-3 months (see Addenda 1). This is a major issue in designing a robust real time water leasing market.

Table 1 details nine of the larger leasing programs and compares the characteristics they have to that of what an ideal market would include. What we see is that the current markets have plenty of the attributes discussed above would entail but not a single program includes all considerations.

Table 1: Market Characteristics

	Clear Defined Goal	Type of Program	What's Traded	Water Storage	Market Players	Market Structure	Management	Fees/ Timeframe	Enforcement	Incentives	Insurance
Texas Water Bank		X	X	X		X	X				
Arizona Water Bank	X	X	X	X	X	X	X		X		
California's Drought Water Bank	X	X	X	X	X	X	X		X		
Salmon Creek Water Lease Bank	X	X	X	X	X	X	X			X	
Colorado's Arkansas River Basin Bank	X	X	X	X	X	X	X				
Pecos River Acquisition Program	X		X	X		X	X				
Idaho Rental Pools	X	X	X	X	X	X	X		X		
Klamath Basin Ridgeland Trust	X	X	X	X	X	X	X			X	
Truckee Meadows Ground water Bank	X	X	X	X	X	X	X			X	

H. Reflections

What is the prevalence of current markets? Are the current markets true robust markets as defined by the definition of a water market?

- While there appears to be many markets set up across the west, there are not any that appear to be a truly robust water market. The programs are meeting the needs of the participants at this time but the programs are not robust and leave out key considerations such as insurance, quick turnaround time, and enforcement.

What characteristics do current markets consist of?

- Current water markets are not uniform throughout. Some programs are clearly more robust than others. (Addenda 2). The programs take into account many characteristics of an ideal market but appear to leave out some considerations. Every program leaves out considerations but it is different in every case. This does tell us that programs are trying to customize themselves depending on the participants needs but there is a lack of communication between the participants and management. This leads to missed steps in setting up the market and often times not the best solution for the participants. There needs to be an outreach area of the program dedicated to communication with participants and giving them the information needed to make a well informed decision.

Is there any futures or ecosystem considerations involved in current markets?

- There does appear to be ecosystem considerations in a majority of the current programs. There are not any futures trading set up or in the works for any current programs. Ideally this is a missed opportunity to provide participants with another way to conserve and still gain profits. Each participant has different circumstances so a futures market will enable participants to make least cost decisions about what to do with their water. By setting this type of market up, there is an incentive provided for water to go to the most beneficial economical uses[16].

What should the ideal water market look like?

- We have discussed the key considerations that should be examined. It is not a one size fits all approach but rather individualized to the needs of the area. There are tradeoffs with each decision to be made. When setting up a market the following are the key considerations:
  - Goal
  - Water Storage
  - Market Players
  - Market Structure
  - Management
  - Fees/Timeframe
  - Enforcement
  - Incentives
  - Insurance program

Do current markets live up to what an ideal water market looks like?

- After looking at the current programs and comparing them to the structural market considerations, we find that there are not any programs that meet the criteria. Most programs do a good job of targeting a few considerations but there is not a single program that deals with all the considerations needed for an ideal water market.

How can current and future water markets be changed in order to act in accordance with water market ideas?

[16] Beneficial economical uses: Water shall go words the greatest potential for use depending on what is defined as beneficial by the program goals.

- Water markets need to be reevaluated and set up using a new system. A water market should start by surveying the participants to get an idea of their preferences. Questions on all key considerations should be asked and then tallied up to find the needs of the area. From there the rules and regulations can be built accordingly. There needs to be an outreach department within the program management to keep participants up to date on current information so the best decisions are made.

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III. Addenda 1: Operational Spreadsheet

The following is a spreadsheet of current water market programs in the west and the operational attributes that they are comprised of.

indicates an update to the Washington Report

State[i]	Primary Banks	Est.	Active	Activity	Bank Format	Market Structure	Pricing	Price Range ($/AF/Year)	Inter- or intra-district trading	Length of approval process or TC
Arizona[ii]	Colorado & Central Arizona Project	1996	1997	>10[iii]	Long-term underground storage[iv]	Non-market[v]	Fixed[vi]	$29-$67	Inter-state	1-3 months
California	California Drought Water Bank	1991	1991, 1992, 1994	>10	One-year surface leasing program	Clearinghouse – Pooling of supplies for transfer[vii]	Fixed	$74-$193[viii]	Intra[ix]	<month
California	California Dry Year Purchasing Program	2001	2001-2003	>10	One-year surface leasing program[x]	Clearinghouse – Pooling of supplies for transfer[xi]	Fixed but negotiable	$83-$123	Inter-state	2-3 months

California	Semitropic Ground water Banking Program	1991	1990?	10-May	Long-term ground water storage[xii]	Clearinghouse	Market based	Ranges based on annual water quantity	Inter-state	2-5 months
Colorado	Arkansas River Basin	2001	2003	0[xiv]	1-yr lease of stored water	Clearinghouse – bilateral trades	Market Based[xv]	$500-$1000[xvi]	Intra[xvii]	2-3months
Idaho	Boise River Rental Pool	1988[xxix]	1988	5-10[xxx]	Leasing of stored water	Clearinghouse – bilateral trades	Fixed but negotiable between buyer and seller	$6.50 w/i bs	Both	<month
Idaho	Lake Fork Creek Rental Pool	1999	1999	>10[i]	Leasing of stored water	Clearinghouse – bilateral trades	Fixed	$60	Inter-state	<month
Idaho	Shoshone-Bannock Tribal Water Bank	1994[vi]	1994	<5[vii]	Contractual	Clearinghouse – bilateral trades	Fixed	$14	Inter-state	<month
Idaho	Lemhi River Rental Pool	2001[ii]	2001	<5	Institn. (leasing to USBR for min flow)	Clearinghouse – bilateral trades[iii]	Fixed[iv]	$146[v]	Inter-state	

Idaho	Snake River Rental Pool[xxiv]	1979[xxv]	1979	>10	Leasing of stored water	Clearinghouse – bilateral trades	Fixed[xxvi]	$3.00 w/i bs	Both[xxviii]	<month
Idaho	Payette River Rental Pool	1990	1990	>10[xxxi]	Leasing of stored water	Clearinghouse – bilateral trades	Fixed[xxxii]	$4.20 w/i bs	Both	<month
Idaho	Idaho State Water Supply Bank	1979[xix]	1995[xx]	10-May	Leasing of stored water	Clearinghouse – bilateral trades	Market Based[xxi]	$24	Statewide program[xxii]	Trades must be pre-reviewed by state.[xxiii]
Nevada	Interstate Water Bank	2002	2002	<5[viii]	Storage[ix]	Non-market[x]	Fixed	$87	Intra-	
Nevada	Truckee Meadows Ground water Bank	2000	2000	<5	Long-term ground water storage	Non-market accounting system[xi]	Fixed	$65	Inter-state	1-2 months
New Mexico	Middle Rio Grande Water Bank	2006	2008	>10[i]	Annual Lease Bank	Non-market accounting system[xi]	Admin			2-5 months
New Mexico	Acequias Water Banks	2003	2004	<10	Institutional	Clearinghouse – bilateral trades	Fixed		Inter-state	2-3 months
New Mexico	Santa Fe Water Bank	2004	2006	<5[vii]	Institutional	Clearinghouse – bilateral trades	Fixed[iv]		Inter-state	1-3 months

New Mexico	Pecos River Basin Water Bank	2002	Not to date	0	Institutional[xii]	Clearinghouse – bilateral trades	Market Based		Intra-	2-3 months
New Mexico	Pecos River Acquisition Program	1991	1992	10-May	Institutional	Clearinghouse – bilateral trades	Market Based	$55-$120[xiii]		2-3 months
New Mexico	ESA Mitigation on Pecos River	Proposed	2003	<5[xiv]	Institutional	Clearinghouse – bilateral trades	Market Based	Water exchange		1-3 months
Oregon	Deschutes water Exchange – Annual Leasing Program[xviii]	2001	2001	>10[xix]	Annual Lease Bank	Bilateral Trades, Reverse Auction, Standing Price	Admin	$3.91 - $19.57	Inter-state	1-2 months
Oregon	Deschutes Water Exchange Ground water Mitigation Bank[xv]	2003	2003	<5[xvi]	Ground water mitigation/institutional[xvii]	Standing price Auction	Fixed Price	$80/af of consumptive use	Inter-state	Initial account set-up fee of $250 (p 100)

Oregon	Walla Walla Lease Bank	2001	2001	<5[xx]	Annual Lease Bank[xxi]	Bilateral Trades	Fixed Standing Price	$15 to $18.52	Inter-state	1-3 months
Oregon	USBR Klamath Basin Leasing Program[i]	2001	2001	>10[ii]	Annual Lease Bank	Reverse Auction and Bilateral Trades	2001 – Market Based	$35 - $95	Inter-state	1-3 months
Oregon	Klamath Basin Rangeland Trust	2002	2002	<5	Annual Lease Bank[iii]	Bilateral Trades	Market based, negotiable with individual landowners	$87.16	Inter-state	1-3 months
Washington	Yakima Basin Pilot Water Bank[iv]	2001	2001	5-10[v]	Institutional	Clearinghouse – bilateral trades	Market Based	$0 - $768	Inter-state	15-30 days
Washington	Salmon Creek Water Lease Bank	2000	2000-2002	5-10[vi]	Annual Lease Bank	Clearinghouse – bilateral trades	Fixed Price	535 - $72	Inter-state	<30 days
North Dakota	North Dakota State Waterbank Program	2006	2007	5-10[v]	Annual Lease Bank	Clearinghouse – bilateral trades	Market based		Inter-state	2-4 months

South Dakota	South Dakota Water Bank Program	2007	2008	5-10[v]	Annual Lease Bank	Clearinghouse – bilateral trades	Fixed		Inter-state	1-4 months
CO, ID, MT, UT, WA, WY	TU western water project	2011	2012	<5	Non-market	Non-market	Non-market		Inter-state	1-3 months

indicates an update to the Washington Report

IV. Addenda 2: Legal Program Spreadsheet

The following is a list of the current water markets and the legal attributes they are comprised of.

indicates an update to the Washington Report

State	Primary Banks	Contacts/info/Administrators	Enabling Legislation/Agreements
Arizona	Colorado & Central Arizona Project	Arizona Water Banking Authority (AWBA)	Created in 1996 by House Bill 2494 (42nd Legislature and codified as ARS, §45-2401 through§45-2472) and amended in 1999 by House Bill 2463 (44th Legislature).
			In 1999, federal regulation (Department of the Interior, Bureau of Reclamation. 43 CFR Part 414: Offstream Storage of Colorado River Water; and Development and Release of Intentionally Created Unused Apportionment in the Lower Division States. November 1, 1999) allowed the banking to be an interstate bank between AZ, NV & CA.
			In 2002, agreements signed to authorize an interstate banking program between NV and AZ (No formal agreements yet in place between AZ & CA). Agreements include:
			-Agreement for Interstate Water Banking between AWBA, Southern Nevada Water Authority (SNWA), and Colorado River Commission of Nevada (CRCN).
			-Agreement for the Development of Intentionally Created Unused Apportionment. AWBA and Central Arizona Water Conservation District (CAWCD).

			-Storage and Interstate Release Agreement. USBR, AWBA, SNWA, AND CRCN. December 18, 2002
			(p 31-32)
California	California Drought Water Bank	Department of Water Resources (DWR) (mainly because it oversaw the State Water Project (SWP)) (p 41)	No legislation specifically enabling or authorizing water banks, but several statutes and initiatives:
			-Executive Order No. W-3-91 relating to five-year drought.
			-Assembly Bill 9X in 1991 allowed water right transfers outside supplier's service area and Assembly Bill 10X protected supplier's right during drought
	California Dry Year Purchasing Program	Department of Water Resources (DWR)	-Assembly Bill 1584 and chapter 725 declared that conjunctive use (temporary storage of water in a ground water aquifer for extraction later) is an effective management tool.
	Semitropic Ground water Banking Program	Semitropic Improvement District	(p 38)
Colorado	Arkansas River Basin	www.coloradowaterbank.org	House Bill 1354 in 2001.
		Southeastern Colorado Water Conservation District with regulatory oversight by State Division Engineer's Office.	Colorado Revised Statute 37-80.5-104.5
			See Arkansas River Basin Water Bank Rules
Idaho	Idaho State Water Supply Bank	http://www.idwr.idaho.gov/waterboard/water%20bank/waterbank.htm	Idaho Code 42 – 1761 through 1766
	Snake River Rental Pool	See state link	IDAPA 37: DEPARTMENT OF WATER RESOURCES TITLE 02 CHAPTERs 3 and 4 Idaho Code 42 – 1761 through 1766
		http://www.idwr.idaho.gov/waterboard/water%20bank/05_WD01_procedures05.pdf	
		Administered by Water District #1	

	Boise River Rental Pool	http://www.idwr.idaho.gov/waterboard/water%20bank/WD%2063-amended%202005.pdf Administered by Water District #63	IDAPA 37: DEPARTMENT OF WATER RESOURCES TITLE 02 CHAPTERs 3 and 4 Idaho Code 42 – 1761 through 1766
	Payette River Rental Pool	http://www.idwr.idaho.gov/waterboard/water%20bank/WD%2065%20amended%202005.pdf Administered by Water District #65	IDAPA 37: DEPARTMENT OF WATER RESOURCES TITLE 02 CHAPTERs 3 and 4 Idaho Code 42 – 1761 through 1766
	Lake Fork Creek Rental Pool	http://www.idwr.idaho.gov/waterboard/water%20bank/waterbank.htm Administered by Water District #65-k	IDAPA 37: DEPARTMENT OF WATER RESOURCES TITLE 02 CHAPTERs 3 and 4Idaho Code 42 – 1761 through 1766
	Lemhi River Rental Pool	http://www.idwr.idaho.gov/waterboard/water%20bank/Lemhi%20River%20Basin%20WSB%20Procedures.pdf Administered by Water District #74	IDAPA 37: DEPARTMENT OF WATER RESOURCES TITLE 02 CHAPTERs 3 and 4 Idaho Code 42 – 1761 through 1766
	Shoshone-Bannock Tribal Water Bank	Administered by Shosone-Bannock Tribe and reviewed by state	IDAPA 37, Title 02, Chpt 04 Shoshone-Bannock Water Supply Bank Rules 1990 Fort Hall Water Rights Settlement Agreement
Nevada	Interstate Water Bank	http://www.snwa.com/html/wr_index.html Southern Nevada Water Authority	Senate Bill 489 Section 27 was codified as Nevada Revised Statutes Title 48 § 540A.240
		Colorado River Water Users Assoc http://www.crwua.org/news/news.html	Decree entered by US Supreme Court in Arizona v. California, 376 US 340 (1964), as supplemented or amended
		See Southern Nevada Water Bank http://www.snwa.com/html/wr_colrvr_snbank.html	

	Truckee Meadows Ground water Bank	Truckie Meadows Water Authority	http://tmwa.com/customer_services/waterrules/
New Mexico	Pecos River Basin Water Bank	Interstate Stream Commission (ISC)	House Bill 421 (2002) – approved development of water banks within the Lower Pecos River Basin (between Fort Sumner Dam and TX state-line). All transfers must be –temporary replacement water" and stay in the basin (p 90). NMSA § 72-1-2.2
	Pecos River Acquisition Program	ISC	House Bill 417 (2002) – approved a long-range plan to buy farmland and associated water rights, pump ground water into river to supplement its flow, and increase water saving in Southeastern NM. Functions like a water bank by transferring irrigation rights to instream flow rights?? (p 91).
	Santa Fe Water Bank	Santa Fe Water Authority	Ordinance - 2009-038
	Acequias Water Banks	Acequias Water Authority	HB 243 Section 7-2-55.1 NMSA 1978 http://www.abqlaana.org/Acequia/AcequiaBylaws.pdf
	Middle Rio Grande Water Bank	Middle Rio Grande Conservancy District	http://www.mrgcd.com/uploads/files/Water%20Distribution%20Policy%20Final%2006-25-12.pdf
	ESA Mitigation on Pecos River	US Bureau of Reclamation	State Engineer approved an Emergency Authorization to temporarily change place and purpose of use of ground water to offset depletions to Carlsbad Project Water resulting from modified reservoir operation at Sumner Reservoir (p 91).
Oregon	Deschutes Water Exchange Ground water Mitigation Bank	Administered by Deschutes Water Exchange – Deschutes Resources Conservancy with regulatory oversight by Oregon Water Resource Department (OWRD) (p 98).	Deschutes Basin Ground water Mitigation Rules (formed in response to a study by USGS and OWRD) includes rules allowing for creation of a water bank where mitigation credits can be bought and sold (p 97).
	Deschutes water Exchange – Annual Leasing Program	Administered by Deschutes Water Exchange – Deschutes Resources Conservancy with regulatory oversight by Oregon Water Resource Department (OWRD) (p 100).	OAR Chapter 690, Division 505 Senate Bill 1033 HB 2184

	Walla Walla Lease Bank	Administered by Oregon Water Trust with regulatory oversight by Oregon Water Resource Department (OWRD) (p 102).	The Second Substitute House Bill (2SHB) 1580
	USBR Klamath Basin Leasing Program	Administered by US Bureau of Reclamation with regulatory oversight by Oregon Water Resource Department (OWRD) (p 103).	
	Klamath Basin Rangeland Trust	Administered by Klamath Basin Rangeland Trust with regulatory oversight by Oregon Water Resource Department (OWRD) (p 108).	
Washington	Yakima Basin Pilot Water Bank	http://www.roundtableassociates.com/ywe/ Administered by Yakima River Basin Water Enhancement Project – Water Transfer Working Group with regulatory oversight by Washington Department of Ecology and USBR (p 126)	RCW 90.14.140
	Salmon Creek Water Lease Bank	http://www.roundtableassociates.com/ywe/Bank%20Documents/Salmon%20Creek%20Summary.htm Administered Washington Water Trust, Colville Nation, and the Okanogan Irrigation District with regulatory oversight by Washington Department of Ecology (p 131)	RCW 90.14.140
North Dakota	North Dakota State Waterbank Program	ND Department of Agriculture http://www.nd.gov/ndda/program/waterbank-program	NDCC 61-31 Waterbank Program - Title 7-Article-08
South Dakota	South Dakota Water Bank Program	NRCS http://www.sd.nrcs.usda.gov/programs/2012_WaterBankProgram.html	

indicates an update to the Washington Report

V. Addenda 3: Terms Defined

[1] This table is an adaptation from *Analysis of Water Banking In the Western States*. Washington State Department of Ecology. West Water Research. July 2004. Publication No. 04-11-011.

Arizona

[1] In Arizona, surface water is considered public property and the right to use is based on prior appropriation doctrine, beneficial use and historic use. Ground water is not included in the state‘s definition of public water. Ground water basins are delineated and limitations are placed on withdrawal rates, use and storage in specified areas (p 29).

[1] Currently, AWBA is accruing water storage credits, has provided storage for NV, but has not engaged in any water banking service agreements with other AZ entities (p 34).

[1] Storage system includes eight underground storage facilities and fourteen ground water savings facilities. Underground storage facilities provide direct recharge of surface water via spreading basins. The ground water savings programs create storage credits through the use of surface water in lieu of pumping ground water (p 33).

[1] AWBA purchases excess CAP water or effluent. AWBA has three primary sources of funding: 1) allocation from state general fund (last used in 2001), 2) ground water withdrawal fees collected within Phoenix, Pinal and Tucson Active Management Areas, 3) $0.04 ad valorem property tax charged by CAWCD in three counties of service. Purchased water is delivered by CAP. An accounting system records long-term storage credits earned. These credits equal the purchased quantity minus the delivery conveyance losses and the statuary five percent contribution to the aquifer for maintaining long-term health of the ground water system (p 33).

[1] Price is set annually by CAP (p 33).

California

[1] The goal was to create ―new" surface water through 1) fallowing agriculture land (this option was not used in 1992), 2) ground water contracts for selling surface water and using ground water, and 3) stored water contract for releasing water from reservoirs. The DWR negotiated 351 contracts and 820,000 af of water. All contracts were pooled as one supply unit in 1991 (p 41). The DWR sold 396,000 af to 12 purchasers. The remaining 264,000 af was sold to the state at $45 million to increase carryover storage which was delivered to SWP contractors in 1992 (p 42). In 1992, DWR could purchase water only after a contract was signed with a potential buyer. Additionally, the single-pool was changed to six separate pools which could each have different pricing mechanisms (p 42).

[1] The base sell price was $125 in 1991. A price escalation clause limited price uncertainty for the seller. If new contracts were negotiated with similar sellers for more than 10%, the initial sellers would receive the higher price (p 41). In 1992, the six separate pools opted for the same pricing structure. Water was bought at $50/af and sold at $72 (p 42). A precautionary bank in 1995 switched to options contracts with a $3.50/af option to buy which could be exercised at between $36.50 and $41.50/af. However significant precipitation that year rendered the bank non-operational (p 42).

[1] Most sellers were located in Northern CA and recipients were south of the Delta. The concentrations of transfers lead to arguments that the third party impacts were disproportionate in a few areas (p 42).

[1] The Dry Year Purchase Program is similar to the drought banks, but may be operational in years that are dry, but not officially declared a drought. This was initiated as a program to purchase water from willing sellers (p 44).

[1] Buyer must submit an option request to DWR by Nov 30th of previous year specifying the quantity, maximum price and delivery terms. The decision to exercise or forfeit option must be made by Mar 31st. Direct purchases could be made. Requests were submitted by Mar 31st and required a $25/af purchase deposit, of which $5 was kept by DWR for administrative costs (p 45).

[1] This functions as a ―savings bank." Banking partners deliver a portion of their SWP water to Semitropic when water is available (put). Semitropic uses this water in lieu of ground water pumping. In dry years, Semitropic delivers water either through pumping stored water from ground water basin or by providing them with an equivalent portion of their SWP entitlement. Only stored water can be returned. Each partner is entitled to draw a consistent amount of water each year, regardless of hydrologic conditions (p 51). Capacity?

[1] Fees assume partners have a water source, in the future, new partners may be contracted that do not have a water source and they would also be charged for raw water source (p 53).

[1] In 2003, 4 individuals deposited water, all but one were withdrawn due to lack of interest by bidders (p 58). In their effort to provide transparency to the market, the bank may be limiting its own success. It is easy for buyers or sellers to directly contact trading partners without going through bank since names and addresses of depositors and bidders are provided on website (p 60).

Colorado

[1] Offers are posted on the website (p 58).

[1] This price appears to be above the market rate, since no transactions have occurred. Others contend that a longer-time frame for the leases would be necessary to attract municipal entities (p 56).

[1] Originally, out of basin was allowed. However this was the most controversial aspect of the pilot program. In 2003, the program was changed with restrictions placed on out of basin transfers (p 56).

[1] Water owners gather information, fill out application and submit to Southeastern Water Activity Enterprise with application fee of $15. Application reviewed by Division 2 Engineer's office. Staff posts offering on water bank website. Bidders may post bids. On 11th business day after posting the offer, staff will review the in-basin bids. Highest bids meeting the minimum posted by lessor will be submitted to lessor for acceptance. Lessor may then accept any out-of-basin bid as posted. If accepted, lease is posted for a 30-day public review. After review, Division Engineer has 5 days to consider comments and provide terms and conditions for transaction. Then, agreement is signed and transaction fee is paid to the bank. The bank will notify the Division Engineer's office, reservoir operator and those on notification list. (p 57)

Idaho

[1] Operated informally since 1932. In 1932, 14,700 af rented for $0.17/af. In 1934, 40,000 af rented for $0.25/af. In 1937, the Upper Valley Storage Pool was established through the first formal rules for water banking. In 1979, the creation of a water supply bank for the purpose of acquiring water rights from willing sellers for reallocation to new or existing uses. Legislation also allows local rental pools to coexist with the state bank. (p 62)

[1] Activity has varied until recently, (when?) the state bank dealt exclusively with natural flow water and the water pools dealt with the exchange of stored water (p 63).

[1] Pricing is negotiated by buyer and seller and participation is open for both buyers and sellers.

[1] There is 1979 legislation that prohibits leases of water that result in an out-of-state transfer of water. Idaho Dept. of Water Resources determined that leases for maintaining instream flows were in violation of this legislation. In 1992, legislation was passed to provide temporary authority for the USBR to lease water for salmon recovery efforts. This has been extended three times and was set to expire in 1/1/05. (p 62)

[1] Administered by Idaho Dept. of Water Resources.

[1] The Rental Pools have rules that give preference to irrigators within the local area. Most pools have a ―last-to-fill rule" which states that space of storage water which is rented to users outside the hydrologic basin shall be the last space to fill during the following year. This has become an issue with environmental leases, especially as higher volumes of water are being leased to meet flow targets for endangered species needs. (p 62)

[1] This is the oldest and largest rental pool. It has 4.1 million af of storage capacity in eight reservoirs. Historically, this pool represented approximately 90% of the trades through the Idaho rental pools. (p 65)

[1] The price is administratively set by Water District #1 and is based on the cost of delivery and is not reflective of market prices. (p 65) There is current debate regarding the change to market based pricing. (p 66)

[1] Differential pricing for water used below Milner Dam was begun in 1993. (p 66)

[1] Since 1995, 90% of the water traded through the bank was released below Milner Dam. USBR is the largest market participant. (p 66)

[1] Includes three reservoirs.

[1] Recent trading volumes from 38,000 to 44,000 af with a drop since the drought in 2001 (p 69)

[1] The pool has a reputation for consistent volumes and has historically provided approximately 56% of USBR total annual leasing requirement. The trading volumes have been 101,382 to 166,176 af with a drop since the drought in 2000. Trading increased again in 2002. (p 70)

[1] Pricing set by Idaho Water Resource Board, prices are reviewed by the Advisory Board on an as-requested basis. The next price review is scheduled for 2006, the last was done in 2001. (p 70)

[1] USBR is the largest participant in the market.

[1] This pool was created expressly for maintaining minimum flows for Salmon. The authorizing legislation was passed in response to litigation by Western Watersheds Project against Lemhi irrigators. (p 63) It is the only pool that leases natural flow and doesn‘t trade storage entitlements. (p 72) The Lemhi River has minimum flow requirements of 35 cfs placed by Idaho Water Resource Board to protect fish migration. The regulation is subordinate to senior rights. (p 72)

[1] This functions more as a leasing program than as a bank. (p 73)

[1] Lemhi Rental Pool is the only basin in the state that allows transfer of natural flow rights to Lemhi River Rental Pool. Doing this created a more market-based approach to policies toward instream flows. (p 72)

[1] Pricing is set based on an acre-basis rather than on af. The price is $220 per acre which equals roughly $146 per acre foot. The price was arbitrarily set at a level ―to get landowner‘s attention." (p 73)

[1] The 1990 Fort Hall Water Rights Settlement Agreement authorized creation of a bank. The settlement confirmed tribal water rights in the Upper Snake River and allowed for marketing opportunities. (p 74)

[1] Actually only one transaction has occurred. This was a 5-year lease for 39,000 af at $9/af/yr. Still, the tribal bank could be important for USBR in dry years. (p 75)

Nevada

[1] Originally, the impetus between the agreement between AZ and NV was AZ‘s lack of general funds in 2001, so AZ offered unfunded storage capacity to NV. In 2002, storage of 40,000 af was offered to NV and actual storage was 66,595. 50,000 af of long-term storage credits were transferred to NV from CAWCD for total deposits of 116,595 af. (p 83) Agreement is limited in years when AZ has sufficient funding. In 2003, no storage was offered to NV.

[1] See agreement information between Arizona and Nevada under Arizona. Specific terms of AZ/NV 2001 agreement include: NV can divert some or entire share of the Colorado River water to AZ or purchase some AZ entitlements to Colorado River; Unused Colorado River water will be injected into ground for long-term storage credits in AZ facilities; AWBA will store water for SNWA only after meeting the needs of AZ and only up to 1.2 million af.; AWBA creates annual plan identifying storage available and SNWA will request storage; SNWA is limited to recovering 100,000 af/year; and SNWA is responsible for all associated costs (p 82).

[1] Banks were intended to primarily operate as storage programs and were not intended to specifically encourage market exchanges. (p 79)

[1] Bank is primarily an accounting system of water withdrawal and recharge for water rights held by Sierra Pacific Energy Company (a single entity as the only ―buyer" and ―seller"). (p 79) The total long-term average that can be withdrawn is 15,950 af/year. Excess or lower withdrawals are counted as credits or debits in the bank to be made up in following years. (p 85)

New Mexico

[1] Institutional in function, providing a temporary source of water through accrual, pooling, exchange, assignment or lease of water rights (p 90).

[1] ISC maintained an annual lease with Carlsbad Irrigation District (CID) since 1990s with lease payments at $50/af. Drought in 2001 pushed price to $100/af were they have continued to hold (p 93).

[1] In initial stages and trading is limited. USBR transferred 500 af from irrigation to stored water for flow mitigation. To offset this change, USBR fallowed 178.8 acres of land and transfer 375 af of ground water to Brantley Reservoir (conveyance loss between Sumner and Brantley Reservoirs is 25%) (p 95).

Oregon

[1] Ground water permit applicants are required to fulfill mitigation obligations prior to receiving permit They can either purchase mitigation credits of implement a mitigation project (p 99).

[1] In 2003, the bank registered 574 af of credits, 169 were purchased by a single buyer. Early results from 2004 included 18 customers acquiring 602 credits.

[1] Deschtues Ground water Mitigation Bank operates as a water bank in conjunction with the DWE leasing program. The leasing program provides the leases to back the mitigation credits and the Bank serves as the funding vehicle. Temporary credits require a reserve so two af must be leased for each 1 af of credit provided to market (p 99).

[1] Supplies Ground water mitigation Bank with temporary mitigation credits, but the majority is for stream flow restoration (p 100).

[1] In 2002, DWE leased 7500 af and in 2003 number rose to 15,715 af. In 2004, over 24,000 af was leased (p 101).

[1] In 2001, 6 landowners participated and enrolled 58.37 acres totaling 0.73 cfs of water. In 2002 this increased to 11 landowners with 91.61 acres for 1.145 cfs of water (p 103).

[1] Participants limited to Walla Walla Irrigation District members and non-district landowners (p 103).

[1] In 2001, the Irrigation Demand Reduction Program was initiated to reduce demand from surface water in the Upper Klamath River Basin as part of the Klamath Basin Leasing Program?? The average af cost of this program was $74/af. This program consisted of USBR leasing water through willing users. The predominant crop types were pasture, grass hay and alfalfa (p 105).

[1] In 2001, there were 64,846 af contracted (p 104).

[1] Provides a mechanism for bundling multiple lease agreements. Under the agreement, landowners reduced livestock numbers by 80% and enrolled 3,161 acres in the program. The estimated water provided through the leases was 12,800 af. Several aspects of this program were controversial (p 108).

Washington

[1] Not initially designed as a water bank, but provided a mechanism to facilitate transfers between buyers and sellers (p 127).

[1] During 2001 drought, nearly 61,000 af were transferred between May and October. Some lands were fallowed, but the transfers allowed the high valued permanent crops such as orchards and vineyards to remain in irrigation (p 128).

[1] In 2001- 42 irrigators enrolled 322 acres. In 2002- 60 irrigators enrolled 624 acres. This left approximately 1,900 feet of water for use as instream flows. In 2003 the OID elected not to participate in program (p 132)

Citation:

Clifford, Peggy, Clay Landry, and Andrea Larsen-Hayden. "Analysis of Water Banks In the Western States." West Water Research and Washington Department of Ecology. (2004): n. pag. Print.

VI. Addenda 4: Program Details

The following is a list of water markets in the west compared to that of the attributes that an ideal market is comprised of as identified by this report.

Arizona Water Bank

Goal:
Long term underground storage

Geographic Area:
Penal, Tucson, Phoenix areas

Environmental impacts:
None

Funds:
Able to purchase water through state funds, transaction fees, and tax for people in that region
2.50 per acre foot

Management:
Private – Nonprofit Organization

Operational Policy and Market Creation:
Non-Market, but provides storage credits for CAP, fixed price $25-58 per acre foot per year
As part of the water banking agreement, Arizona stores available Colorado River water in an underground aquifer. Nevada receives "credits" for the water stored in this ground water "bank."
When Nevada needs to recover some of this banked water, it uses its storage credits and withdraws a portion of Arizona's Colorado River water directly from Lake Mead. Arizona then withdraws the same amount of water from its ground water aquifer.
The AWBA cannot own, develop, operate or construct storage facilities but can buy permits for water rights.
The CAWCD determines the quantity of credits it needs on an annual basis.
in process of determining how many credits go to CAWCD
CAWCD prioritizes who get water by Indians, agriculture, and then there is no set order.
Maximum recovery rate of 40,000 acre-feet per year until the bank reserves have been fully exhausted
Withdrawals will be taken from Lake Mead, Nevada also will receives return flow credits for the portion of water used indoors

Timeframe for Trade:
1-3 months

Citations:
Virginia O'Connell: Manager of the Arizona Water Banking Authority

"Welcome." *AWBA*. Arizona Water Banking Authority, n.d. Web. 24 July 2012. <http://www.azwaterbank.gov/>.

California’s Drought Water Bank

Goal:
One-year surface leasing program

Geographic Area:
In basin only

Environmental impacts:
Low flow through the delta region

Funds:
$15 per application

Management:
California Department of Water Resources

Operational Policy and Market Creation:
Fixed pricing $72-$182, clearinghouse
The DWR was charged with negotiating purchase contracts, monitoring compliance, securing SWCRB permits, and organizing deliveries.
Through optimization of the operations of the SWP, the DWR could facilitate transfers between willing buyers and sellers, optimize storage facilities, and provide the physical area for water transport
Buyers are required to quantify their ―critical needs”

Timeframe for Trade:
Less than a month

Citations:
"Department of the Interior Memorandum." *Water.ca.gov*. Department of Water Resources, California, n.d. Web. <http://www.water.ca.gov/swp/operationscontrol/calfed/ops/2006/2005_b2_banking.pdf>.

California’s Dry-Year Purchasing Program

Goal:
One-year surface leasing program

Geographic Area:
Statewide, Primarily SWP and CVP service areas

Environmental impacts:
Protect stream flow for indigenous fish and wetlands

Funds:
Transaction fee of 25 dollars per application

Management:
California Department of Water Resources

Operational Policy and Market Creation:
Fixed price $68-$175 per acre foot per year
Supply – Northern California users;
Demand – SWP and CVP contractors south of Delta
Can buy and sell water
Must submit application stating the need for the water during the dry year
Takes 1-3 months for approval
Water then gets sent down from physical storage location

The water right owner may then take the water out at the time frame deemed appropriate by the DWR

Timeframe for Trade:
1-2 months

Citations:
Don Strickland, DWR Information Officer for Dry Year Program

ESA Mitigation on Pecos River

Goal:
Increase in stream flows in the Pecos river basin

Geographic Area:
Upper and lower Pecos river basin

Environmental impacts:
Augment flows to protect the habitat of a federally protected species, bluntnose shiner
Most environmental efforts are in the lower basin

Funds:
Taxes

Management and Operation:
US bureau of reclamation

Operational Policy and Market Creation:
Clearinghouse of bilateral trades
Seller submits application for water transfer
US bureau of Reclamation classifies the request as beneficial or not to the environment then finds a buyer in the upper basin for purchase
Though the clearinghouse a price is negotiated per Acre foot
Contract is signed and a date is set for the right to be transferred for use

Timeframe for Trade:
1-3 months

Citations:
Greg Lewis: Pecos River Basin Manager

Texas Water Bank

Goal:
Annual purchasing program

Geographic Area:
Transfers are allowed outside of the state by law but no transfers have happened outside of the state yet

Environmental impacts:
Protect ground water resources

Funds:
A fee system is used to operate the bank but is also subsidized by state taxes
The deposit fee is 1 percent of the asking price of the water right, with maximum fee of $50 per right.
a transfer fee is also levied upon the sale or lease of the right. The transfer fee is 9/10 of 1 percent of the sale on lease value.

Management and Operation:
Texas Water Development Board

Operational Policy and Market Creation:
Clearinghouse negotiated between buyer and seller
The Bank may participate in the market by purchasing and transferring water rights in its own name
A water right holder submits an Application for Deposit form, this tells the TWDB the quantity of water asked for to be bought or leased.
The application process takes approximately t 2-3 months to complete
A water right deposited in the bank is protected from cancellation by the TCEQ for an initial term up to ten years.
In administering the bank, the TWDB may act to
- Serve as a negotiator;
- Provide a free registry and serve as an information resource
- Promote conservation through deposits of conserved water
- Purchase, sell, hold, and/or transfer water and water rights
- Establish regional water banks;
- Prepare and publish a manual on structuring water transactions;
- Accept and hold donations of water rights in trust for environmental purposes;
- Enter into contracts to pay for feasibility studies or the preparation of plans and specifications relating to water conservation efforts or to estimate the amount of water to be saved through conservation efforts; and
- Otherwise facilitate water transactions.

Timeframe for Trade:
2-3 months

Citations:
"Texas Water Bank and Water Trust." *Water Bank Index*. Texas Water Bank, n.d. Web. 17 July 2012. <http://www.twdb.texas.gov/assistance/waterbank/waterbankmain.asp>.

Salmon Creek Water Lease Bank

Goal:
Annual Lease Bank

Geographic Area:
Stretches across 14 miles of the upper basin

Environmental impacts:
Flows in Salmon Creek for summer steelhead and spring Chinook
Conserve water for in stream flow
Increase stream bank stability
Restore riparian habitat

Funds:
Application fee of $20

Management and Operation:
Private non-profit: Washington Water Trust, CCT, OID, and Bonneville Power Administration
National Fish and Wildlife Foundation

Operational Policy and Market Creation:
This project will provide up to 25 cfs and 700 acre-feet of yearly in stream flow to Salmon Creek for increase in Salmon populations in the basin
Sellers will contact the Washington Water Trust
Program will raise funds to buy water rights
Water rights can be sold annually or permanently

Contract is constructed and signed by both parties for transfer

Reporting/accounting:
322 acres at $135 per acre totaling 900 acre-ft. of water was leased
The leasing program costs about $128,000 every year

Timeframe for Trade:
15 days-5 years depending on if the transfer is short term or permanent
Also depends on how fast the program can raise money to buy the water rights

Citations:
Greg McLaughlin: Bank Facilitator for Washington Water trust

Colorado's Arkansas River Basin Bank

Goal:
1-yr lease of stored water

Geographic Area:
Lower basin

Environmental impacts:
Increase in stream flows

Funds:
Application fee of $15.00
When the application is submitted the potential buyer must submit the agreement preparation payment and a purchase deposit of $25 per acre-foot requested. This fee consisted of a $5 administrative fee retained by the DWR and a $20 fee applied to the purchase component.

Management and Operation:
Southeastern Water Activity Enterprise office

Operational Policy and Market Creation:
Clearinghouse, market based
The prices set were based upon market-based negotiations between buyer and seller. A buyer submitted a purchase water request specifying the quantity, maximum price and delivery terms.
The bank functioned primarily through the online registry and webpage.
The deposit information lists the name of the depositor, the quantity of water approved by the Division Engineer, the minimum asking price, the source of the water, as well as other location information.
The website also provides a listing of individuals seeking water, including contact name, requested quantity, and phone number.

The Arkansas River Bank lists the steps required to consummate a transaction (Arkansas Basin River Bank):
Water owners wishing to temporarily lease their water shall fill out an application, gather all pertinent information and submit the documents to the Southeastern Water Activity Enterprise office along with an application fee of $15.00.
The completed application will be reviewed by the Division 2 Engineer's office to assure that the water is available to be leased.
The staff will then post the offering on the water bank website.
Qualified bidders may then post their bids on the water.
Bids are a binding offer to pay such amount.
On the 11th business day after posting the offering, staff will review the in-basin bids. The highest bid(s) meeting the minimum acceptable bid required by the lessor will then be submitted to the lessor for acceptance.
The lessor may then accept any out-of-basin bid as they are posted. Upon acceptance, a lease is prepared and posted as under contract for the thirty-day public review. The proposed lease will also be mailed to those on the

notification list. After the thirty-day review, the Division Engineer has 5 days to consider comments and will provide the terms and conditions for the transaction.
Quantification of the available water is based on historical consumptive use.
Once all parties involved in the transaction accept the Terms & Conditions, then an agreement is signed and a transaction fee is paid to the bank.
The water bank will notify the Division Engineer's office, the reservoir operator where the water is stored, and those on the notification list.
The lessee must notify the Division Engineer 24 hours in advance of when they need the water released.

Timeframe for Trade:
2-3 months

Reporting/accounting:
1.3 million acre-feet of Colorado river Basin
1 million are from senior water rights holders
490,000 acre-feet or 98 percent come from junior water rights

Citations:
Water Banks: A Tool for Enhancing Water Supply Reliability, Michael O'Donnell, Research Assistant, and Dr. Bonnie Colby, 2009

Pecos River Acquisition Program

Goal:
Annual purchasing program

Geographic Area:
Upper basin of Colorado river

Environmental impacts:
Yes: secondary objective to meeting flow compact with Texas

Funds:
State taxes and fundraising raise money for purchase of water rights

Management and Operation:
Interstate stream commission

Operational Policy and Market Creation:
Clearinghouse, Market-based through negotiations between ISC and the Carlsbad Irrigation District
Program is only allowed to buy water rights for purpose of helping to meet or prepare for future water deliveries to Texas.
Sellers contact the office and a price is negotiated between the sellers, ISC and the Carlsbad Irrigation District
Contract is drawn up and length of lease is decided

Reporting/accounting:
$20.5 million was spent on the Pecos River water rights acquisition program between 1991 and 1997,
$10 million on the purchase and retirement of 16,600 acre feet of water rights, $10 million on leases of water to meet short-term delivery needs,
$500,000 on administrative, professional and appraisal fees. (http://www.ose.state.nm.us/publications/97-98-annual-report/pecos.htm)

Timeframe for Trade:
Less than a month

Citations:
Greg Lewis: Pecos River Basin Manager

Interstate Water Bank

Goal:
Annual purchasing program

Geographic Area:
Lower basin of Colorado river

Environmental impacts:
None

Funds:
State taxes

Management and Operation:
Public: Southern Nevada Water Authority/Arizona Water Banking Authority

Operational Policy and Market Creation:
Non-Market, fixed price set annually by a the CAP
Nevada may store Colorado River water that is either Nevada's unused basic or surplus portion of water or Arizona's basic or surplus portion of water.
If the water is Nevada's portion then the Secretary of the Interior for Consumptive Use in Arizona shall release the water.
The AWBA will acquire Colorado River water. The Colorado River water will be diverted through the Central Arizona Project facilities operated by CAWCD and injected into Arizona storage facilities.
The AWBA will establish a long-term storage account with the Arizona Department of Water Resources for the SNWA.
The AWBA will update the registry of long-term storage credits to be held in the SNWA account for every deposit in an Arizona storage facility.

Reporting/accounting:
$19,649,616 has been legislatively transferred from the Nevada Resource Account. The $19.65 million equates to approximately 200,000 acre-feet of water not stored by the AWBA

Timeframe for Trade:
Less than a month

Citations:

"Second Amended Agreement for Interstate Water Banking." *Azwaterbank.gov*. Arizona Water Banking Authority, n.d. Web. <http://www.azwaterbank.gov/documents/SecondAmendedAgreementforInterstateWaterBanking_000.pdf>

"Interstate Water Banking Report." *Azwaterbank.gov*. Arizona Water Banking Authority, n.d. Web. <http://www.azwaterbank.gov/Plans_and_Reports_Documents/documents/FinalInterstateAccountingReportFY11.pdf>.

"CENTRAL ARIZONA PROJECT." *Bureau of Reclamation: Lower Colorado Region*. US Bureau of Reclamation, n.d. Web. 24 July 2012. <http://www.usbr.gov/lc/phoenix/projects/capproj.html>.

Colorado & Central Arizona Project

Goal:
Long-term underground storage
Private- public

Geographic Area:

Lower basin of Colorado river

Environmental impacts:
None

Funds:
Taxes

Management and Operation:
Private- public entity

Operational Policy and Market Creation:
Arizona Banks water for Nevada and is able to call water for their own use
System of debits and credits between the states.

Reporting/accounting
In normal years:
Arizona is entitled to 2.8 maf from the Colorado River
California's allocation is 4.4 maf
Nevada's is 300,000 af.
In times of surplus:
California is entitled to 50 percent of the excess flow
Arizona 46 percent
Nevada 4 percent.

Timeframe for Trade:
15-30 days

Citations:
"CAP Channel." *Central Arizona Project: Water for Arizona's Municipal and Agriculture Needs*. N.p., n.d. Web. 17 July 2012. <http://www.cap-az.com/>.

Oregon's Deschutes water alliance bank

Goal:
Annual Lease Bank

Geographic Area:
Upper basin

Environmental impacts:
Yes: augment flows to protect the habitat of a federally protected species, bluntnose shiner in lower basin
Stream flow restoration in lower basin

Funds:
Application fee of $30 dollars but may be waived depending on water scarcity

Management and Operation:
Deschutes Water Exchange/OWRD

Operational Policy and Market Creation:
Prior appropriation state
No transactions for last 2 years
Supply – Open
Demand – Bank Administrator
No surface water transactions anymore: all ground water

Halt use of surface water right and sell to state to gain credits then sell credits to gain ground water use
Process may take anywhere from 1-5 years
In stream is beneficial use by law
Auction, market based
Buyers must be ―qualified” according to predetermined standards once the application is submitted
Applicants have two ways in which to fulfill mitigation requirements. They may either purchase mitigation credits from a mitigation bank, or implement a mitigation project. Mitigation projects include:
Allocation of conserved water when the applicant‘s portion of conserved water is allocated and legally protected for in stream use
The transfer of an existing eligible surface water right to in stream use
A permit to use water for artificial recharge of ground water
A secondary permit to use stored water from an existing reservoir
Provide the secondary permit is for in stream use.
Bank can buy, sell, hold credits for environmental purposes

Timeframe for Trade:
1-4 months

Citations:
"Balancing Water Demand in the Deschutes Basin." *Deschutesriver.org*. N.p., n.d. Web. <http://www.deschutesriver.org/DWA-Water-Bank.pdf>.http://www.wrd.state.or.us/OWRD/Deschutes_five_year_eval.shtml

Zachary Tillman: bank administrator

New Mexico’s Pecos River Basin Water Bank

Goal:
Institutional but for environmental benefits

Geographic Area:
Lower and upper basin

Environmental impacts:
Augment stream flows in the upper basin of the Colorado river

Funds:
The depositor will pay an administration fee of $30

Management and Operation:
Uses waterbank.com as a website bulletin for willing buyers and willing sellers (private entity)

Operational Policy and Market Creation:
Clearinghouse, bid process
Facilitate bilateral trades of permanent purchases and temporary leases
An owner of senior water rights or water stored in ground or surface water reservoirs may contract with the water bank under a written agreement. The agreement is the deposit in the bank, and no actual water is transferred at that time.
Market activity and withdrawals are likely to increase if the State Engineer enacts a priority call in the region where a bank is established.
Under a priority call, junior right holder diversions will be reduced or curtailed unless they obtain replacement water. The junior right holder may obtain replacement water from a water bank if supplies are available.
Prices will be determined through a bid process.
A potential purchaser will submit bids for deposits to either the depositor or the bank.
If accepted by the depositor, the purchaser and depositor will enter into a transaction agreement for the exchange of real water.
A purchaser must use the banked water for replacement of water rights cut off by priority administration.

The water bank will submit to the ISC and State Engineer a monthly summary of deposit and transaction agreements.

Timeframe for Trade:
1-3 months

Citations:
NM House Bill 421

Colorado West Slope Bank

Goal:
Annual lease

Geographic Area:
Colorado West Slope basin

Environmental impacts:
None

Funds:

Management and Operation:
SCWDC

Operational Policy and Market Creation:
Market: buyers and sellers use a bulletin board to contact each other directly and negotiate price for water rights and term of lease
The program does not facilitate the sale of water accounts for the ground water credits and withdrawals in the basin.
Credits are realized during years when withdrawals are less than 15,950 acre-feet, and debits are created during years when withdrawals exceed 15,950 acre-feet

Timeframe for Trade:
Less than 30 days

Citations:
Colorado River Water Bank: Making Water Conservation Profitable, *Reed Watson & Brandon Scarborough Edited by Laura Huggins, 2008*

"Making Water Conservation Profitable." *Perc.org*. Perc, n.d. Web. <http://www.perc.org/files/Colorado%20Case%20Study.pdf>. Colorado River Water Bank Feasibility

"Colorado River Water Bank Feasibility Study." *Crwcd.org*. MWH Americas Inc., n.d. Web. <http://www.crwcd.org/media/uploads/2012_Water_Bank_Phase1_Rept_draft.pdf>.

Idaho Rental Pools Water Bank(s)

Goal:
Leasing of stored water

Geographic Area:
Varies on the water district

Environmental impacts:
Last fill policy:

Funds:
Application fee ranging from $15-$45

Management and Operation:
Various water districts

Operational Policy and Market Creation:
Clearinghouse, fixed price set by various water districts for the predicted market price $11/AF/YR for state wide bank
$3.00 for in- basin, $10.50 out-of-basin for rental pools
Participation: Supply – Open;
Demand – Open
Lessors submit their application presenting their water rights to the Board.
The application outlines the desired terms of the transaction, including an indication that the suggested rental rate is acceptable—currently at $14 per acre-foot, or a different suggested selling price.
The State Bank operates under a ―first in, first out" rule that prioritizes the rights in the bank, not according to price, but according to the order in which the right was placed in the bank.
All water deposited in the bank is protected from forfeiture.
If the water right is leased, 90 percent of the lease valued is paid to the water right owner and 10 percent is paid to the board to cover administrative fees.

Timeframe for Trade:
1-2 months

Citations:
"Idaho Water Resource Board." *Idaho Water Resource Board*. Idaho Water Resources, n.d. Web. 17 July 2012.<http://www.idwr.idaho.gov/WaterManagement/WaterRights/waterSupply/ws_default.htm>.

Klamath Basin Rangeland Trust

Goal:
Annual Lease Bank

Geographic Area:
Only people in the basin can participate in market

Environmental impacts:
Augmenting in stream flow
Improve water quality by reducing tail water returns

Funds:
Fundraisers, taxes, and donations

Management and Operation:
Klamath Basin Rangeland Board

Operational Policy and Market Creation:
Fixed price decided annually: usually between $45-$165 per acre foot
The bank can make short term and permanent transactions
In stream flow is a beneficial use
Sellers contact the bank to sell at the fixed cost rate of 1500 per acre for permanent and 85 per acre for short term
No transaction fees to seller
Money is pays to seller by the trust in 2 installments typically
Process takes 3-4 months to complete for short term transactions
1-3 years to complete for permanent transactions. This is because they trust must raise more money to buy a permanent water right

Timeframe for Trade:
1-3 months

Citations:
"Klamath Basin Rangeland Trust 2010 Year In Review." *Kbrt.org*. Klamath Basin Rangeland Trust, n.d. Web. <http://www.kbrt.org/pdf/Annual%20Reports/2010_Year-In-Review.pdf

http://www.kbrt.org/watershed_restoration/about_KBRT.html>.

"KBRT." *Kbrt.org*. N.p., n.d. Web. 17 July 2012. <http://www.kbrt.org/watershed_restoration/about_KBRT.html>.

Semitropic Ground water Banking Program

Goal:
Long-term ground water storage

Geographic Area:

Environmental impacts:
None

Funds:
put fees, take fees, annual operation and maintenance fees, and capital contributions based on initial contractual arrangements. The fee is negotiated for each contract depending on the size of the trade.

Management and Operation:
DWR

Operational Policy and Market Creation:
Fixed

Timeframe for Trade:
1-2 months

Citations:
"Semitropic Water Storage District | Ground water Banking." *Semitropic Water Storage District | Ground water Banking*. N.p., n.d. Web. 17 July 2012. <http://www.semitropic.com/Ground waterBanking.htm>.

Truckee Meadows Ground water Bank

Goal:
Long-term ground water storage

Geographic Area:
Truckee Meadows upper basin

Environmental impacts:
none

Funds:
$25 application fee

Management and Operation:

Operational Policy and Market Creation:

Non-Market,

Credits are realized during years when withdrawals are less than 15,950 acre-feet, and debits are created during years when withdrawals exceed 15,950 acre-feet.

The bank can also be credited by water recharge as specified in the bank's recharge permit.

Reporting/accounting:

This baseline determines the credits and debits of the water accounting system.

Timeframe for Trade:

15-60 days

Citations:

"Truckee Meadows Water Authority." *Tmwa.com*. N.p., n.d. Web. 17 July 2012. <http://tmwa.com/about_us>.

"Ground water Banking Order: Truckee Meadows Basin." *Images.water.nv.gov*. Office of the State Engineer, n.d. Web. <http://www.azwaterbank.gov/>.

Walla Walla Lease Bank

Goal:

Annual Lease Bank

Geographic Area:

Upper basin (south and North Fork)

Environmental impacts:

Increase fish population in the upper basin

Funds:

Application fee of $45 dollars and some taxes

Management and Operation:

Oregon Water Trust/OWRD

Operational Policy and Market Creation:

Bilateral trades, fixed

Supply – Open

Demand – Bank Administrator

Timeframe for Trade:

1-2 month

Citations:

"Transaction Proposal Form for Specific Water Right Transactions to Increase Tributary Flows." *Cbwtp.org*. N.p., n.d. Web. <http://www.cbwtp.org/jsp/cbwtp/checklist_pdf/checklist_pdf.jsp?project_id=67&transaction_id=340>.

Cathy Schaeffer: Program Manager

"Walla Walla Watershed Management Partnership." *Walla Walla Watershed Management Partnership*. N.p., n.d. Web. 17 July 2012. <http://www.wallawallawatershed.org/>.

"Columbia Basin Water Transactions Program." *Columbia Basin Water Transactions Program*. N.p., n.d. Web. 17 July 2012. <http://www.cbwtp.org/jsp/cbwtp/projects/transactions.jsp?transaction_id=77>.

"Columbia Plateau Basin and Fifteen mile Sub basin Water Rights Acquisitions." *Bpa.gov*. Bonneville

Power Administration, n.d. Web. <https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=00005134-1>.

Yakima Basin Pilot Water Bank

Goal:
Institutional

Geographic Area:
Yakima upper basin

Environmental impacts:
Increase flows to benefit fish populations

Funds:
- Transaction fees

Management and Operation:
Yakima River Basin Water Enhancement Project/ WDE/USBR

Operational Policy and Market Creation:
Applications are submitted by buyers and sellers to WTWG
The seller demonstrated intent to use water in previous year.
The new use is a beneficial use.
The water right is valid, and the seller can demonstrate historic use.
The seller demonstrated historic availability of water at seller's point of diversion during transfer period.
The seller demonstrated evidence of no adverse impacts on in stream flow
The transfer satisfies operational considerations within the USBR Yakima
Project reservoir operations.
Process takes about 15 days

Timeframe for Trade:
1-3 months

Citations:
"WASHINGTON STATE REGISTER." *WASHINGTON STATE REGISTER*. N.p., n.d. Web. 17 July 2012. <http://apps.leg.wa.gov/documents/laws/wsr/2009/02/09-02-079.htm>.

Barwin, Bob. "Yakima Pilot Water Exchange/Bank." *Ecy.wa.gov*. N.p., n.d. Web. <http://www.ecy.wa.gov/programs/wr/instreamflows/Images/trust/bbarwin_yakimawex_112108.pdf>.

Texas Water Trust

Goal:
Institutional facilitation of permanent and temporary transfers

Geographic Area:

Environmental impacts:
None

Funds:

Management and Operation:
Texas Water Development board

Operational Policy and Market Creation:

The TWDB and the Parks and Wildlife Department deposit water rights into the trust upon review.
Water rights will be held by the trust for a contractual term.
A water right is transferred by deed in a similar manner to a real estate transaction.
Any water right holder may temporarily or permanently change the point of diversion, place of use, and/or type of use.
An application must be submitted and approved by the state engineer for any transfer.
must prove beneficial use and beneficial use does not include in stream flows

Reporting/accounting:
The deposit fee associated with the Texas Water Bank is waived by the TWDB.

Timeframe for Trade:
1-4 months

Citations:
"Twdb.state.tx.us." *Texas Water Trust*. N.p., n.d. Web. <http://www.twdb.state.tx.us/assistance/waterbank/wtrust.asp>.

Edwards Aquifer Authority Ground water Trust

Goal:
Use ground water to increase surface flows

Geographic Area:
- Edwards Aquifer ground water basin

Environmental impacts:
Increase in stream flows to surface water as beneficial use

Funds:
Application fee of $25.00
Permit recording fee of $24.00 per permit

Management and Operation:
- Edwards Aquifer Authority

Operational Policy and Market Creation:

Timeframe for Trade:
30-60 days

Citations:
OFFICIAL EDWARDS AQUIFER AUTHORITY RULES

TU's Western Water Project

Goal:
- Restore healthy stream flows in the west states

Geographic Area:
- Focus is placed on where the in stream flows are low enough to damage indigenous population.

Environmental impacts:
- Preserve environment and in stream flows for indigenous species.

Funds:
- Donations as well as fees and selling merchandise

Management and Operation:
- Trout Unlimited

Operational Policy and Market Creation:
- Non market
- Water managers visit ranches and water basins to help make the ranchers work flow more efficient with water use.
- The management pays for the changes

Timeframe for Trade:
- No transactions

Citations:
"Western Water Project." *Home*. Trout Unlimited, n.d. Web. 20 Aug. 2012. <http://www.tu.org/conservation/western-water-project>.

Appendix 2: Notes from 11/3/2011 and 4/9/2012 Stakeholder Meetings in the Mimbres Valley

STAKEHOLDER FEEDBACK: 11/3/2011 MIMBRES STAKEHOLDER MEETING

How could a market be of use/value to you?
-If intra-ditch leases were plausible/allowed.
-If using supplemental wells were cost-effective.
-If the market would be a leveraging tool to use in interactions with the OSE.
-If credits could be received for efficiency (i.e., if I demonstrate that I am using less than my water right, I should be able to lease remainder).

Concerns?

Market/OSE Administration

-Soils up and down basin vary so you are going to need a different head to deliver; will model account for this? Will conveyance losses be accounted for?
-How are you going to get –me” water if there are senior water rights above me?
-How do you make sure I get water that I, for instance, leased from 15-miles upstream? May only work on nearby ditches OR will need to be able to use supplemental wells to assure delivery.
-Can you stack? Can you lease more than land –calls” for as long as you prove you are not wasting (i.e., putting to beneficial use)?
-Can I use wells to supplement?
-Can I lease water from up river and pull out from supplemental well?
-What about third party effects?
-Who will manage the voluntary water leasing market?
-Can water be moved outside the basin? Can the Mine lease rights?
-What is my liability of leasing a surface right, pumping from my domestic well, thereby harming other supplemental wells and myself (i.e., by drawing down the water table)?
-Just not enough water, even after adjudication. Need to be more efficient. La Joya Acequia; John Carangelo, farmer: Laser level fields, demonstrate taking less than my water right, I should be able to lease that water. As of now, State Engineer takes it back; no incentive structure.
-How do we look at priorities within a ditch?
-How do you reconcile adjudicated (paper) vs. actual (wet) right?
-Is this an agricultural market only? Can I fill a pool with leased water?

Hydrologic

-What is there to lease? How much water do we have? Need complete model of basin and results of this hydrological study to really determine.
-Impact of increased use from domestic wells?

Personal/Cultural

-How is this [management scheme] different from what has been going on for a long time? Why do away with traditional management mechanisms?
-How will we manage conflict amongst neighbors?
-Why try to create a market in a basin that has seen drought for 10+ years? Why are you pushing this when things are just getting worse?
-Resistance to change.
-What about acequia-specific rules/limitations?

-Coursey article.
-Project partners. Who are you working with?
-How much is the grant?

STAKEHOLDER FEEDBACK: 4/9/2012 MIMBRES STAKEHOLDER MEETING

Hydrologic model of the Mimbres Basin: What is it and how is it linked to a voluntary water leasing market that could provide an additional mechanism for easing the stress of potential future water shortages in the Mimbres Valley?-

Administration

-Will these temporary trades need to be approved by the Mimbres Commission (as is currently required for transfers)?
-Will single ditches still manage within their own ditch?
-Who administrates?

Hydrologic Implications

-How do you keep track of use on leased wells?
-Conservation should be mandatory before leasing allowed (i.e., don‘t allow lease to inefficient ditches and/or where losses occur because of inefficiency).

Concerns

-This might be able to occur in 30-75 years, but right now there is simply not enough desire to cooperate amongst basin stakeholders.

Appendix 3: Ditch Metering Agreement Mimbres River Basin

THIS AGREEMENT is made and entered into this ____ day of _________, 2007, by and between the New Mexico Office of the State Engineer (OSE) and ________________________, (Ditch).

WITNESSETH:

Whereas, the Ditch operates certain water diversion and conveyance facilities that divert from the Mimbres River, and

Whereas OSE, pursuant to its authority, intends to measure and continually meter diversions in all ditches and canals overseen and operated by Ditch,

Now, therefore, in consideration of the mutual promises contained herein, the parties agree as follows:

1) OSE, or a contractor it may hire, shall install appropriate meters and measuring devices at each location it deems appropriate. OSE shall pay for all such devices, including instrumentation, gage housings, flumes, and similar items, and shall retain ownership of those and any other reusable and removable materials installed by OSE or its contractor.

2) Ditch shall pay for the materials, installation and maintenance associated with all locking headgates, and shall maintain all ditches in the vicinity of all headgates and OSE's metering devices so that all remain fully functional.

3) The Ditch and its members shall maintain clear and safe access to all headgates and measuring facilities for OSE's representatives, and the Ditch shall use its best efforts to inform its members of this obligation and facilitate cooperation between all ditch members affected by this obligation and representatives of OSE.

4) The Ditch shall designate a contact person for Ditch in all dealings between OSE and Ditch. The Ditch shall provide OSE with the address and phone number of the contact person and shall advise OSE if another person is subsequently designated as the contact person.

5) Ditch shall provide the OSE District III Office in Deming with keys to all headgates and access gates. The contact person identified in the previous paragraph shall keep a second set of such keys. OSE shall have the right of access to monitor and maintain all measuring facilities, to operate and lock all headgates, and for all other purposes authorized by law.

6) Ditch acknowledges that all obligations of OSE under this Agreement are subject to the availability of state appropriations and OSE's judgment as to the advisability of providing equipment for a particular location within the constraints of its budget. Nothing in this agreement shall be construed as creating any obligation of future appropriations by the New Mexico legislature.

7) Nothing in this Agreement, and no action taken by OSE pursuant to this Agreement, shall serve in any way to modify or waive OSE‘s immunity from suit under the New Mexico Tort Claims Act, including, but not limited to, the provision at NMSA 1978, §41-4-6, that sovereign immunity is not waived “for any damages arising out of the operation or maintenance of works used for diversion or storage of water.”

8) This Agreement shall not be amended except by a writing signed by authorized representatives of both parties, or their successors.

9) This Agreement incorporates and merges all agreements and understandings between the parties hereto concerning the subject matter of this Agreement. No other agreement or understanding, verbal or otherwise, of the parties or their agents shall be valid or enforceable unless embodied in this Agreement or a written amendment signed by all parties‘ authorized representatives.

10) This Agreement may be terminated by either party, by notice to the other, in writing, by an authorized representative; provided, however, that termination of this Agreement shall not relieve Ditch and its members of any legal obligations existing apart from this Agreement, including OSE‘s right to reimbursement for the cost of metering devices and their installation and maintenance incurred after the termination of this Agreement.

11) Any legal proceeding arising under this Agreement shall be brought before the Sixth Judicial District Court of the State of New Mexico.

12) If any portion of this Agreement is deemed unenforceable, the Agreement‘s other provisions shall remain in effect.

IN WITNESS WHEREOF the parties have caused this Agreement to be signed by the duly authorized officers, the day and year hereinabove written.

Ditch Name:

____

Ditch Mailing Address:

____

____

____

By: ______________________

Chairman/President

Office of the State Engineer

____

for John D‘Antonio, Jr., State Engineer

Approved as to legal form

By: _______________________________

Special Assistant Attorney General

Appendix 4: Hydrologic Model and DSS for Mimbres AWRM

Conceptual Model

The Mimbres River has its headwaters in the Black Range and Pinos Altos Range [Hawley et al., 2000]. Water moves into the river system via surface water inflows and ground water seepage. Water is lost from the river system by surface water diversions, leakage to the ground water system, and open water evaporation to the atmosphere. Riparian evapotranspiration (ET) removes water from a shallow ground water system, which is in rapid exchange with the river. Water diverted for agricultural irrigation use can be lost to the ground water system through conveyance system (i.e., ditch) leakage and crop seepage, and lost to the atmosphere via crop ET. Baseflow to the river can be estimated at a gross level by evaluating flows between gages over dry winter months. The majority of ground water pumping and agricultural diversions take place in the lower two reaches of the river, centering on San Lorenzo, the most senior ditch in the system. The river itself generally supports very small flows with river geometry changing rapidly. Historically it appears that each ditch diverts the full amount of water in the river and ground water seepage to the river provides flow for the next downstream ditch to do the same. River dynamics and historical agricultural operations suggest that open water evaporation does not result in significant losses from the system.

Spatial and Temporal Extent and Resolution

The spatial extent of the model is informed by the Mimbres River Active Water Resource Management Areas (AWRMs), the Upper, Middle, and Lower, shown in Figures A1a-c; these AWRMs exist within the Mimbres River Basin, shown in Figure 1. The extent of the Mimbres River that is explicitly modeled starts at the point of diversion of the Grijalva ditch and terminates at the point of return from the Tigner B ditch, 35 miles downstream. There are several ditches in the system that are no longer used and therefore not modeled; these include the Mitchell ditches, Kasson ditch, and Lower Canaigre ditch. There are 13 tributaries in the modeled stretch of the Mimbres, none of which are gaged but whose contribution to surface water flows can be estimated from mainstem gage flows; these tributary flows are discussed later in Modeled Surface Water Flows: Ungaged Surface Water Inflows. One reservoir operates in the system,
Bear Canyon Lake, discussed under **Error! Reference source not found.**.

The spatial resolution of the model is defined by active ditches within the AWRM, where the river system can be divided into 33 conceptual spatial units referred to as reaches, based on the locations of point of diversions and returns of 33 operating agricultural ditches. The major physical parameters used to model the 33 Mimbres ditches are shown in Table A4- 1.

The model runs on a daily timestep in order to capture the hydrologic implications of daily agricultural diversions. Optimally, the model should be run for one year at a time only as it has been designed and calibrated to look at alternative management scenarios throughout one growing season; the model can be run any time between 1932 and 2006, as dictated by availability of stream gage data.

Table A4- 1: Primary parameters used to model 33 ditches in Mimbres AWRM.

Ditch	Priority	Acreage[1]	Fallowed Acreage[2]	Ditch Efficiency[3]	Reach Length (m)[4]	Reach Width (m)[5]	Reach Eleveation (m)[6]	Alluvial Ground water Area (acres)[7]	Alluvial Fill Thickness (m)[8]	Associated Tributaries
Grijalva	1893	48.8	2.60	0.65	415.63	115.67	1792	11.88	24.38	
Montoya	1880	36.60	0.00	0.65	699.02	234.35	1797	40.48	24.38	
Kenly 1	1894	35.70	0.00	0.65	5464.09	399.06	1768	538.81	24.38	Bear Canyon
Kenly 2	1894	50.60	0.00	0.65	2325.95	336.89	1779.5	193.63	24.38	Sheppard
Heuchling 1	1870	5.80	0.00	0.65	1790.16	329.15	1808	145.60	24.38	Shingle
Heuchling 2	1870	3.90	0.00	0.65	1595.57	236.64	1819	93.30	13.11	Willow Spgs
Heuchling 3	1870	3.50	36.49	0.65	433.15	268.79	1832	28.77	5.18	
Heuchling 4	1870	13.60	43.10	0.65	834.85	344.17	1824	71.00	7.62	
San Lorenzo	1869	275.73	24.90	0.85	741.60	258.39	1843	47.35	2.74	Brunner
Ancheta Galaz	1876	109.30	0.00	0.65	1100.48	61.42	1755.00	16.70	50-100	
Heredia Community	1870	103.70	29.21	0.65	1803.21	27.73	1748.00	12.35	0-100	Noonday
Llano	1873	56.50	23.10	0.65	1447.94	68.56	1739.00	24.53	0-100	
Tajo	1870	105.70	129.14	0.65	1977.25	141.82	1723.00	69.29	0-100	
Perrault	1870	49.60	0.00	0.65	1853.16	116.76	1718.00	53.47	50-100	Ancheta
Duran	1888	21.30	21.60	0.65	750.59	87.04	1705.00	48.43	50-100	
Goforth	1880	39.30	0.00	0.65	2962.84	53.79	1703.00	39.38	50-100	
Swartz	1884	108.10	18.79	0.65	1327.71	48.82	1676.00	16.02	0-50	Gallinas, Hot
Parra	1886	21.40	7.99	0.65	3486.01	105.87	1674.00	91.19	0-50	
Kimmick	1889	77.10	0.00	0.65	1109.83	159.19	1658.00	43.66	0-50	Donahue
Dominguez	1885	27.70	0.00	0.65	1904.42	88.05	1648.00	41.44	0-50	
Nan	1880	75.60	6.71	0.65	352.03	50.96	1636.00	4.43	0-50	Tom Brown
Greenwald	1886	31.20	9.65	0.65	2754.74	110.27	1628.00	75.06	0-50	
Eby & Baca	1887	115.70	37.69	0.65	916.87	77.91	1621.00	17.65	0-50	Gavilan
Macedonio	1887	70.10	6.87	0.65	1429.08	130.46	1611.00	46.07	0-50	
Baca	1885	81.50	0.00	0.65	1514.06	229.27	1607.00	85.78	0-50	
Martin	1891	71.70	0.00	0.65	867.90	292.36	1595.00	62.70	0-50	
Wardwell-Herron	1880	110.50	0.66	0.65	765.24	298.31	1588.00	56.41	0-100	
Tustin-McIntosh	1884	119.30	32.34	0.65	1334.95	475.48	1586.00	156.85	0-100	
OSullivan-McSherry-Pena	1880	10.00	0.00	0.65	4001.43	353.01	1581.00	349.04	0-100	
Tigner	1890	119.20	60.62	0.65	5617.64	330.07	1560.00	458.18	0-200	
Tigner A	1871	130.90	47.32	0.65	2295.07	68.73	1535.00	38.98	50-100	
King	1912	121.20	169.42	0.65	663.63	171.49	1515.00	28.12	50-300	
Tigner B	1871	85.50	0.00	0.65	119.89	468.70	1519.00	13.88	100-200	

[1] 'MIMBRES OWNERSHIP 2_09.xls' provided by Adam Polley of OSE Deming on 11092010. [2] Determined and provided by SNL Barbie Moreland from analysis of aerial images provided by NM OSE; saved in Mimbres/Data/Ditches as 'Middle and Lower Acreages.xls'. [3] Personal communication between OSE Deming and Marissa Reno-Trujillo on 01312012. [4,6] Determined by SNL Barbie Moreland using GIS files provided by Adam Polley (OSE, Deming) on 11092010. [5] Determined via visual inspection of aerial images provided by NM OSE and map on page 37 of "Trans-International Boundary Aquifers in Southwest New Mexico" by John W. Hawley, Barry J. Hibbs, John F. Kennedy, Bobby J. Creel, Marta D. Remmenga, Molly Johnson, Monica M. Lee, and Phil Dinterman; Technical Completion Report prepared for U.S. Environmental Protection Agency - Region 6 and the International Boundary and Water Commission - U.S. Section; March 2000. [7] Calculated as reach length X reach width. [8] Estimated by SNL Barbie Moreland; reach maps previously generated from the GIS files provided by the OSE were overlain on Figure 4 from "Estimation of Alluvial-Fill Thickness in the Mimbres Ground-Water Basin, New Mexico, from Interpretation of Isostatic Residual Gravity Anomalies", USGS Water-Resources Investigations Report 02-4007.

Governing Equations

River Reach Mass Balance

Employing mass balance, the amount of water that flows out of a given river reach can be expressed mathematically as a function of inflows, outflows, and change in storage within the reach. At a daily timestep and given the short reach lengths, the change in storage in a river reach is assumed to be negligible with respect to the other flows through the reach and precipitation gains to open water are also assumed to be negligible. The governing equation for a generic reach (*j*) is shown in Equation A4- 1below.

$$Q^j_{msout} = Q^j_{msin} + Q^j_{sw} + Q^j_{gwsw} - Q^j_{evap}$$

Equation A4- 1: River reach mass balance.

In Equation A4- 1, Q^j_{msout} represents mainstem flow out of the bottom of reach j, which is the location representing the lower end of the reach. The term Q^j_{msin} represents mainstem flow into reach j, from the reach above or the input on the model boundary. If reach *i* is immediately above reach j, the flow out of reach *i* is the same as the flow into reach j: $Q^i_{msout} = Q^j_{msin}$. During the calibration period, the mainstem inflow term (Q^j_{msin}) is based on historic gage data. The surface water term (Q^j_{sw}) is found using Equation A4- 2 below, whose terms are modeled. The ground water exchange (Q^j_{gwsw}) is based on a coupled, dynamic ground water model, representing the net sum of all interactions between the river and ground water system in the reach, and is positive for a ground water gaining reach, and negative for a ground water losing reach; modeling of the ground water system is described in Ground water Flows. The term Q^j_{evap} represents open water evaporative losses, which are described in detail below under Evapotranspiration.

$$Q^j_{sw} = Q^j_{swungaged} - Q^j_{swdiversion}$$

Equation A4- 2

The term $Q^j_{swungaged}$ represents ungaged surface water inflows, addressed under Ungaged Surface Water Inflows, and the term $Q^j_{swdiversion}$ represents surface water diversions, described under Surface Water Diversions and modeled generally using Equation A4- 3:

$$Q^j_{swdiversion} = Q^j_{cropET} + Q^{\ j}_{convgw} + Q^j_{convevap}$$

Equation A4- 3

Equation A4- 3states that surface water can enter the ditch by diversion from the associated reach ($Q^j_{swdiversion}$). Water is lost from the system to the atmosphere by ET from crops (Q^j_{cropET}) or from open water evaporation in the uncovered ditches ($Q^j_{convevap}$). Conveyance water moves to the ground water system as seepage from crops and ditches ($Q^{\ j}_{convgw}$).

Reservoir Mass Balance

Bear Canyon Lake is the only reservoir in the modeled area and no operations data/records exist for this relatively small (550-AF storage capacity) reservoir. Based on anecdotal evidence from the NM OSE, the reservoir is assumed to fill up by the beginning of each year and releases up to the amount of 270 AF, that amount not owned by the New Mexico Game and Fish, can be requested by San Lorenzo, the senior irrigator in the Mimbres, when there is not enough water in the Mimbres to meet their diversion request. The only other governing input is the number of days that releases are requested.

Evapotranspiration

Reference Evapotranspiration Rate

Reference evapotranspiration (ET) for this model was calculated using Hargreave's running average daily method. Daily maximum and minimum temperatures were taken from Faywood, Mimbres Ranger Station, and Fort Bayard weather stations and weighted for each reach. A single latitude was used in the calculations and assumed reasonable because of the relatively small extent of the Mimbres Basin. Reference ET is then multiplied by a plant or open water coefficient, described below, to get the ET rate for a specific plant type or open water.

Plant Coefficients

Reference ET is modified by empirically determined unitless coefficients to scale reference ET to a particular plant or environment type. Evaporation coefficients for riparian and crop vegetation were derived according to ET Toolbox methodology [Brower, 2004], which uses either a growing degree day (GDD) or monthly average method to estimate crop coefficients. The monthly average method always applies the same crop coefficient to a given crop in a given month. The growing degree day method is used to track the energy that can contribute to plant growth and development through the growing season, and is essentially a model of plant growth through a growing season as a function of air temperature. Using the growing degree method, a given crop ET will be greater in a warm year than a cool year. The growing degrees available for plant utilization in a given month *m* by plant type *p* can be calculated as:

$$GD^{m,p} = \left(\frac{\left(T_{max}^{m,p} + T_{min}^{m,p}\right)}{2} - T_{base}^{p}\right) * days^{m}$$

Equation A4- 4: Growing degree day calculation.

$GD^{m,p}{}_p$ = growing degrees in month m for plant type p [degrees/T]
$T_{max}^{m,p}$ = the average maximum monthly temperature for month m, or plant maximum temperature cutoff parameter for plant type p, whichever is smaller [degrees/T]
$T_{min}^{m,p}$ = the average minimum monthly temperature for month m, or $T_{base}^{m,p}$, whichever is larger [degrees/T]
T_{base}^{p} , = the base temperature parameter for plant type p [degrees/T]
$days^{m}$ = the number of days in month m [-]

Relationships between growing degree days and plant ET coefficient as a function of plant species were used to go from growing degree days to plant coefficient [Brower, 2004]. Regardless of coefficient method, ET is only applied during the growing season of a given plant type. Table A4- 2 summarizes the crop and plant types represented in the model, the method used for calculation of crop coefficients, the growing degree parameters for the plant type where applicable, and the beginning and end months of growing season of the plant type. Table A4-3Table A4- 4 give coefficients specific to plant types.

Table A4- 2: Crop types with ET coefficient calculation information.

	Plant Type	Coefficient Method	Base Temp GD (F)	Max Temp Cutoff GD (F)	Start Month	Stop Month
Agricultural	Row Crops	GDD	5	50	March	September
	Pasture	GDD	4.4	50	January	December
	Garden/Orchard	Monthly	N/A	N/A	January	December
Riparian	Bosque	GDD	10	50	April	November

Table A4- 3: Growing degree day coefficient K_c is calculated, using GD from Equation A4- 4 and the constants below, as K_c = A + B *GD1 + C *GD2 + D *GD3 + E *GD4+ F *GD5.

	Growing Degree Day Coefficients					
	A	B	C	D	E	F
Row Crops	1.6E-02	6.00E-04	-2.00E-08	-3.00E-11	0	0
Pasture	0	1.29E-03	-5.42E-07	5.74E-11	0	0
Bosque	0.12	0.00225	-5.1E-06	5.85E-09	-2.8E-12	3.38E-16

Table A4- 4: Monthly vegetation coefficients.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Garden/Orchard	0.4	0.4	0.43	0.62	0.8	0.86	0.86	0.86	0.86	0.86	0.86	0.76

Open Water Coefficients

Open water evaporation is predicted by multiplying reference ET by a unitless open water evaporation coefficient, an approach that is analogous to the method described above for vegetation. The open water coefficient method is used to estimate direct evaporation from a river reach. Table A4- 5 shows the coefficients used by the ET Toolbox method, developed by M. E. Jensen in the lower Colorado system [Jensen, 1998] .

Table A4- 5: Open water evaporation coefficients from Jensen 1998.

Month	Open Water Evaporation Coefficient
January	0.52
February	0.57
March	0.67
April	0.79
May	0.84
June	0.89
July	0.89
August	0.85
September	0.89
October	0.86
November	0.87
December	0.68

Volumetric Evapotranspiration

In order to get Q_{evap}^{j} for use in Equation A4- 1, reference ET is multiplied by the relevant growing degree day or monthly vegetation coefficient and the associated area of plant or water.

Modeled Surface Water Flows

Gaged Streams

The Mimbres River has been gaged historically at McKnight, approximately three miles upstream of the modeled area, and at Mimbres (At Mimbres, Near Mimbres and Faywood), internal to the modeled area. Bear Canyon tributary was also gaged between 1937 and 1955. Table A4- 6 summarizes gages along the Mimbres and how they are used in the model. Inflows to the model are set equal to McKnight flows when data are available; when McKnight data are missing, inflows are projected as Near Mimbres gage flows correlated to McKnight. Gage data from Mimbres near Faywood are used to calibrate the flows on the Lower portion of the Mimbres.

Table A4- 6: Mimbres stream gages used for model forcing and calibration.

Gage	USGS Gage #	Location	Historical Record	Use in Model
Mimbres River at McKnight Dam Site (McKnight)	8476300	32° 56‘ 14” 108° 0‘ 55”	1964-1972	Inflows
Bear Canyon near Mimbres	8476500	32° 52‘ 50” 107° 59‘ 20”	1937-1955, sporadic	Reservoir operation
Mimbres River near Mimbres (Near Mimbres)	8477000	32° 58‘ 28” 107° 58‘ 5”	1931-1976	Calibration, linear regression with McKnight data
Mimbres River at Mimbres (At Mimbres)	8477110	32° 51‘ 17” 107° 58‘ 23”	1978-Present	Using linear regression from Near Mimbres and McKnight, serves as a basis for inflows for years McKnight has no data
Mimbres at Faywood	8477500	32°35'10" 107°55'10"	1930-1968	Calibration

Surface Water Diversions

Surface water diversions are modeled as the smaller of inflow to a reach and the desired agricultural diversion. Desired diversions for irrigation are equal to adjudicated acreage by ditch less fallowed acreage (shown in Table A4- 1) multiplied by the consumptive irrigation requirement (CIR) divided by ditch efficiency. For all ditches upstream of Swartz ditch, the CIR has been set equal to 2.7 AF/acre; for Swartz and all ditches downstream, the CIR is 3.0 AF/acre. Due to ditch inefficiencies (i.e., loss from ditch to shallow ground water through seepage), the OSE assumes that for all ditches except San Lorenzo, only 65% of the diverted water makes to the fields; for San Lorenzo, 85% makes it to the field. Therefore, every diversion from the mainstem must consider efficiency losses.

A delivery schedule has been set up in the Upper Mimbres to help minimize conflicts between ditches; such a system has not been adopted in the Middle and Lower Mimbres. For ditches in the Upper Mimbres, water is only requested on scheduled diversion days; for ditches in the Middle and Lower Mimbres, water is requested on every irrigation day, starting on March 1 and ending on September 30. The daily diversion for any given ditch is equal to total annual diversion less water already diverted divided by days left in the irrigation season; any water not delivered is accumulated as a shortage and even though there might be extra water in the future that could be taken to offset this shortage, the model assumes that water is needed on the days that it is requested in the amounts that it is requested and that shortages cannot be ―made up” (e.g., if Kenly 1 wants 5 cfs on day 2 of the irrigation season but can only divert 3 cfs, being able to divert an extra 2 cfs on day 80 of the irrigation season might not be beneficial in any way in terms of their crop yield).

In a basin governed by priority administration, which the Mimbres is, the senior water right holder on the river has the ability to make a call, that is, when there is not enough water in the river for them to receive their full adjudication, ditches junior to them can be effectively shut off so that the senior water right holder might divert their adjudication. The model allows the use three options to deal with diversion shortages: (1) Do nothing, let ditches take the water as it flows by; (2) Share shortages equally amongst all juniors; (3) Shut ditches off in order of their priority date, from youngest to oldest.

Ungaged Surface Water Inflows

Having defined all terms necessary, surface water inflows can be solved for by combining Equation A4- 1 and Equation A4- 2, and solving for ungaged surface water inflows:

$$Q^j_{swungaged} = Q^j_{msout} - Q^j_{msin} - Q^j_{swgaged} + Q^j_{swdiversion} - Q^j_{gwsw} + Q^j_{evap}$$

Equation A4- 5: Ungaged surface water inflows.

The model is calibrated to minimize error between the modeled and observed peak flows at the Near Mimbres and Faywood gages by adding a modeled ungaged surface water inflow term. This ungaged surface water term is equal to twice the error and is divided into known tributaries based on drainage area and input to the associated river reach. Table A4- 7 shows tributaries used for calibration.

Table A4- 7: Tributary fractions and associated reaches.

Reach	Tributary	Fraction of Ungaged Flow
Above reaches	Upstream	0.45
Kenly 1	Bear	0.18
Kenly 2	Sheppard	0.17
Heuchling 1	Shingle	0.13
Heuchling 2	Willow	0.04
San Lorenzo	Brunner	0.03
Heredia Community	Noonday Canyon	0.08
Perrault	Ancheta Canyon	0.02
Swartz	Gallinas Canyon	0.20
Swartz	Hot Springs Canyon	0.20
Kimmick	Donahue Canyon	0.15
Nan	Tom Brown Canyon	0.25
Eby & Baca	Gavilan Arroyo	0.10

Ungaged Ground Water-Surface Water Interactions

In addition to minimizing modeled versus measured peak flows by adjusting tributary contributions, ground water-surface water interactions were also adjusted to most accurately match measured streamflows. This calibration exercise was informed by the 2009 Mimbres Streamflow Measurement Study, conducted by NM Hydro Logic LLC in cooperation with the NM OSE in January of 2009. Gross reach gains (+) and losses (-) are shown in Table A4- 8.

Table A4- 8: Reach gains and losses from 2009 streamflow study.

Reach	Alluvial Gain/Loss (cfs/mile)
Kenly 1 to Heredia Community	-2.18
Heredia Community to Perrault	-0.46
Perrault to Goforth	+0.49
Goforth to Swartz	-1.85
Swartz to Dominguez	-3.50
Dominguez to Nan	+0.30
Nan to Eby & Baca	+1.20
Eby & Baca to Tigner	-1.50
Tigner to Lower Mimbres End	+1.10

Ground water Flows

Basin Description

The Mimbres underground water basin is located in southwestern New Mexico and is bordered on the north by the Gila Basin, the east by the Rio Grande Basin, the south by Mexico, and the west by Lordsburg and Hachita Basins. The Basin includes parts of Luna, Grant, Dona Ana, and Sierra counties. The Mimbres Basin has been geologically studied by Hawley et al [2000] and Hansen et al [1994]. John Shomaker & Associates, Inc. [McCoy and Finch, 2006] produced a MODFLOW model of the area for the Chino Mines, and Daniel B. Stephens & Associates, Inc. 2005] completed the Southwest Planning Region Water Plan for the Mimbres Basin including only Luna and Grant Counties. According to this information the Mimbres is a closed basin, which drains to playa lakes near the U.S.-Mexico border. The Mimbres demonstrates a classic basin and range architecture that is a large alluvial filled basin bounded by mountains. Recharge to the basin is from direct infiltration of precipitation and mountain front recharge [McCoy and Finch, 2006). Demands on the basin‘s water resources are predominately from mining and agriculture. Municipal demands are growing, particularly around Deming and Silver City. Most water use depends on ground water pumping.

Ground Water Model Description

For the purposes of this project, we are only modeling the portion of the Mimbres basin that is immediately connected with the modeled surface water of the Mimbres River. Demands in this area are predominantly from domestic wells. The ground water studies discussed previously do not have a small enough scale to capture the salient features of the ground water near the Upper Mimbres River. The area is also devoid of USGS observation wells, so there is no historical head data. The following sections discuss our method of modeling in this data-scarce area.

Ground Water Compartments (zones)

Studies have demonstrated that the Mimbres River is well connected to an alluvial aquifer that underlies it [Hawley et al 2000]. For this reason, we chose to model an alluvial aquifer with compartments that match the surface water reaches that overlie it. Not enough ground water data was available to differentiate the alluvial aquifer through any other distinguishing geologic characteristics. The Mimbres River sits in the middle of a distinct valley, with the alluvial aquifer expected to fill the bottom of the valley, so the width of the aquifer compartments was determined using GIS and topographic maps. This width was multiplied by the surface reach length to obtain the acreage. Alluvial thickness for each reach was also estimated using USGS [2002] Basin Fill GIS Maps and the assumption that the alluvium is never more than 80ft deep in this area. Initial head was related to the elevation of each surface water reach, and is generally expected to be above the surface water datum. The head, specific yield, hydraulic conductivity, and a distance L for each compartment, were estimated using ground water reports [McCoy and Finch 2006, Daniel B. Stephens & Associates 2005] and refined through model calibration, discussed in section **Error! Reference source not found.**.

Intercompartmental Flows

Head-driven ground water movement between zones can be conceptualized using an alpha matrix as follows.

$$Q_{ij} = \alpha_{ij}\left(h_j - h_i\right) \rightarrow \alpha_{ij} = \frac{Q_{ij}}{h_j - h_i} \qquad \text{Units of } \alpha_{ij} \text{ are } [L^2/\text{time}]$$

Equation A4- 6

If Q and the heads are known, an alpha can be calculated. \However, in this case, neither Q nor the heads are known precisely. We can either attempt to estimate Q, h, and alpha and refine through calibration, or we can attempt to calculate alpha using Darcy‘s Law. In this case, alpha

=AK/L where A is the cross-sectional area between the zones, K is the effective hydraulic conductivity between the zones, and L is the length across which flow occurs, in this case estimated as centroid to centroid. A can be calculated using alluvial thickness and width at the interzonal area. K is calculated from estimates of zonal conductivity which are refined through calibration. We can then plug alpha and the calibrated heads into Table A4- 6 to find interzonal flow. In this case, each zone connects with the zones directly upstream and downstream of it, but no others, making the matrix actually linear. Non-negative alpha values result in flow from zones of higher head to zones of lower head, in this case downstream. Fluxes modeled as ground water head dependent include aquifer interaction with hydrologically connected surface water and other aquifers.

Boundary Conditions and Fluxes

It is important to note that within a systems context, nearly all of the boundary and source terms may be functions of the operation of other interdependent systems. In a fully integrated systems model, systems affecting ground water source terms include the land surface system (mountain front and tributary recharge), other ground water basins (subflow), the surface water system (canal recharge, river leakage, drain capture), and the human behavioral system (canal, septic, and crop recharge). A significant advantage to systems-level modeling is that linked systems add constraints to make model realizations less non-unique. The amount of water that moves out of the surface water system into the ground water system must be considered in both systems. A key purpose of the spatial aggregation described here is to facilitate dynamic linkages to other systems, specifically a daily timestep surface water model. For this reason, the spatially aggregated ground water model was set up to run on a daily timestep, and fluxes between the surface water and ground water system were set up to take advantage of daily surface water information.

Well extraction

Human ground water extraction is based on ground-truthing of currently operation wells, as there are no specific historical data for this area. The GIS well database enables us to separate wells into our aquifers. Extraction numbers were also compared with the WATERS database to try to attribute the correct amount of water use to the wells. Because most, if not all wells, in the area are not metered, there is not an accurate source of extraction information.

Natural Recharge

Originally recharge was assumed to enter a regional aquifer surrounding the alluvial aquifer that subsequently transferred it to the stream. However, this set-up did not capture the historic streamflow conditions at the Near Mimbres gage through numerous calibration attempts. After considering the area, the regional aquifer was scrapped for smaller aquifers that coincide with the tributaries to the Mimbres. These provide a shallow, quicker path for recharge to affect streamflow. This change in model conception enabled the proper calibration of the model. Well extraction outside of the alluvium is also assumed to be a flux from these tributary aquifers. Aquifer characteristics were estimated and calibrated as with the alluvial aquifer (section **Error! eference source not found.**). Precipitation numbers in depth from Faywood, Mimbres Ranger Station, and Fort Bayard are weight averaged and multiplied by the combined tributary drainage areas of 56,663 acres. Seven point five percent of this precipitation is assumed to recharge aquifers in the area.

Modeled Crop Evapotranspiration

Crop Acreage

Vegetation areas for irrigated agricultural crops are not available historically. Beginning in 2006, the Upper Mimbres Water Master required each Upper Mimbres ditch to provide a list of acreage of every type of crop that was being irrigated. The types of irrigated crops that exist in the Mimbres Valley are alfalfa, small grains, pasture, garden, and orchard, with pasture comprising the major part of irrigated land. The model assumes that all land under cultivation has the evapotranspirative properties of pasture; for planning purposes and alternative management scenario evaluation, the conservative flow estimates that arise using this assumption are acceptable if not preferable.

Riparian Vegetation Acreage

Vegetation areas for riparian vegetation are not available historically. For this model, the riparian vegetation acreage for each reach is based on estimates taken from aerial photography. In addition, all riparian vegetation is assumed to be Bosque, as no studies have been done to differentiate plant type. Riparian acreages used in the model are reported in Table A4- 9

Table A4- 9: Riparian acreage by ditch.

Upper Mimbres Ditches	Riparian Acreage	Middle Mimbres Ditches	Riparian Acreage	Lower Mimbres Ditches	Riparian Acreage
Grijalva	16.00	Ancheta Galaz	64.20	Nan	9.22
Montoya	24.40	Heredia Community	69.34	Greenwald	277.33
Kenly 1	132.60	Llano	10.64	Eby & Baca	0.38
Kenly 2	117.40	Tajo	66.33	Macedonio	132.14
Heuchling 1	73.20	Perrault	162.56	Baca	82.7
Heuchling 2	29.20	Duran	37.16	Martin	8.42
Heuchling 3	11.40	Goforth	118.43	Wardwell-Herron	20.42
Heuchling 4	19.40	Swartz	47.08	Tustin-McIntosh	68.14
San Lorenzo	35.80	Parra	153.74	OSull-McSher-Pena	401.07
		Kimmick	10.01	Tigner	487.32
		Dominguez	162.10	Tigner A	45.16
				King	31.97
				Tigner B	376.41

River Channel Open Water Area

The open water area associated with each reach of the river channel is a function of flow rate and channel cross-section geometry. The relationship between stream width and flow at the Near Mimbres gage is used as a proxy for the relationship in all the reaches. Channel geometry at this location is not likely representative of the entire reach above or below the gage, but additional data are not readily available, and surface evaporation from the reaches is conceptually a relatively small term, so this assumption is considered acceptable. Width as a function of flow rate is available indirectly from field measurement data published online for each gage operated by the USGS. Power curves for the relationships between width and streamflow are developed using historical data. The data indicate that the river changes significantly over time, as R^2 values were quite low for most cases. To improve representation, two different power curves are used: one for low flows and one for high flows, based on fitting of data; these power curves are shown in Table A4- 10. The power curves are applied to the inflows of each reach minus agricultural diversions (at the top of the reach) to obtain a representative reach width. This is multiplied by reach length to get open water area.

Table A4- 10: Power curves for reach width to streamflow.

	Power Curve
Low Flow (<40cfs)	$6.0785Q^{0.4407}$
High Flow (>40cfs)	$6.918Q^{0.3641}$

Potential Versus Actual ET in Model

The previous sections demonstrate the use of reference ET to calculate potential ET for agricultural, channel surface, and riparian ET. The potential ET is the maximum ET expected for a given set of climatic conditions and growing history of a plant (if using growing degree day (GDD) approach). The actual ET observed is less than potential if water availability is limiting. In the case of agricultural ET, crops are often grown in a moisture deficit state, that is, with less water applied than could potentially be transpired. Actual water delivery is restricted in timing and magnitude based on water rights, delivery infrastructure, and social institutions. Diversion rules, assume a certain ditch efficiency, or the amount of water expected to reach the fields. Of the amount estimated to reach the fields, the NM OSE assumes a 50% crop efficiency rate, therefore actual ET is the minimum of water available after ditch loss and assuming the 50% efficiency or the potential ET. In the case of open water evaporation, potential ET can also be limited by water availability. Because each reach has diversions, inflows, leakage, and open water evaporation happening simultaneously, without limiting potential ET, the reach storage could become negative. In this case, potential open water evaporation is limited by the amount of water left in the reach after diversions and leakage. This is generally only a limiting factor in losing reaches. Channel surface water evaporation is not based on coefficients and is assumed to be equal to 4% of the water lost in ditches, except San Lorenzo which is piped and therefore more resistant to diversion losses.

REFERENCES for Appendix 4: Hydrologic Model and DSS for Mimbres AWRM

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Appendix 5: Framework Experimental Instructions

I: Instructions on how to use the Software

There are five steps that must be completed to upload the software and conduct an experiment or run simulation.

Table 1: ID's and Passwords	
ID	Password
grijalva	grijalva
montoya	montoya
kenly_1	kenly_1
kenly_2	kenly_2
heuchling_1	heuchling_1
heuchling_2	heuchling_2
heuchling_3	heuchling_3
heuchling_4	heuchling_4
san_lorenzo	san_lorenzo
casas_adobes	casas_adobes
misc_pumping	misc_pumping

1. Log into the virtual machine by placing http://129.24.63.9:8080/gwdss-generalized/ in a web browser. On this page select the login button on the upper left and you will then be redirected to a log in page
2. There are 11 unique user ID's and passwords that can be used to log into the system as reported in Table 1.
3. Once logged into the system the next step in the process is to click on the Mimbres specialist interface link located on the left hand side.
4. After clicking on this link you are redirected to a new page where the simulation parameters can be selected. These parameters are as follows:
    a. Year: the moderator can choose any historic hydrologic year from 1950 up to 2006.
    b. Rain Switch: this allows the moderator to turn on rainwater in the summer months or not to have a stochastic rainfall event in the summer months.
    c. Trade fallowed switch: this switch allows the moderator to allow for the trading of fallowed acreage if turned on.
    d. Stacking switch: if selected this switch will allow participants to stack water on their land, if not selected stacking is not allowed.
    e. Initial trading cash: this is the total amount of trading cash each participant is allocated to use in the leasing of water.
    f. Maximum debt: this switch allows the moderator to determine how much debt each participant can go into in the leasing of water.
    g. Multi-user mode: if this switch is selected all 11 users will need to log in for the marketplace to be open. If left unselected then the marketplace can be done from a singular computer, thus you can have one market administrator
    h. Multi-user time limit: this allows the moderator to determine how long each trading month will be open before moving onto the next month.

5. Once all the parameters are set click on submit and the last screen is brought up known as the select crops screen. In this screen each ditch can choose how many acres they would like to dedicate to 5 different combinations of crops (i.e. alfalfa, small grains, pasture, garden plots and orchards). This acreage comes from the TBI that is filed prior to each growing season. Once the crop acreage is selected it cannot be changed until the end of a growing season. After this selection is made click on the submit crops button and the trading marketplace is open. At the end of each trading month the software will run the hydrologic model producing stream flow numbers. To move to the next month of trading click on the proceed button and the next month will become active.

Data from the market transactions are stored in two different places:

1. Economic Data
2. Hydrologic data

The economic data can be accessed by first running a program to upload the new csv files which can be done by pasting the following web link into a browser. http://129.24.63.9:8080/gwdss-generalized/xml2csv.jsp Once the files are uploaded each month of trading can be downloaded by going to the root of the server at http://129.24.63.9/ and accessing the list of csv files that have been generated. The newest 12 files are the latest years' worth of trading from this list. Simply click on the hyperlink for the file and an excel sheet with the data will be brought up.

The hydrologic data can be accessed by in the same location as noted above for the economic data. Data files containing hydrologic data include 'mimbres output.xls', 'mimbres data.xls', 'mimbres input.xls', and 'mimbres compare.xls', which are all under the directory c:\apache-tomcat-5.5.28\bin.

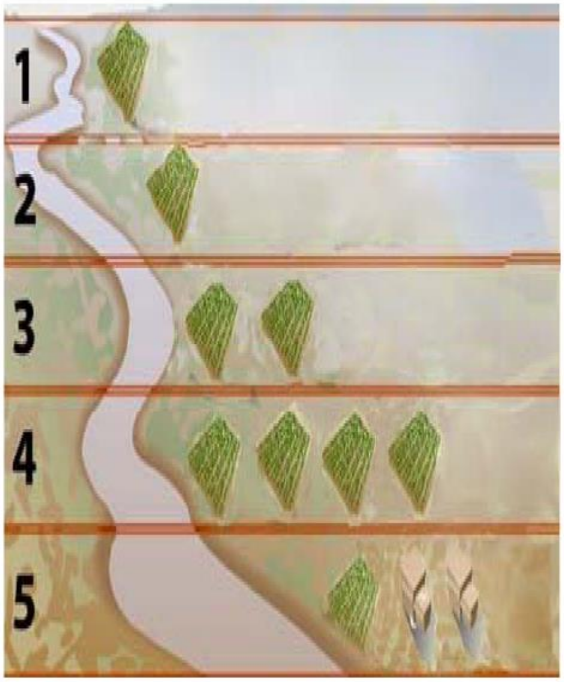
II: Experimental Instructions used for Participants

To educate participants on how to use the developed software a PowerPoint presentation has been developed that demonstrates how to submit bids and offers and how to accept bids and offers for each of the 11 participants in the Upper Mimbres Basin. These PowerPoint files are accessible online at http://www.tech-teachers.net/craig/wlmExpInstructions.html. The PowerPoint file is included below for one of the ditches as an example of the instructions.

Thank you for participating in our experiment. Through the decisions you make today, you will have the opportunity to earn monetary rewards. You will be paid by cash for each session with a bonus at the end, so at the end of the experiment we would like you to verify the information you have provided to us. This procedure is in accordance with University rules.

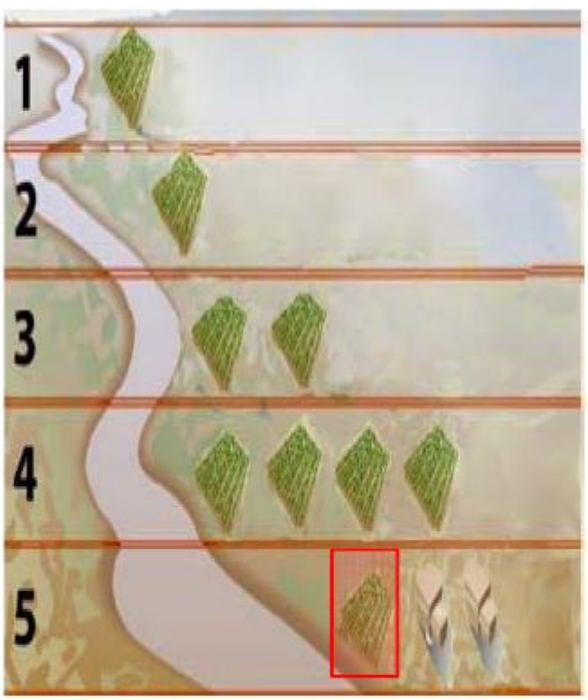
You may use the right or left arrow keys on your keyboard to advance through this tutorial.

If at any time you wish to ask a question during this tutorial or during the experiment please raise your hand and the experiments monitor will attend to you.



This experiment addresses the issue of water leasing amongst buyers and sellers. The setting is a stylized representation of a river system. You can make money in the experiment by buying and selling water to the other participants. This buying and selling of water will occur over a series of trading months. During each of these trading months you will have the opportunity to make money by buying or selling water.

At the beginning of each month you will be told how much water that you have available. You can then choose to keep this water, to sell some or all of it to others, or to buy more water.



You and other participants in the experiment will be buying and selling water from different, fixed locations on a river. Different types of users are represented on the river. The river is structured as follows.

Your location on the river is marked by the red square and you are:
San_Lorenzo

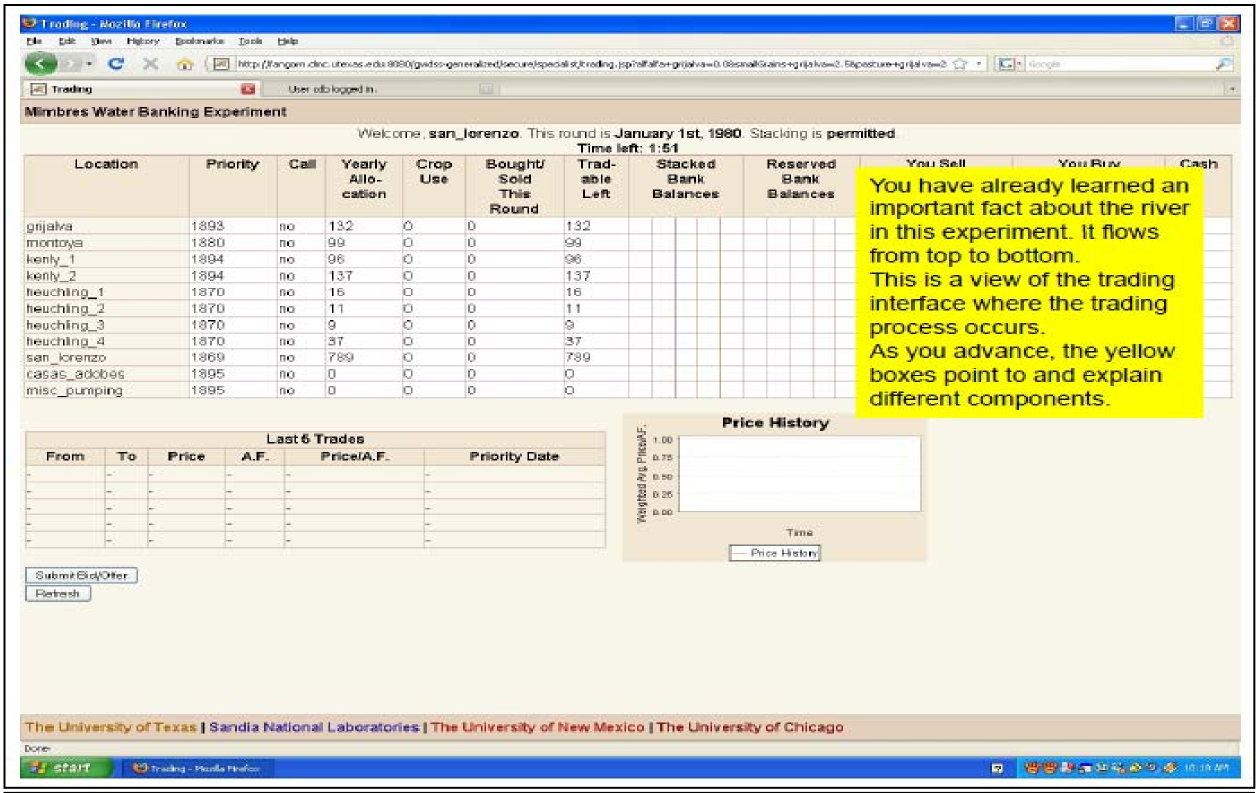
The distribution of other water users at other locations along the river are designated. The river is divided into five sections called "reaches." The river flows from the top to the bottom starting with "reach 1" and going to "reach 5."

A trade of water from the bottom to the top will result in a loss as upstream is less efficient than downstream.

Uses of water include:

Farming 

Municipal use 


Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
Time left: 1:51
You have already learned an important fact about the river in this experiment. It flows from top to bottom.
This is a view of the trading interface where the trading process occurs.
As you advance, the yellow boxes point to and explain different components.
Last 5 Trades
Price History
Submit Bid/Offer
Refresh
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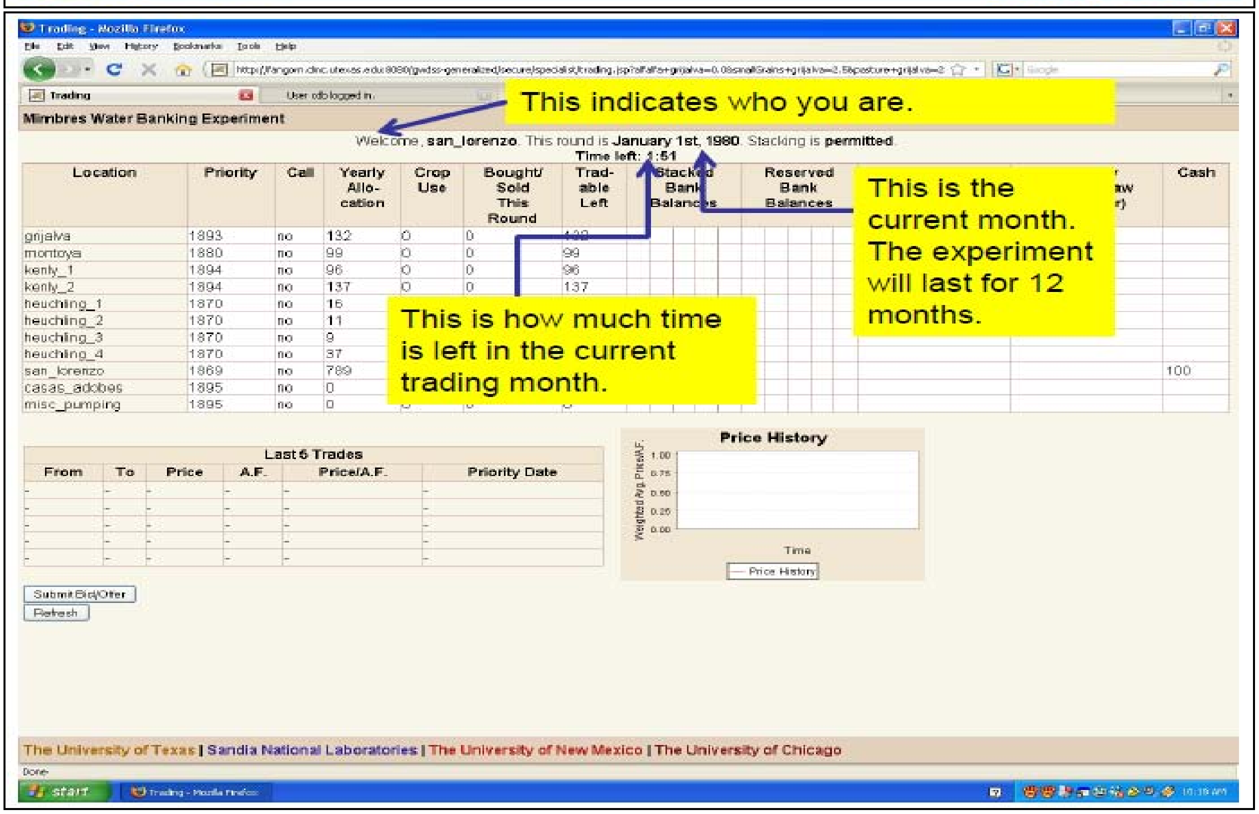
This indicates who you are.
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
Time left: 1:51
This is the current month. The experiment will last for 12 months.
This is how much time is left in the current trading month.
Last 5 Trades
Price History
Submit Bid/Offer
Refresh
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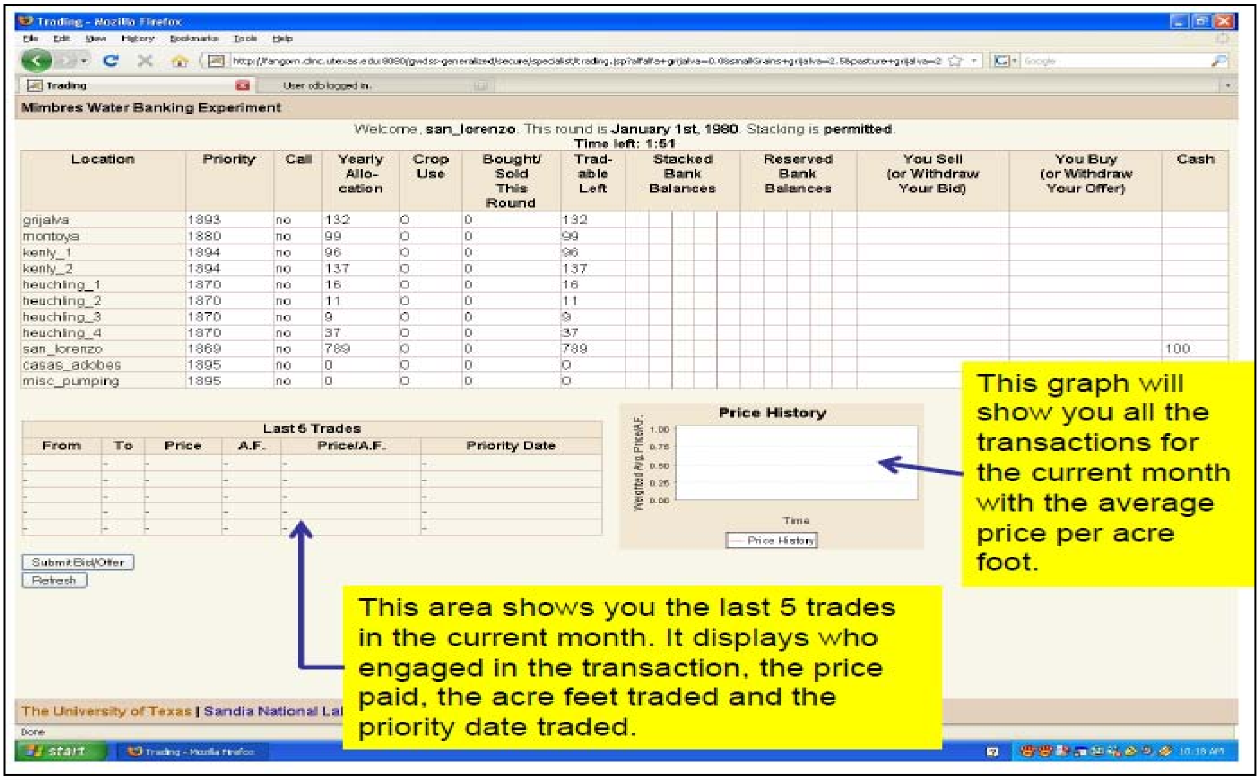
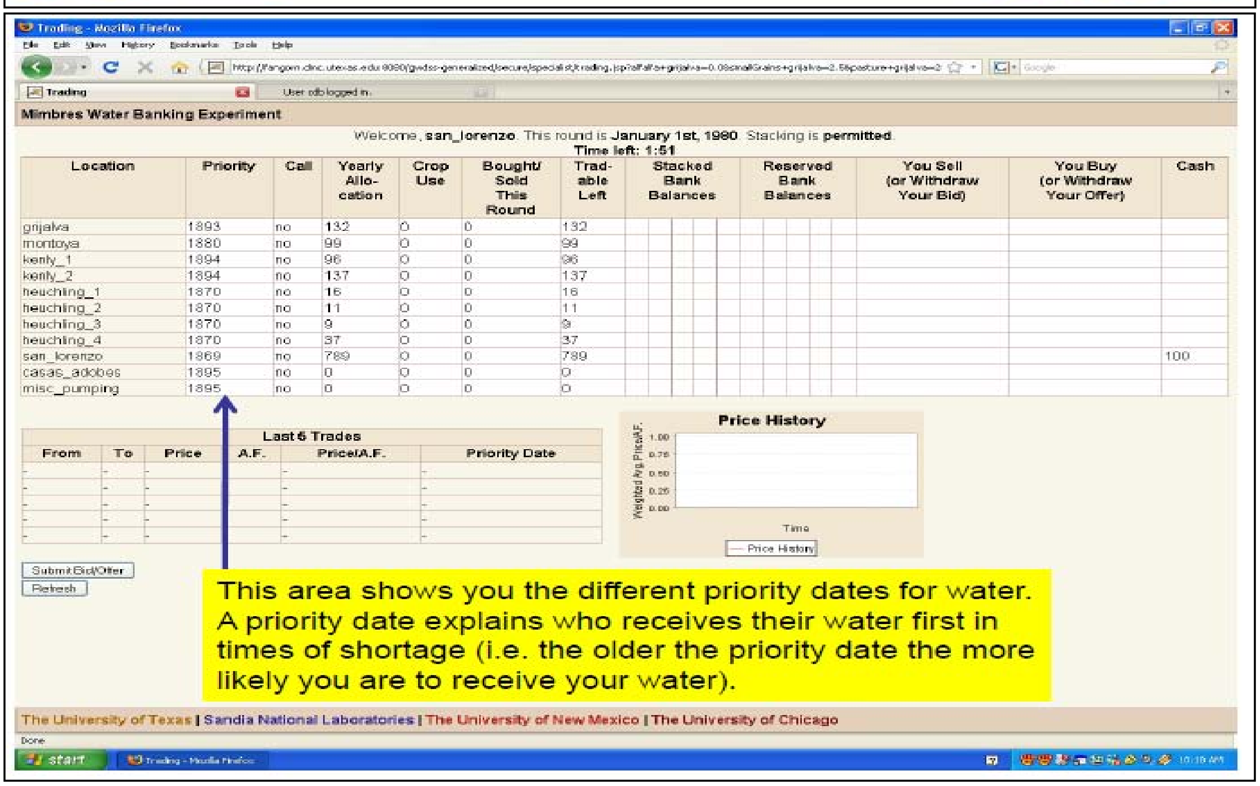

Trading - Mozilla Firefox
Trading
User odb logged in.
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
Time left: 1:51
Location
Priority
Call
Yearly Allo-cation
Crop Use
Bought/ Sold This Round
Trad-able Left
Stacked Bank Balances
Reserved Bank Balances
You Sell (or Withdraw Your Bid)
You Buy (or Withdraw Your Offer)
Cash
grijalva 1893 no 132 0 0 132
montoya 1880 no 99 0 0 99
kenly_1 1894 no 96 0 0 96
kenly_2 1894 no 137 0 0 137
heuching_1 1870 no 16 0 0 16
heuching_2 1870 no 11 0 0 11
heuching_3 1870 no 9 0 0 9
heuching_4 1870 no 37 0 0 37
san_lorenzo 1869 no 789 0 0 789 100
casas_adobes 1895 no 0 0 0 0
misc_pumping 1895 no 0 0 0 0
Last 5 Trades
From
To
Price
A.F.
Price/A.F.
Priority Date
Price History
Weighted Avg. Price/AF
Time
Price History
Submit Bid/Offer
Refresh
This graph will show you all the transactions for the current month with the average price per acre foot.
This area shows you the last 5 trades in the current month. It displays who engaged in the transaction, the price paid, the acre feet traded and the priority date traded.
The University of Texas | Sandia National Lal
Done
start
Trading - Mozilla Firefox


Trading - Mozilla Firefox
Trading
User odb logged in.
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
Time left: 1:51
Location
Priority
Call
Yearly Allo-cation
Crop Use
Bought/ Sold This Round
Trad-able Left
Stacked Bank Balances
Reserved Bank Balances
You Sell (or Withdraw Your Bid)
You Buy (or Withdraw Your Offer)
Cash
grijalva 1893 no 132 0 0 132
montoya 1880 no 99 0 0 99
kenly_1 1894 no 96 0 0 96
kenly_2 1894 no 137 0 0 137
heuching_1 1870 no 16 0 0 16
heuching_2 1870 no 11 0 0 11
heuching_3 1870 no 9 0 0 9
heuching_4 1870 no 37 0 0 37
san_lorenzo 1869 no 789 0 0 789 100
casas_adobes 1895 no 0 0 0 0
misc_pumping 1895 no 0 0 0 0
Last 5 Trades
From
To
Price
A.F.
Price/A.F.
Priority Date
Price History
Weighted Avg. Price/AF
Time
Price History
Submit Bid/Offer
Refresh
This area shows you the different priority dates for water. A priority date explains who receives their water first in times of shortage (i.e. the older the priority date the more likely you are to receive your water).
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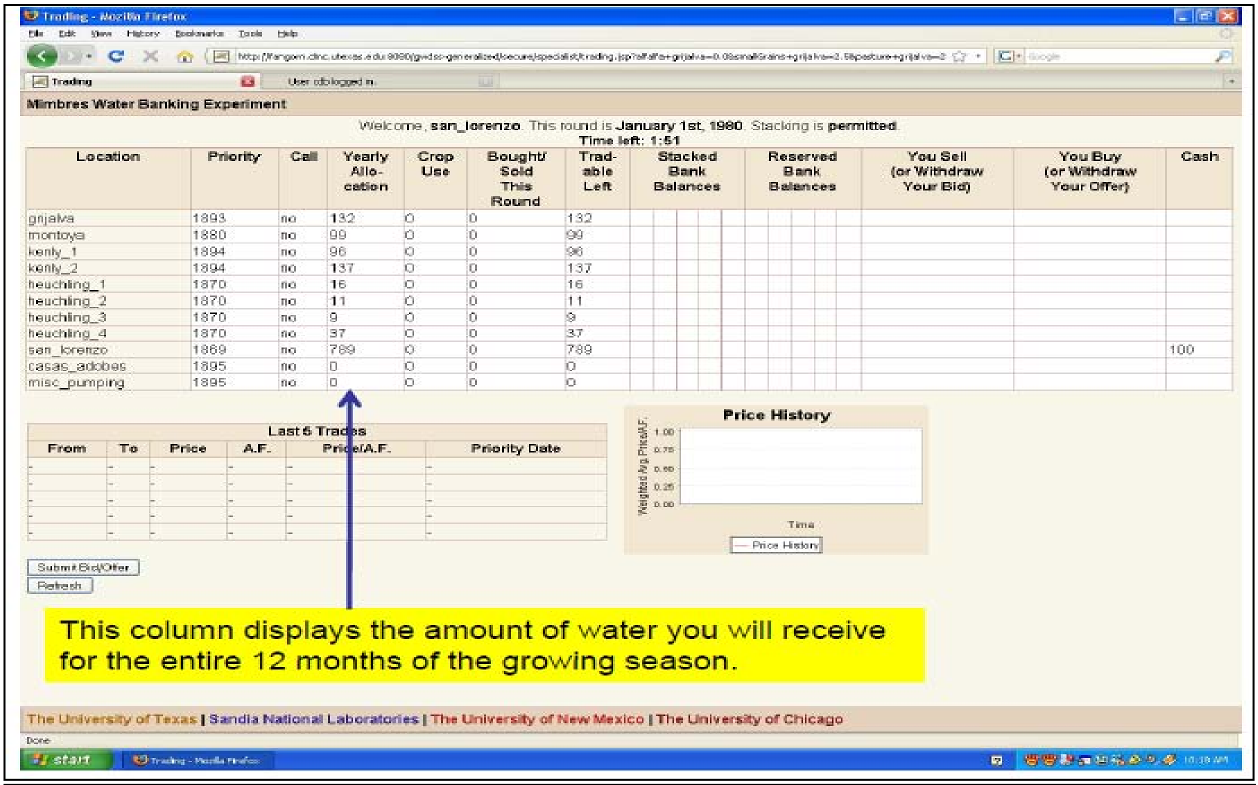
Done
start
Trading - Mozilla Firefox


Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
Time left: 1:51
Location
Priority
Call
Yearly Allo-cation
Crop Use
Bought/ Sold This Round
Trad-able Left
Stacked Bank Balances
Reserved Bank Balances
You Sell (or Withdraw Your Bid)
You Buy (or Withdraw Your Offer)
Cash
Last 6 Trades
Price History
Submit Bid/Offer
Refresh
This column displays the amount of water you will receive for the entire 12 months of the growing season.
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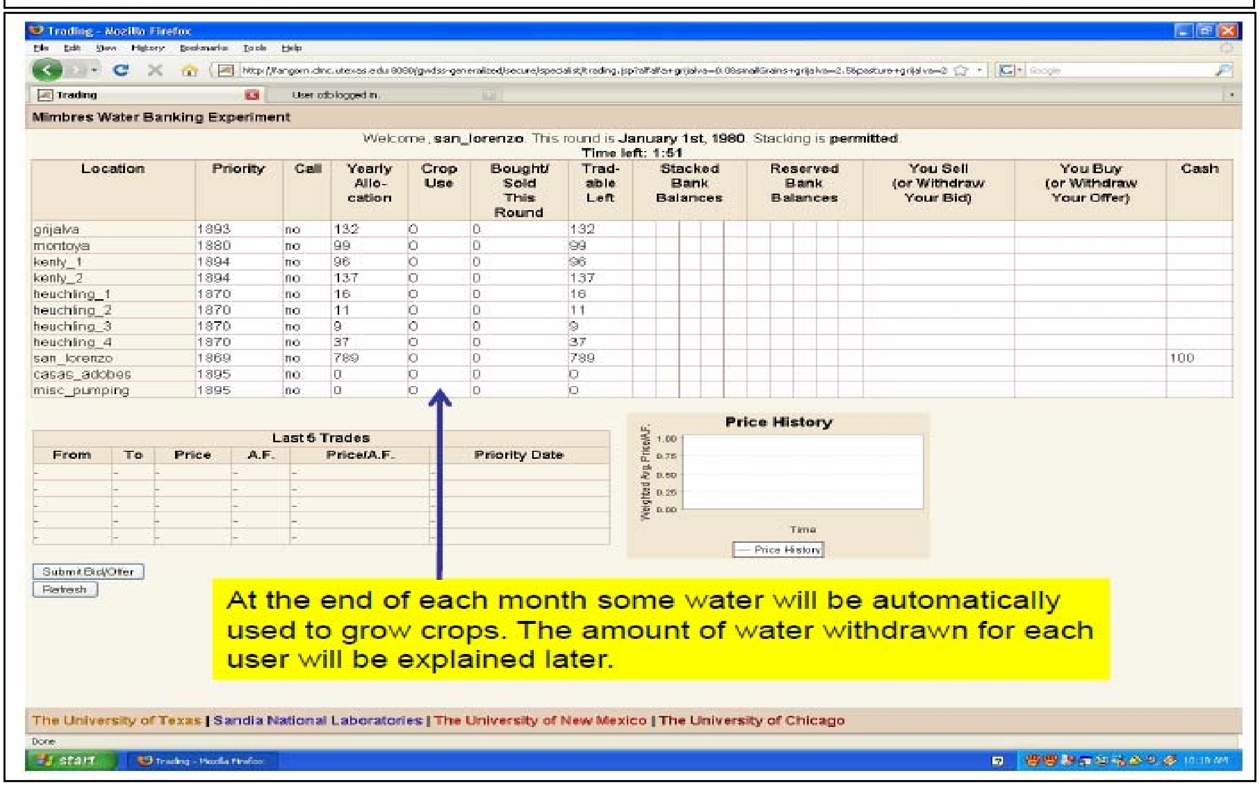
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
Time left: 1:51
Last 6 Trades
Price History
Submit Bid/Offer
Refresh
At the end of each month some water will be automatically used to grow crops. The amount of water withdrawn for each user will be explained later.
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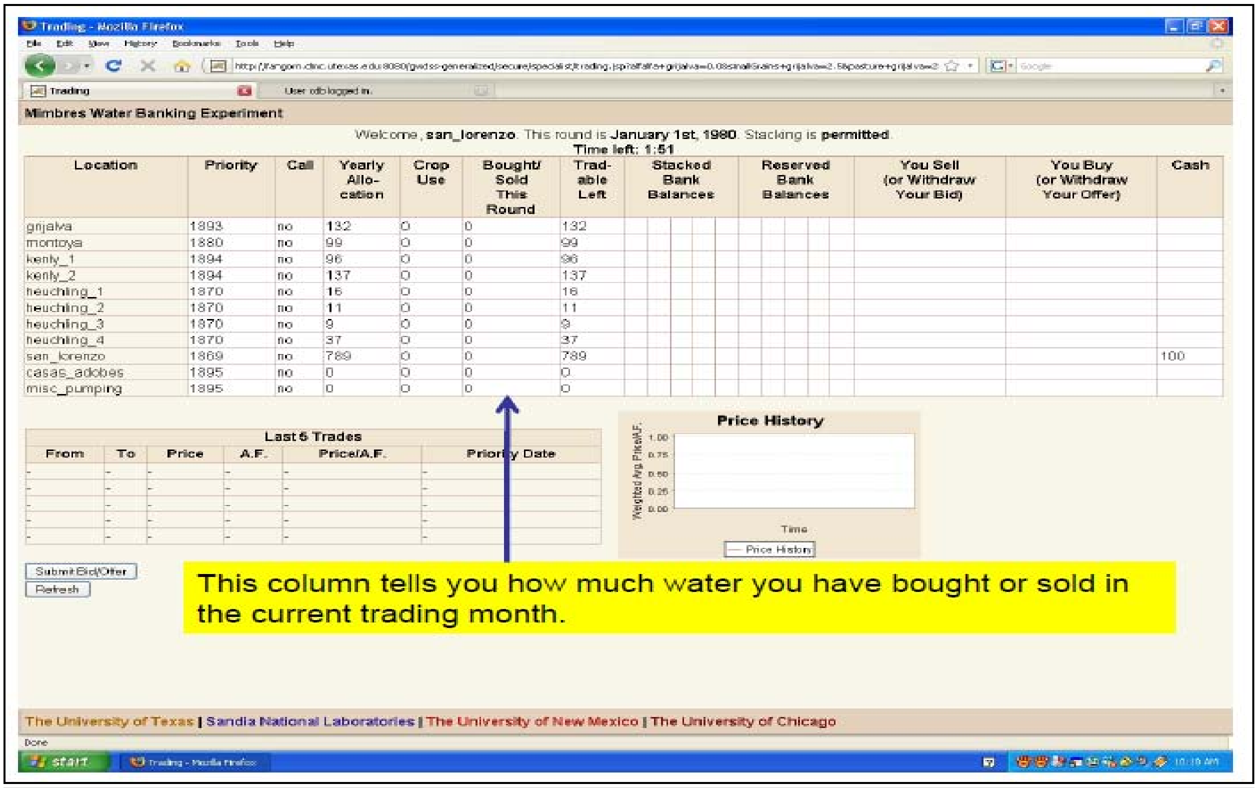
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
Time left: 1:51
Price History
Last 5 Trades
This column tells you how much water you have bought or sold in the current trading month.
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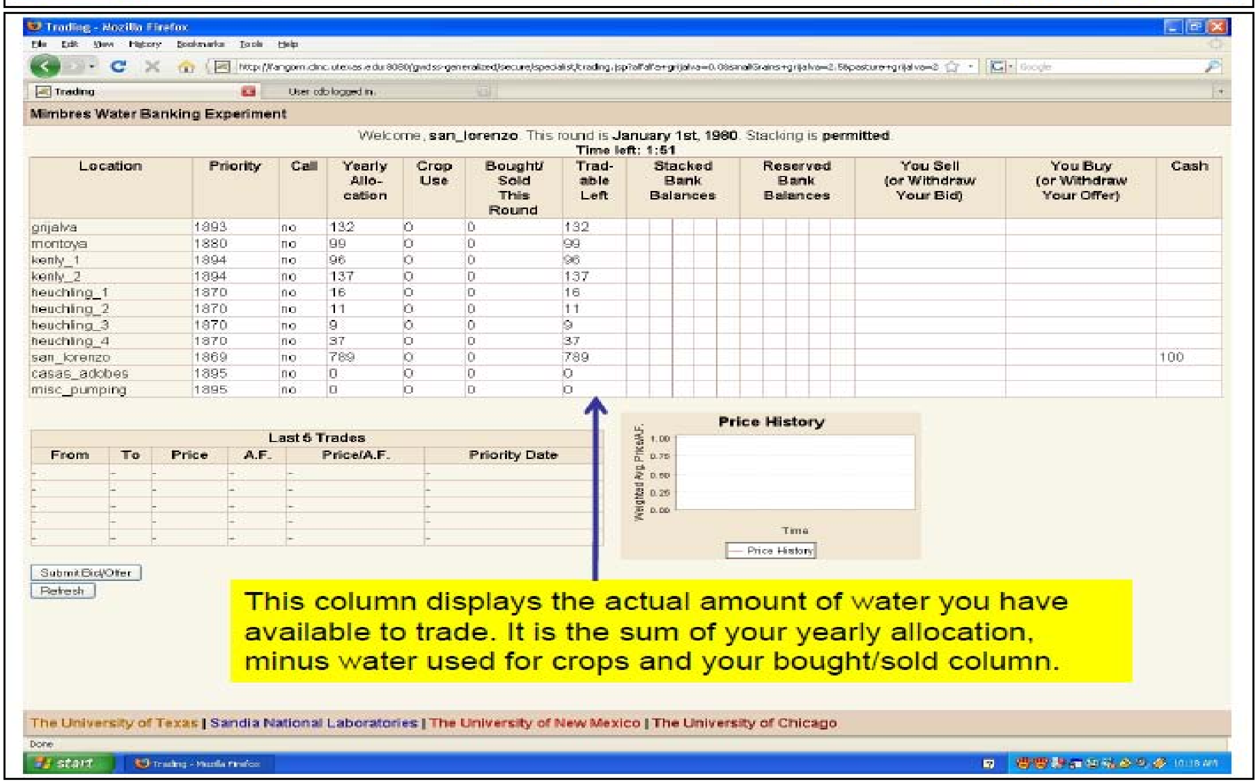
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
Time left: 1:51
Price History
Last 5 Trades
This column displays the actual amount of water you have available to trade. It is the sum of your yearly allocation, minus water used for crops and your bought/sold column.
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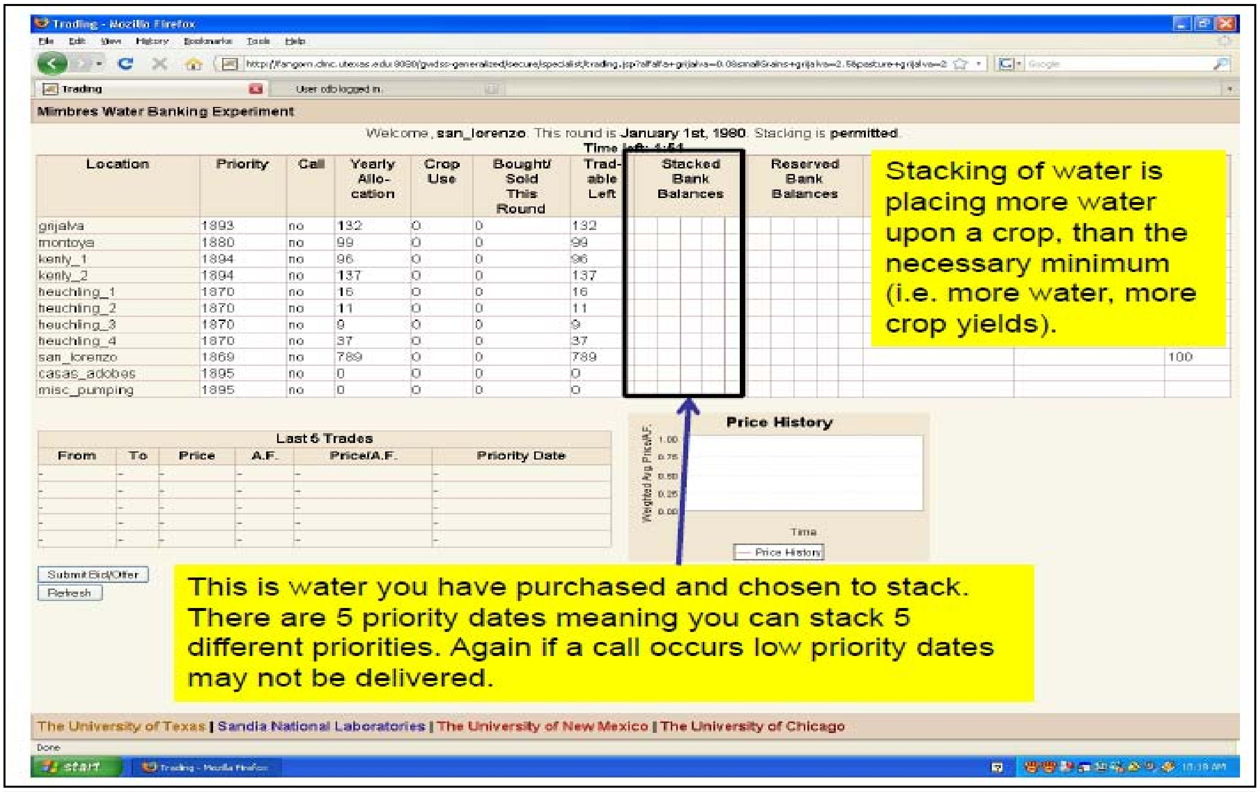
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
Stacked Bank Balances
Reserved Bank Balances
Stacking of water is placing more water upon a crop, than the necessary minimum (i.e. more water, more crop yields).
Last 5 Trades
Price History
This is water you have purchased and chosen to stack. There are 5 priority dates meaning you can stack 5 different priorities. Again if a call occurs low priority dates may not be delivered.
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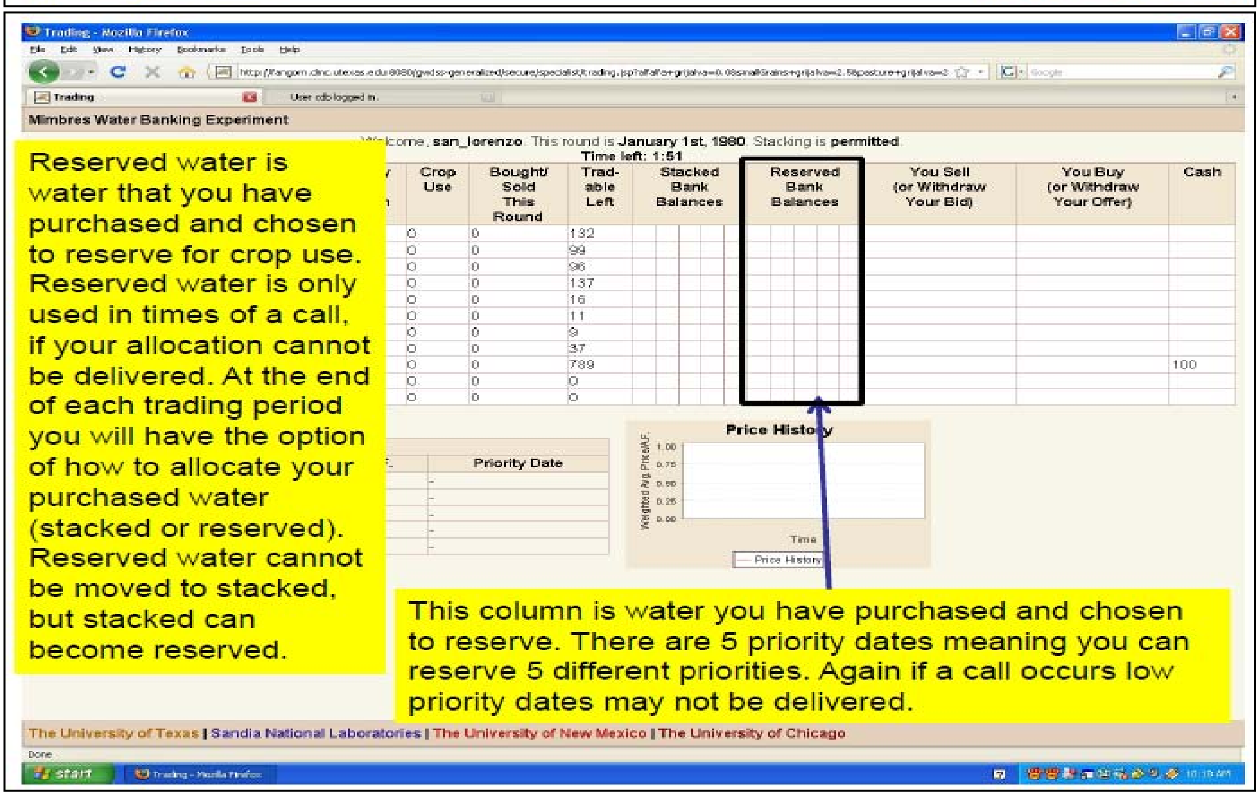
Mimbres Water Banking Experiment
Reserved water is water that you have purchased and chosen to reserve for crop use. Reserved water is only used in times of a call, if your allocation cannot be delivered. At the end of each trading period you will have the option of how to allocate your purchased water (stacked or reserved). Reserved water cannot be moved to stacked, but stacked can become reserved.
Stacked Bank Balances
Reserved Bank Balances
You Sell (or Withdraw Your Bid)
You Buy (or Withdraw Your Offer)
Cash
Price History
This column is water you have purchased and chosen to reserve. There are 5 priority dates meaning you can reserve 5 different priorities. Again if a call occurs low priority dates may not be delivered.
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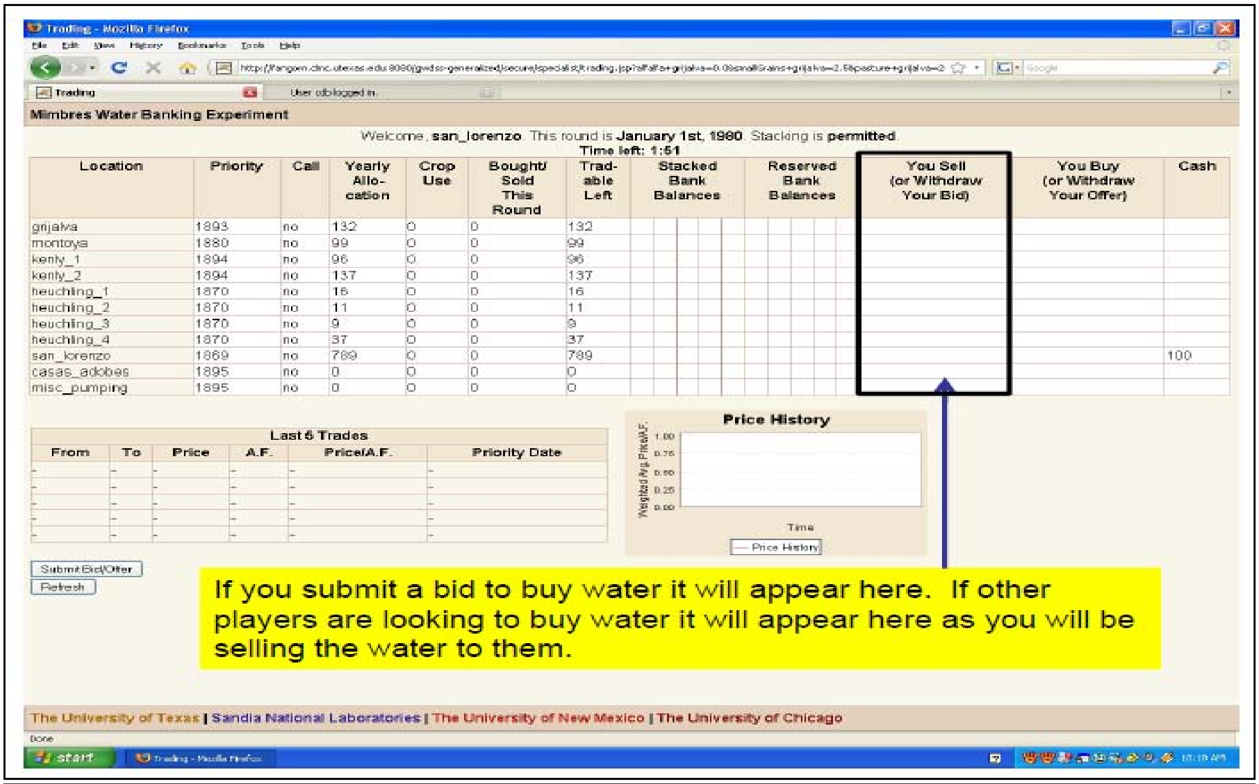
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
Time left: 1:51
You Sell (or Withdraw Your Bid)
You Buy (or Withdraw Your Offer)
Last 5 Trades
Price History
If you submit a bid to buy water it will appear here. If other players are looking to buy water it will appear here as you will be selling the water to them.
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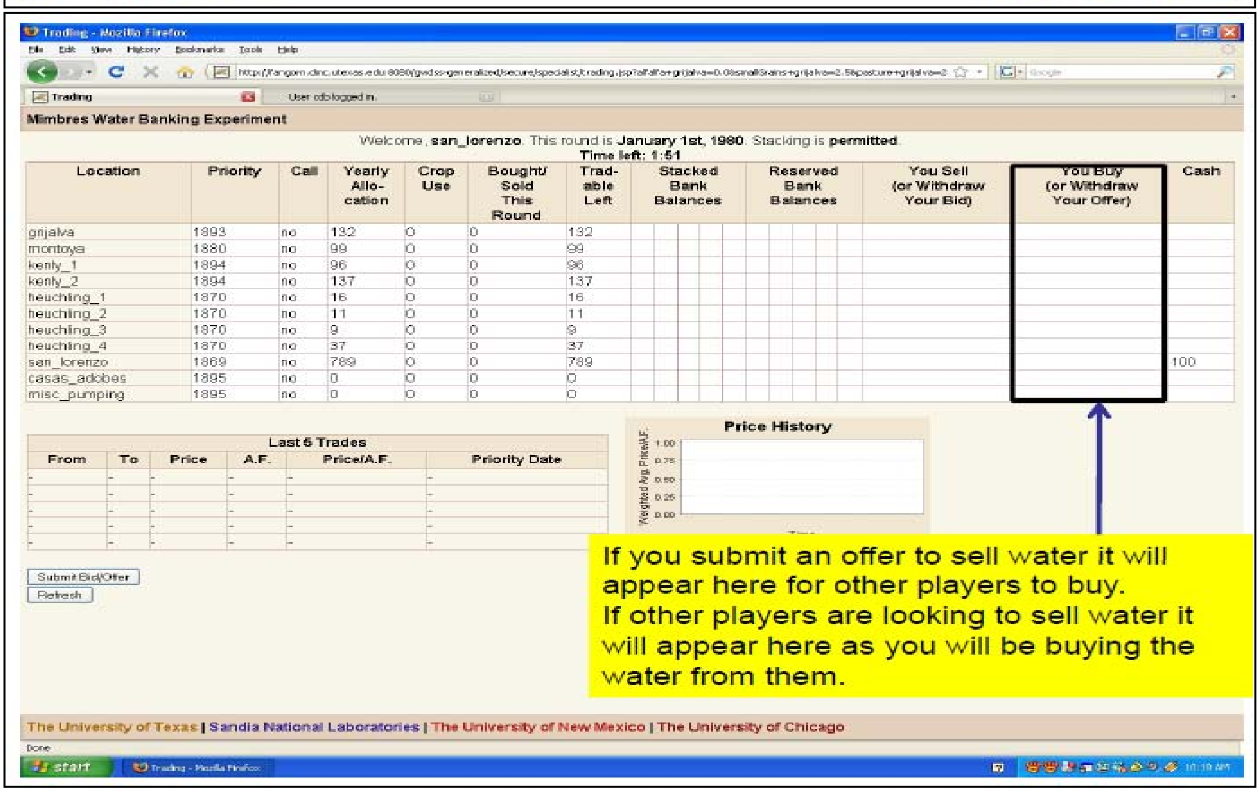
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
Time left: 1:51
You Sell (or Withdraw Your Bid)
You Buy (or Withdraw Your Offer)
Last 5 Trades
Price History
If you submit an offer to sell water it will appear here for other players to buy.
If other players are looking to sell water it will appear here as you will be buying the water from them.
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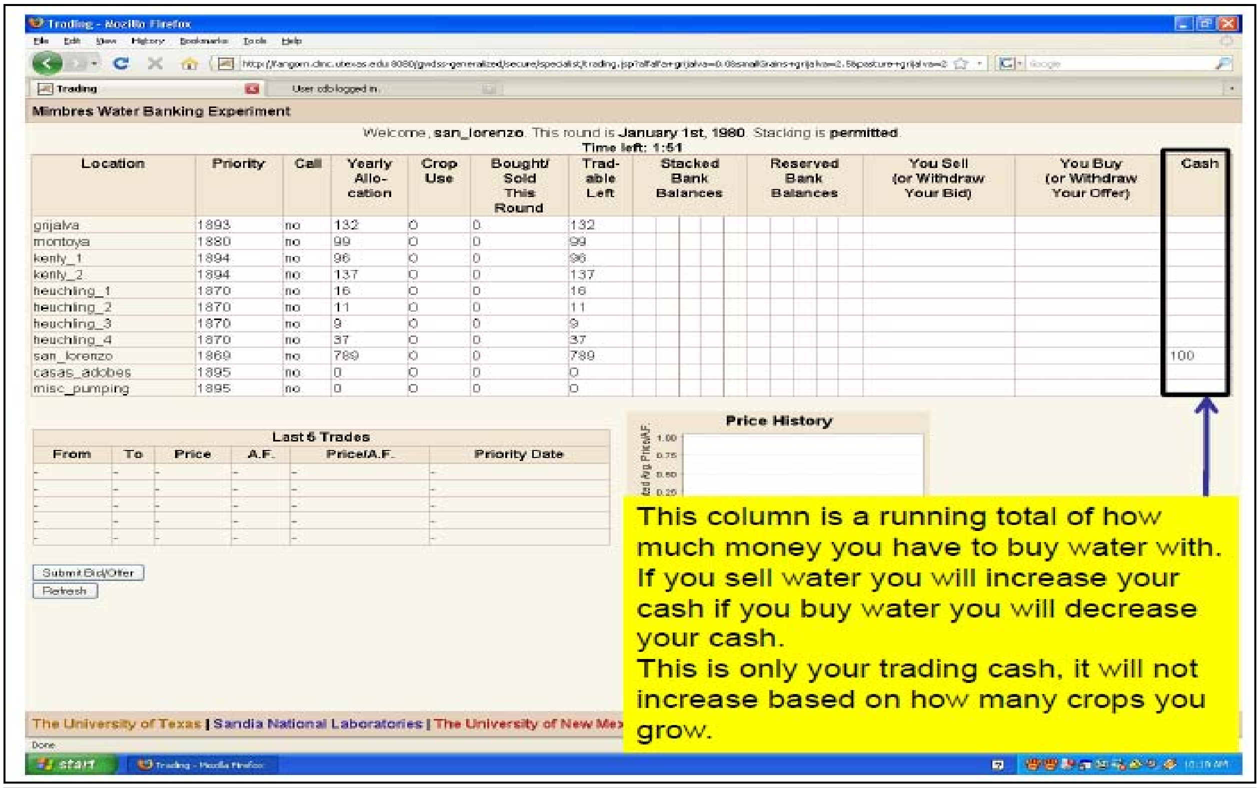
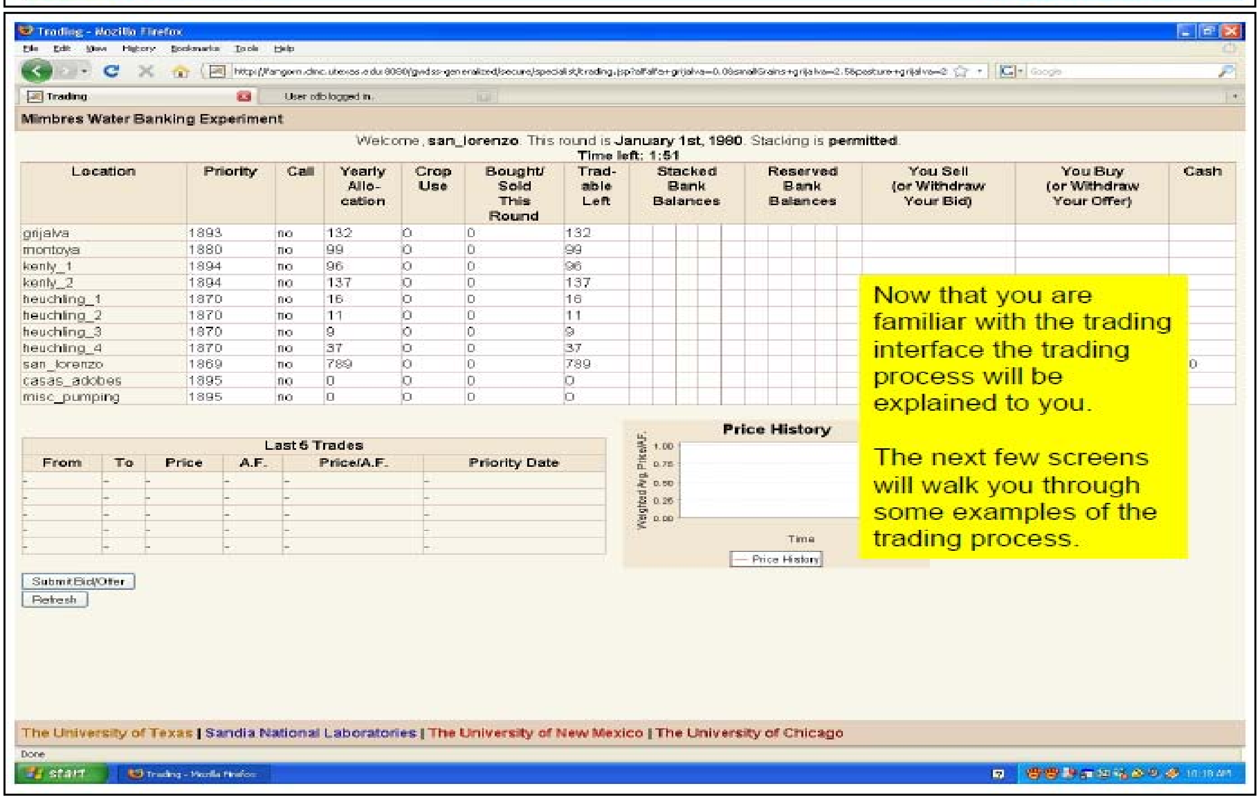
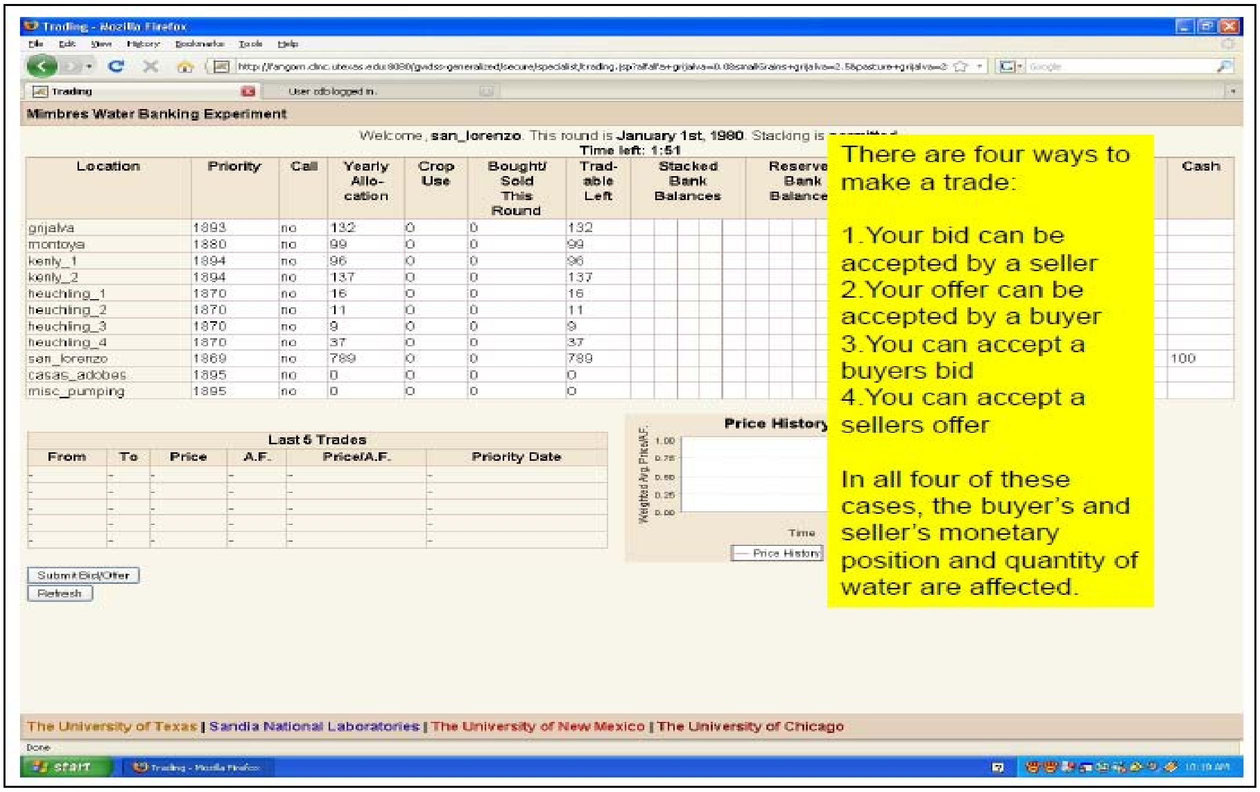

Mimbres Water Banking Experiment
This column is a running total of how much money you have to buy water with. If you sell water you will increase your cash if you buy water you will decrease your cash.
This is only your trading cash, it will not increase based on how many crops you grow.


Mimbres Water Banking Experiment
Now that you are familiar with the trading interface the trading process will be explained to you.
The next few screens will walk you through some examples of the trading process.


Trading - Mozilla Firefox
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980.
Time left: 1:51
There are four ways to make a trade:
1. Your bid can be accepted by a seller
2. Your offer can be accepted by a buyer
3. You can accept a buyers bid
4. You can accept a sellers offer
In all four of these cases, the buyer's and seller's monetary position and quantity of water are affected.
Last 5 Trades
Price History
Submit Bid/Offer
Refresh
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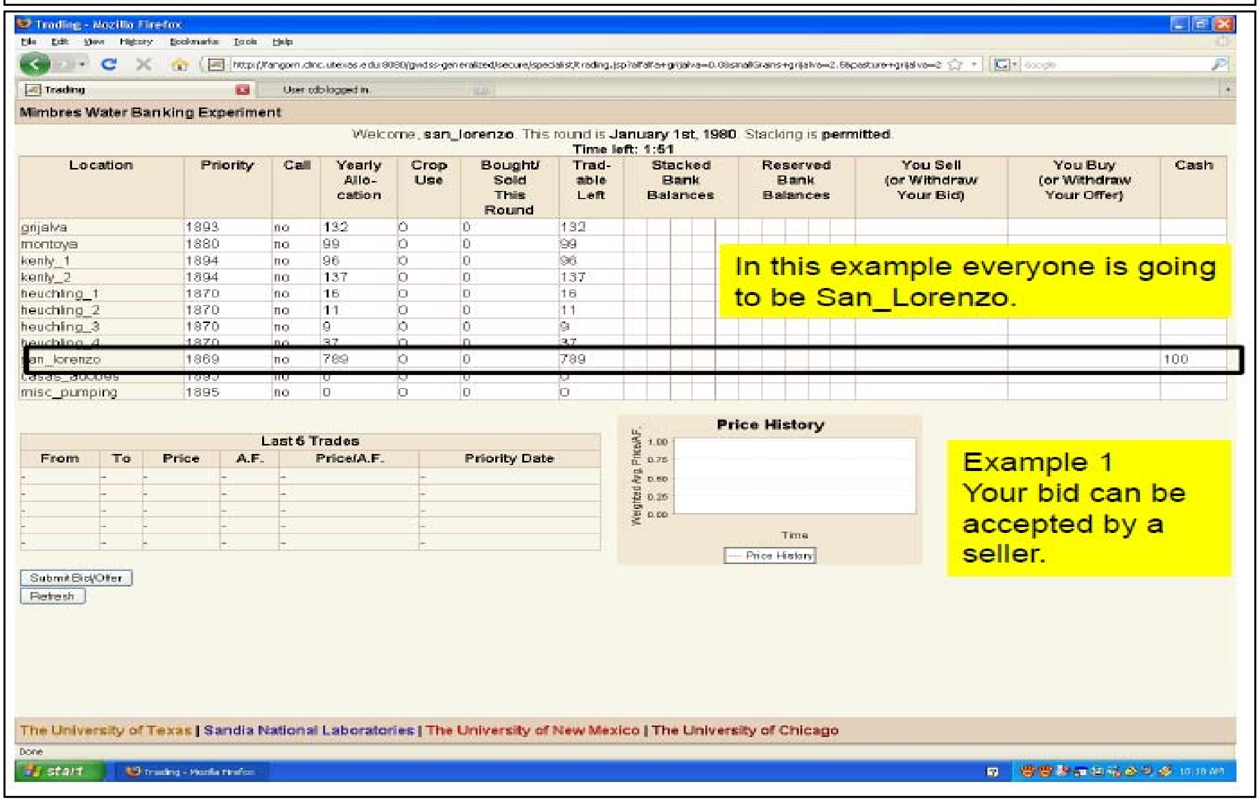
Trading - Mozilla Firefox
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
Time left: 1:51
In this example everyone is going to be San_Lorenzo.
Last 5 Trades
Price History
Example 1
Your bid can be accepted by a seller.
Submit Bid/Offer
Refresh
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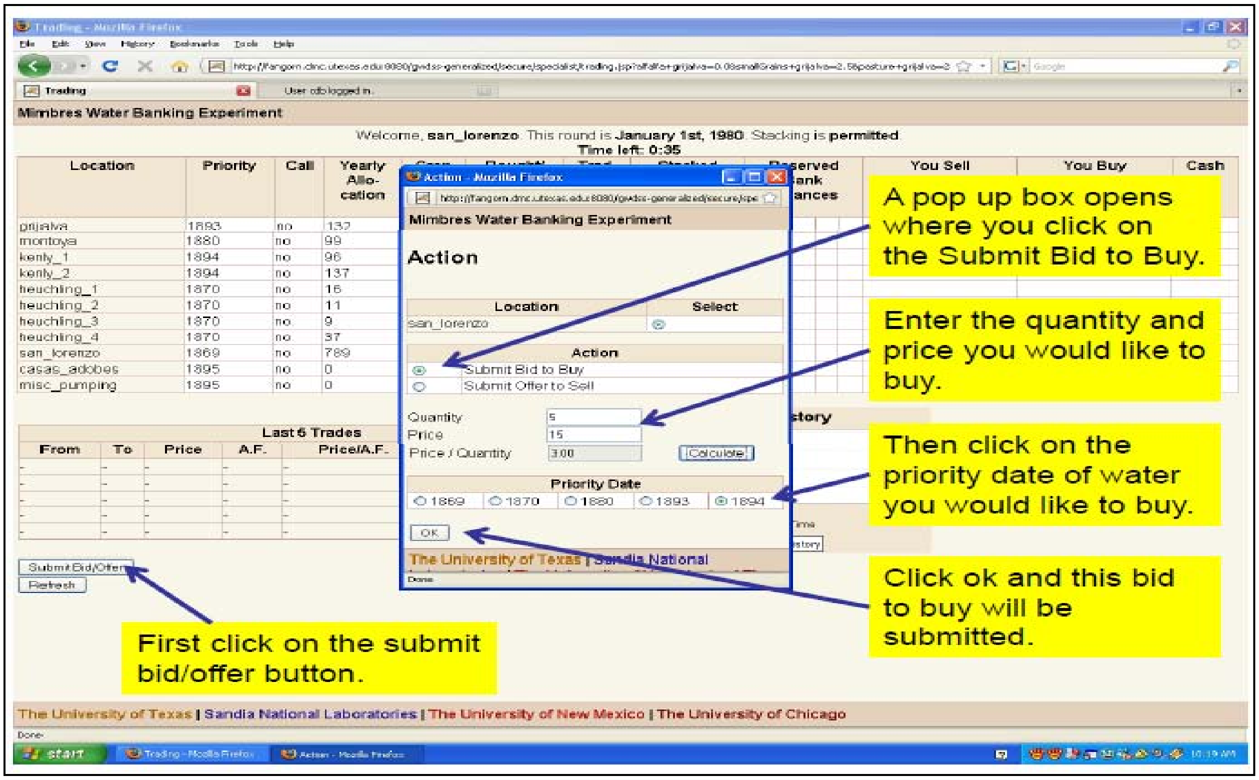
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
A pop up box opens where you click on the Submit Bid to Buy.
Enter the quantity and price you would like to buy.
Then click on the priority date of water you would like to buy.
Click ok and this bid to buy will be submitted.
First click on the submit bid/offer button.
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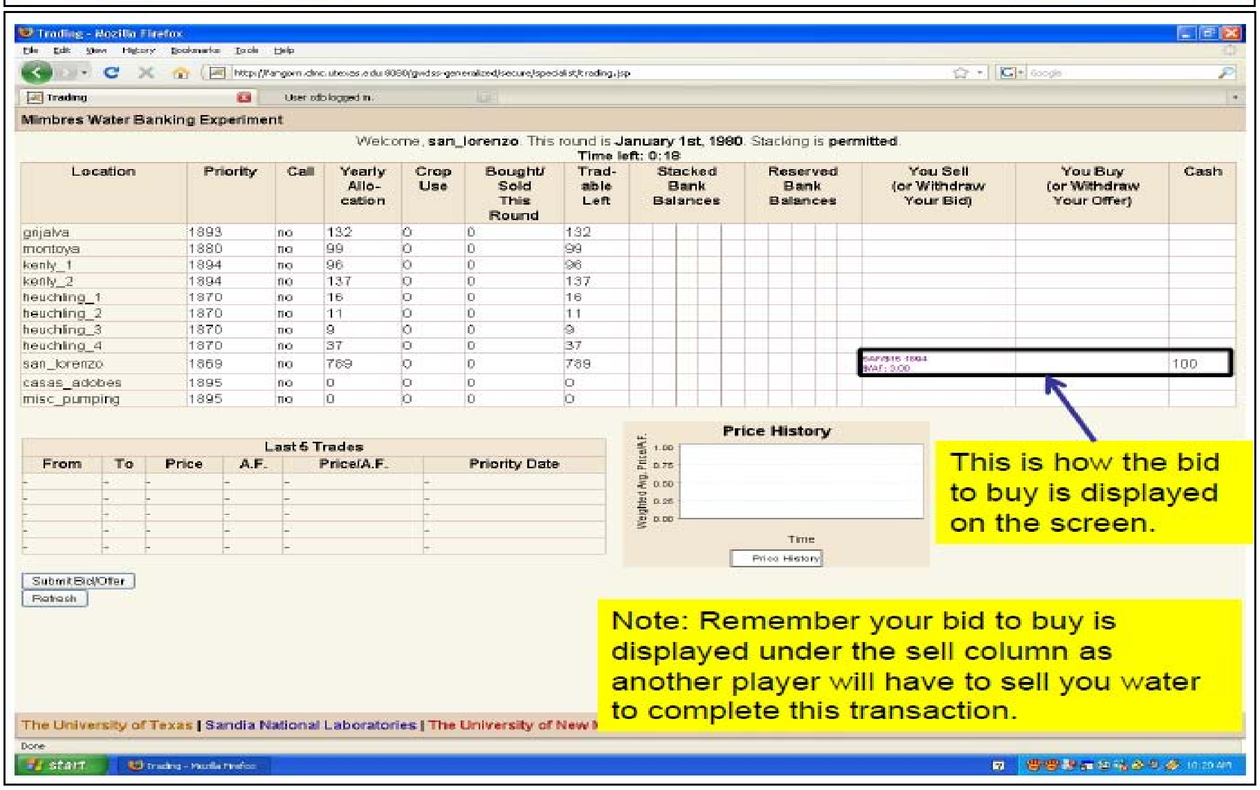
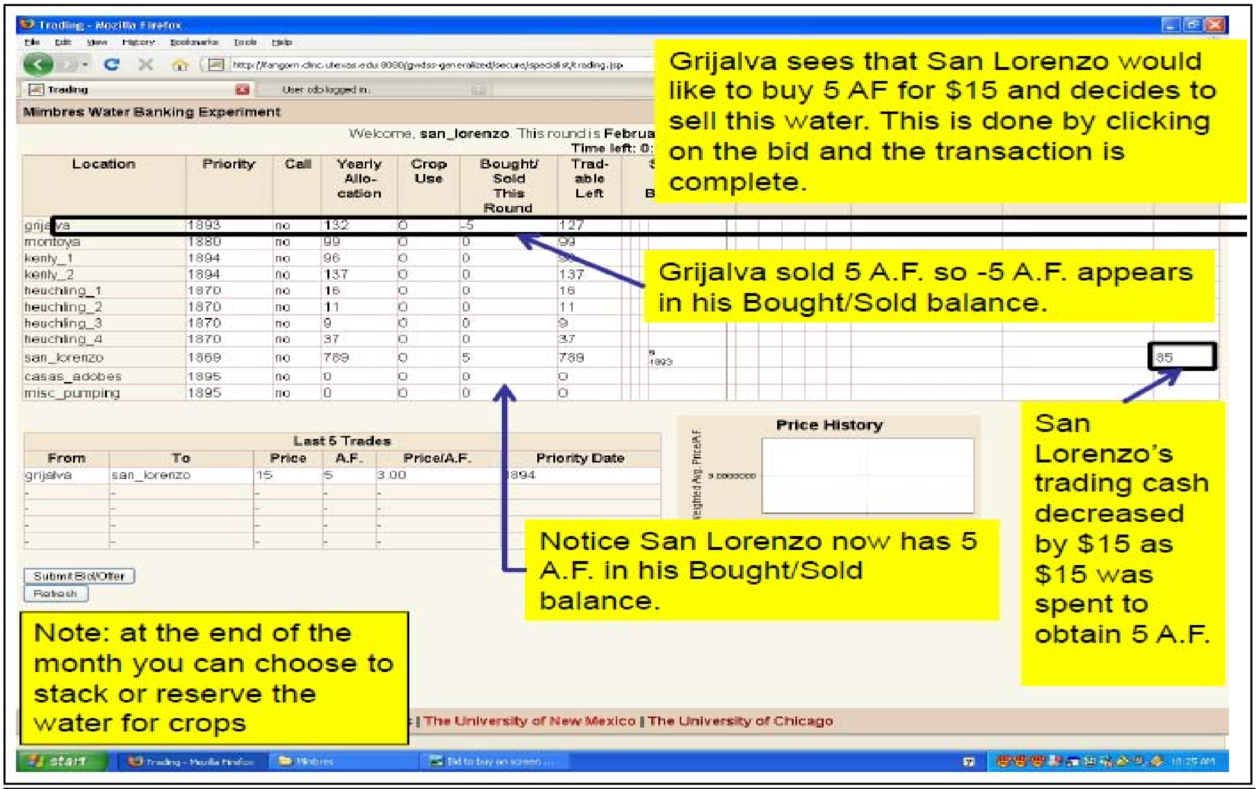
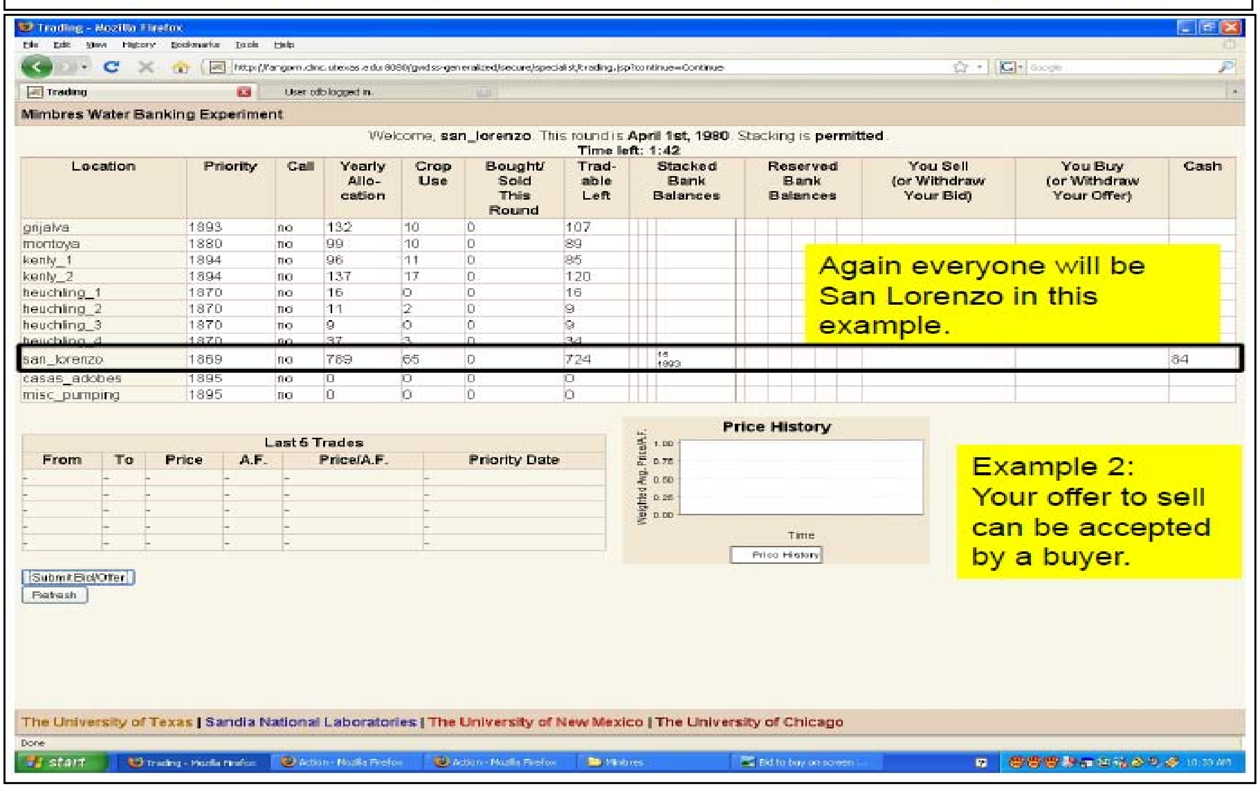

Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
This is how the bid to buy is displayed on the screen.
Note: Remember your bid to buy is displayed under the sell column as another player will have to sell you water to complete this transaction.


Grijalva sees that San Lorenzo would like to buy 5 AF for $15 and decides to sell this water. This is done by clicking on the bid and the transaction is complete.
Grijalva sold 5 A.F. so -5 A.F. appears in his Bought/Sold balance.
San Lorenzo's trading cash decreased by $15 as $15 was spent to obtain 5 A.F.
Notice San Lorenzo now has 5 A.F. in his Bought/Sold balance.
Note: at the end of the month you can choose to stack or reserve the water for crops


Mimbres Water Banking Experiment
Again everyone will be San Lorenzo in this example.
Example 2: Your offer to sell can be accepted by a buyer.
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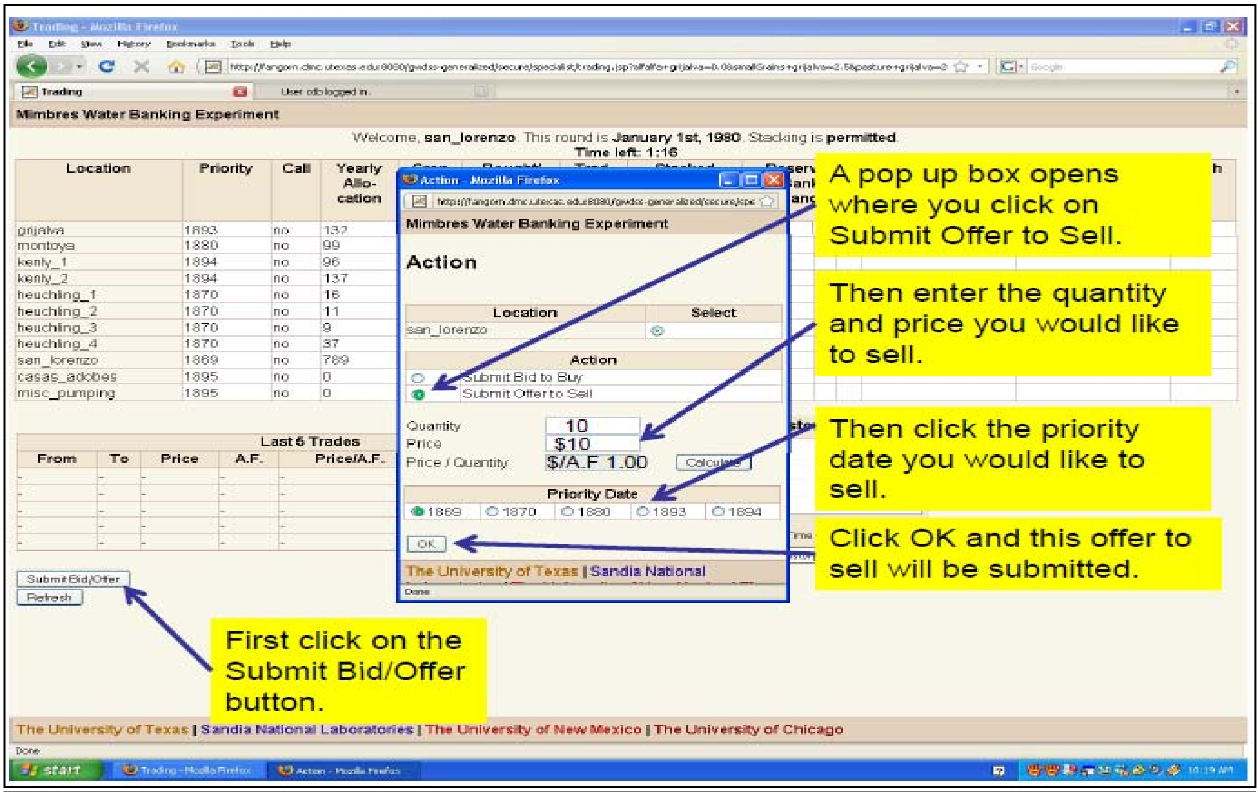
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
A pop up box opens where you click on Submit Offer to Sell.
Then enter the quantity and price you would like to sell.
Then click the priority date you would like to sell.
Click OK and this offer to sell will be submitted.
First click on the Submit Bid/Offer button.
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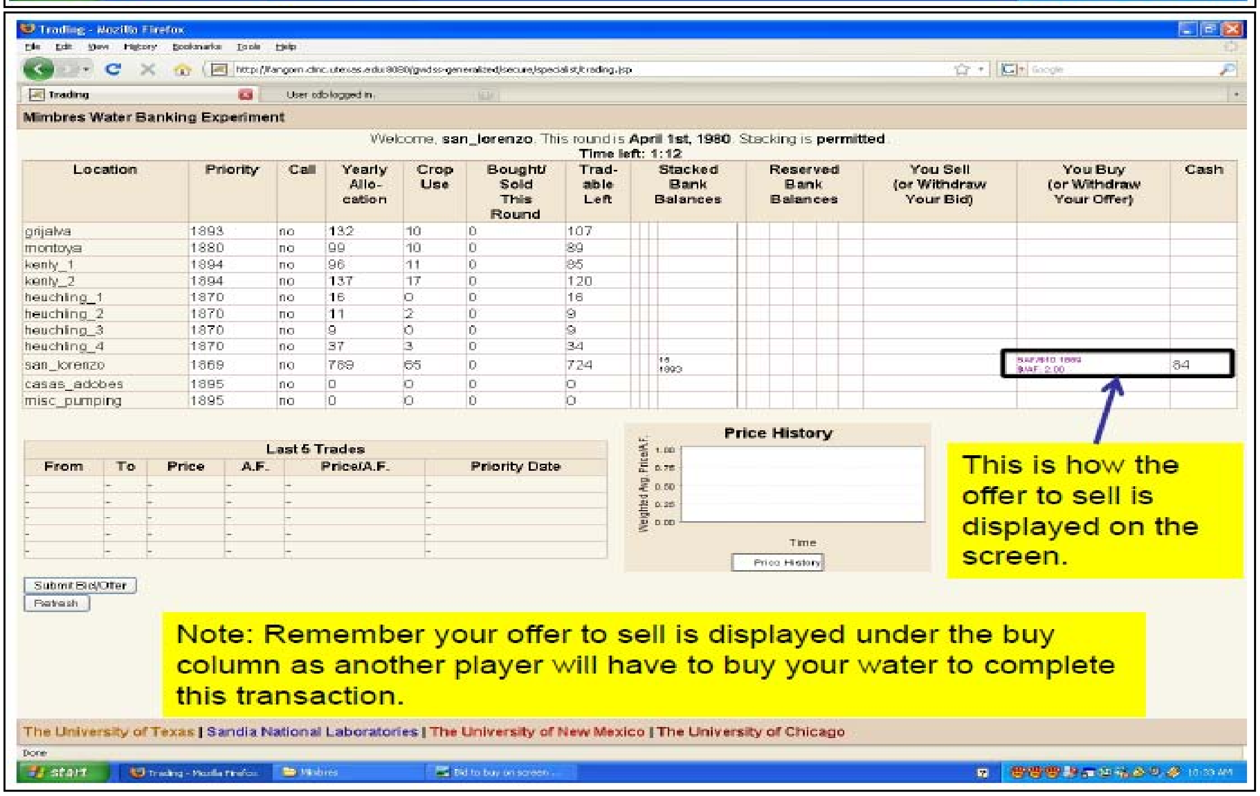
Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is April 1st, 1980. Stacking is permitted.
This is how the offer to sell is displayed on the screen.
Note: Remember your offer to sell is displayed under the buy column as another player will have to buy your water to complete this transaction.
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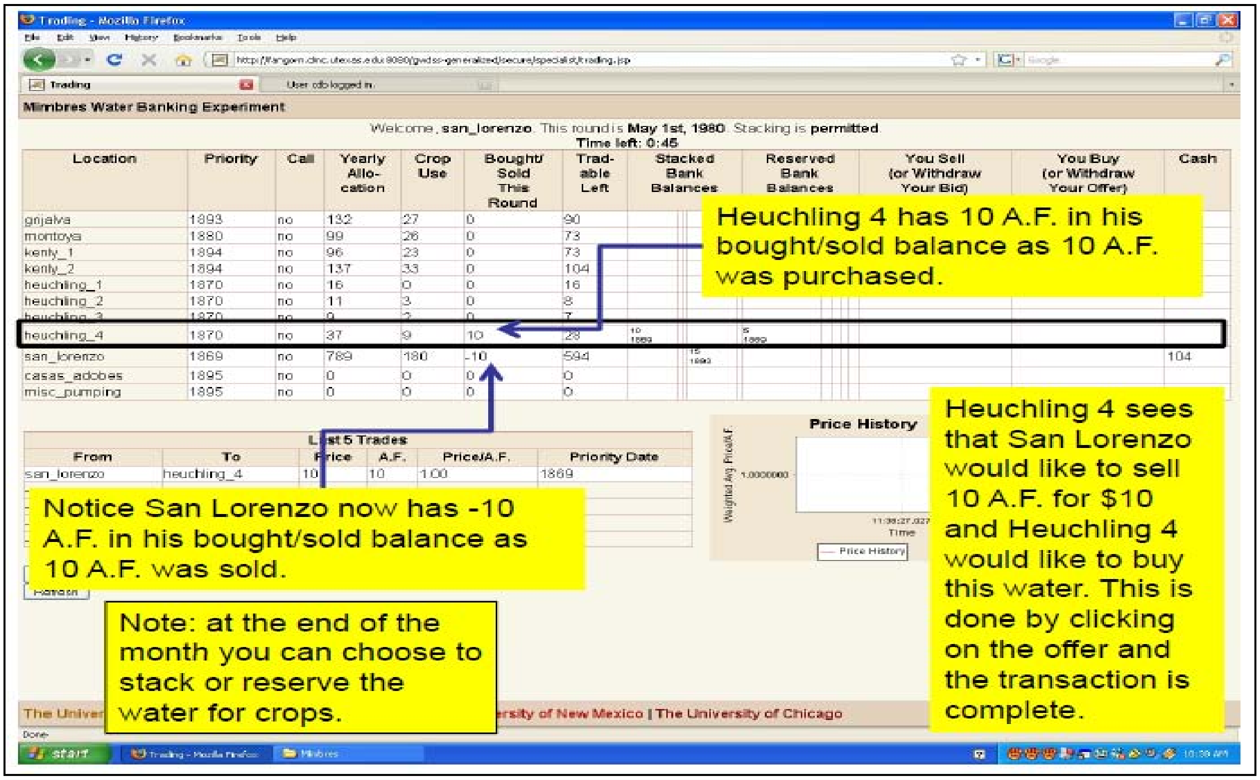
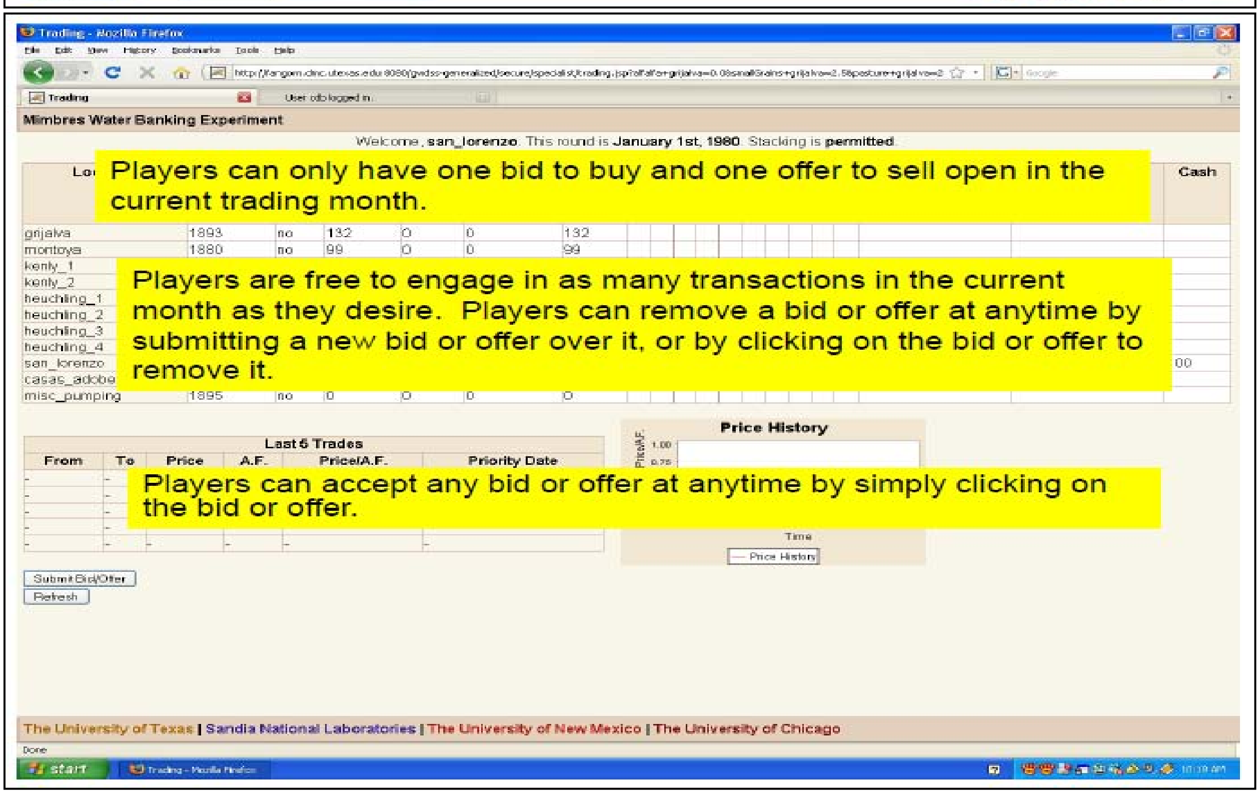

Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is May 1st, 1980. Stacking is permitted.
Heuchling 4 has 10 A.F. in his bought/sold balance as 10 A.F. was purchased.
Heuchling 4 sees that San Lorenzo would like to sell 10 A.F. for $10 and Heuchling 4 would like to buy this water. This is done by clicking on the offer and the transaction is complete.
Notice San Lorenzo now has -10 A.F. in his bought/sold balance as 10 A.F. was sold.
Note: at the end of the month you can choose to stack or reserve the water for crops.
Price History


Mimbres Water Banking Experiment
Welcome, san_lorenzo. This round is January 1st, 1980. Stacking is permitted.
Players can only have one bid to buy and one offer to sell open in the current trading month.
Players are free to engage in as many transactions in the current month as they desire. Players can remove a bid or offer at anytime by submitting a new bid or offer over it, or by clicking on the bid or offer to remove it.
Players can accept any bid or offer at anytime by simply clicking on the bid or offer.
Price History
Last 5 Trades
Submit Bid/Offer
Refresh
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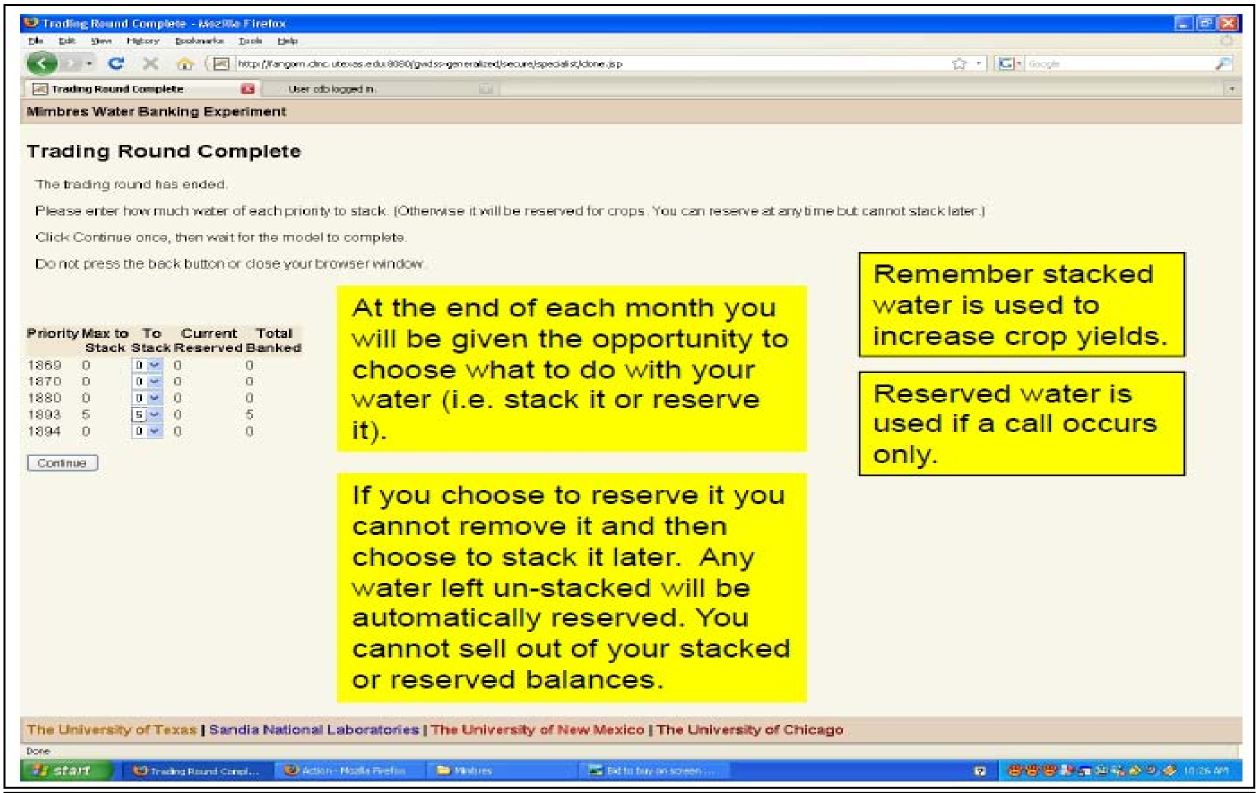
Trading Round Complete - Mozilla Firefox
Mimbres Water Banking Experiment
Trading Round Complete
The trading round has ended.
Please enter how much water of each priority to stack. (Otherwise it will be reserved for crops. You can reserve at any time but cannot stack later.)
Click Continue once, then wait for the model to complete.
Do not press the back button or close your browser window.
Priority Max to Stack To Stack Current Reserved Total Banked
1869 0 0 0 0
1870 0 0 0 0
1880 0 0 0 0
1893 5 5 0 5
1894 0 0 0 0
Continue
At the end of each month you will be given the opportunity to choose what to do with your water (i.e. stack it or reserve it).
If you choose to reserve it you cannot remove it and then choose to stack it later. Any water left un-stacked will be automatically reserved. You cannot sell out of your stacked or reserved balances.
Remember stacked water is used to increase crop yields.
Reserved water is used if a call occurs only.
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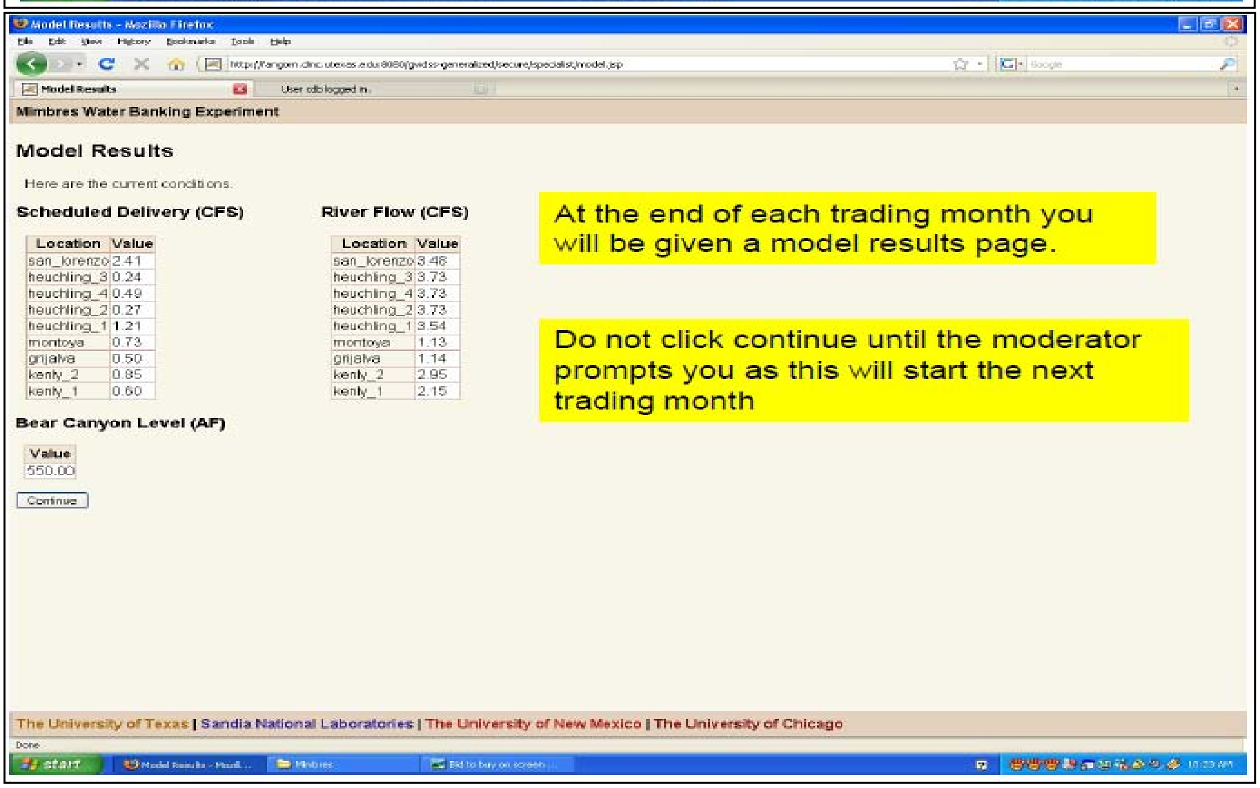
Model Results - Mozilla Firefox
Mimbres Water Banking Experiment
Model Results
Here are the current conditions.
Scheduled Delivery (CFS)
Location Value
san_lorenzo 2.41
heuchling_3 0.24
heuchling_4 0.49
heuchling_2 0.27
heuchling_1 1.21
montoya 0.73
grijalva 0.50
kenly_2 0.85
kenly_1 0.60
River Flow (CFS)
Location Value
san_lorenzo 3.48
heuchling_3 3.73
heuchling_4 3.73
heuchling_2 3.73
heuchling_1 3.54
montoya 1.13
grijalva 1.14
kenly_2 2.95
kenly_1 2.15
Bear Canyon Level (AF)
Value
550.00
Continue
At the end of each trading month you will be given a model results page.
Do not click continue until the moderator prompts you as this will start the next trading month
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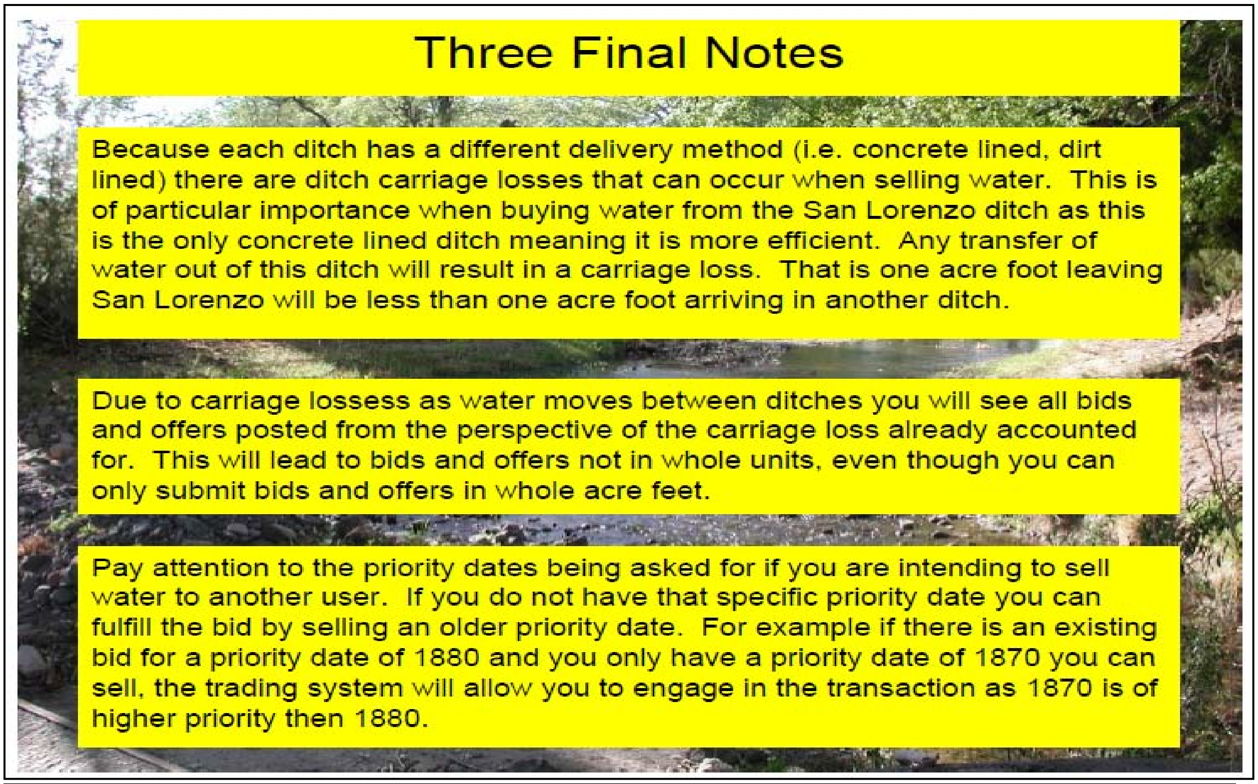
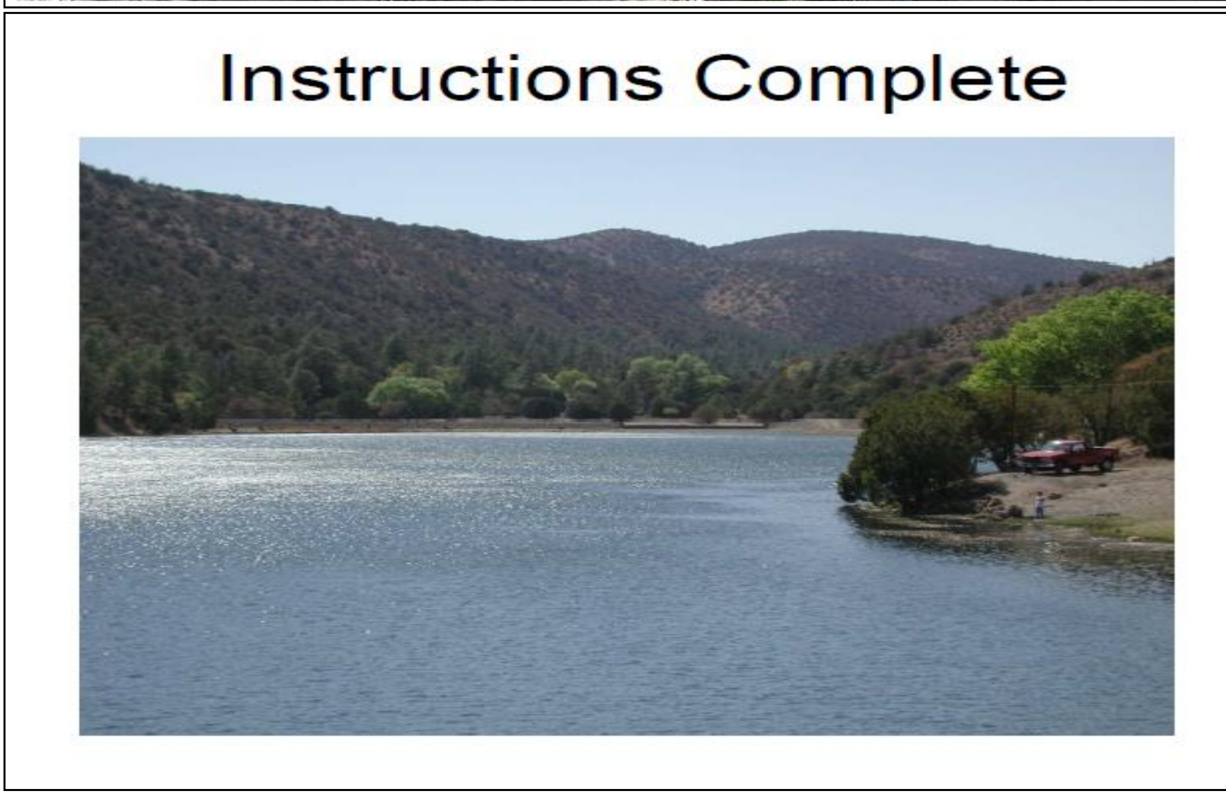

Three Final Notes
Because each ditch has a different delivery method (i.e. concrete lined, dirt lined) there are ditch carriage losses that can occur when selling water. This is of particular importance when buying water from the San Lorenzo ditch as this is the only concrete lined ditch meaning it is more efficient. Any transfer of water out of this ditch will result in a carriage loss. That is one acre foot leaving San Lorenzo will be less than one acre foot arriving in another ditch.
Due to carriage lossess as water moves between ditches you will see all bids and offers posted from the perspective of the carriage loss already accounted for. This will lead to bids and offers not in whole units, even though you can only submit bids and offers in whole acre feet.
Pay attention to the priority dates being asked for if you are intending to sell water to another user. If you do not have that specific priority date you can fulfill the bid by selling an older priority date. For example if there is an existing bid for a priority date of 1880 and you only have a priority date of 1870 you can sell, the trading system will allow you to engage in the transaction as 1870 is of higher priority then 1880.


Instructions Complete

III: Additional Experimental Instructions
In addition to the experimental instructions on how to use the software as previously explained a second set of instructions were provided to the participants for the experiments conducted in September and October of 2012 to educate the participants on the Doctrine of Prior Appropriations. Because all participants in the October 2012 experiments were recruited from upper division economics courses at Illinois Wesleyan University we recognized that many of them were not familiar with western water law, specifically the Doctrine of Prior Appropriations.

To educate each participant two exercises were conducted. The first was a candy bar game where 12 individual candy bars were placed on a table ranging from king size candy bars down to fun small fun size candy bars. As participants entered the room for the first experimental session they were given a number representing their arrival date (i.e. the first person received a 1 down till the last person entered and received a 12). Participants then came and selected one candy bar of their choosing based upon their arrival date. This created a system were the first arriver had priority in their choice while the last arriver was not able to choose which candy bar they desired.

The second part of the educational component took them through a PowerPoint presentation that defined the Doctrine of Prior Appropriations, Stacking and what a call on a river means. Snapshots of this instructional file are below.

Prior Appropriations

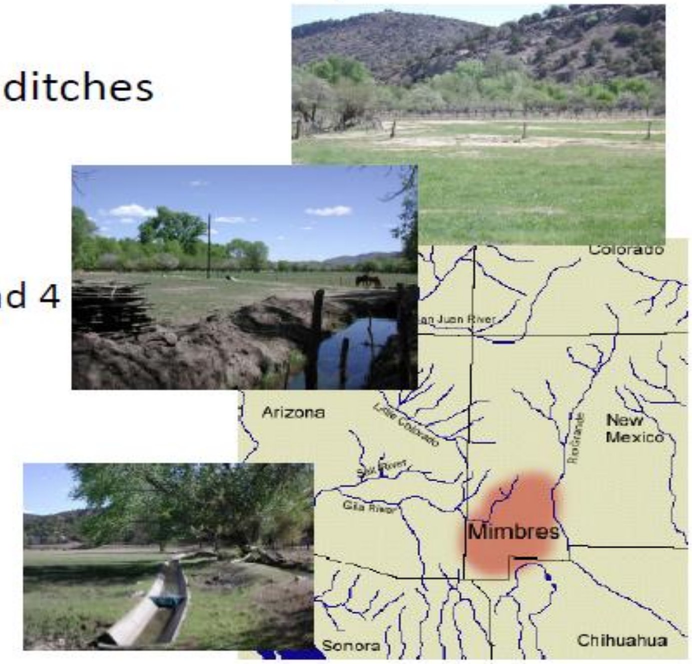
- Defined: The first person to use a quantity of water from a water source of a beneficial use has the right to continual use of that quantity of water for that purpose, subsequent users can use the remaining water for their own beneficial purposes providing that they do not impinge on the rights of previous users.

What Happens in a Drought

- System of Senior and Junior Users
  - Senior User has an older claim to water
  - Junior User has a newer claim to water
- A Call is placed by a Senior User
  - Junior users access is denied based upon who has the newest priority date up to the total supply that is still available during the drought.

History of the Basin in Question

- 9 agricultural water ditches
  - Montoya
  - Grijalva
  - Kenly 1 and 2
  - Heuchling 1, 2, 3, and 4
  - San Lorenzo
- Crops Grown
  - Pecans and Apples
  - Alfalfa and Pasture
  - Hard Beans



Legal Questions Being Investigated

- How are junior users able to keep farming in droughts?
- Can we allow people to engage in “stacking” water?
  - Stacking is a situation where you place more water on a crop then is legally allowed, it is deemed wasteful to place more than 2.7AF per acre per year on any crop.

IV. Experimental Payouts for Participants

In order to conduct economic experiments the experimental participants must have values for each crop that can be grown in the experiments. In actuality this is well known to agricultural users as they can sell crops in an open market at the end of a growing season or through a futures market during the growing season. If the participants in the marketplace does not have an understanding about the commodity market a value for crops must be induced to each participant. In addition, a value for crops that are grown from stacked water must also be induced to each participant. We chose to use an induced value framework similar to that employed by Broadbent et al., 2009[17]. On the pages that follow are the payout sheets given to experimental participants that list the amount of water needed in each month of the growing season along with the tonnage of crops that will be produced and the price that each ton of crops will be paid for the 11 different water users in the software.

[17] Broadbent et al. (2009) ―Water Leasing: Evaluating Temporary Water Rights Transfers in New Mexico Through Experimental Methods." *Natural Resources Journal* 49 (3-4): 707-741.

Grijalva										
						Stacked Water				
Month	Minimum Water	Crops (tons)	Additional Water	Crops (tons)	Tradeable Left	1869	1870	1880	1893	1894
January	0	0	0	0						
February	0	0	0	0						
March	11	33	5.5	16.5						
April	19	57	9.5	28.5						
May	20	60	10	30						
June	20	60	10	30						
July	16	48	8	24						
August	22	66	11	33						
September	21	63	10.5	31.5						
October	3	9	1.5	4.5						
November	0	0	0	0						
December	0	0	0	0						
Totals	132	396	66	198						

You will receive 1 experimental dollar for each ton of crops grown.
At the end of the experiment you will be paid 5% of each experimental dollar you obtain from your crop production and trading cash

Montoya										
						Stacked Water				
Month	Minimum Water	Crops (tons)	Additional Water	Crops (tons)	Tradeable Left	1869	1870	1880	1893	1894
January	0	0	0	0						
February	0	0	0	0						
March	10	30	5	15						
April	16	48	8	24						
May	12	36	6	18						
June	17	51	8.5	25.5						
July	11	33	5.5	16.5						
August	19	57	9.5	28.5						
September	9	27	4.5	13.5						
October	5	15	2.5	7.5						
November	0	0	0	0						
December	0	0	0	0						
Totals	99	297	49.5	148.5						

You will receive 1 experimental dollar for each ton of crops grown.
At the end of the experiment you will be paid 7.5% of each experimental dollar you obtain from your crop production and trading cash

Kenly_1										
						Stacked Water				
Month	Minimum Water	Crops (tons)	Additional Water	Crops (tons)	Tradeable Left	1869	1870	1880	1893	1894
January	0	0	0	0						
February	0	0	0	0						
March	11	33	5.5	16.5						
April	12	36	6	18						
May	14	42	7	21						
June	15	45	7.5	22.5						
July	10	30	5	15						
August	10	30	5	15						
September	18	54	9	27						
October	6	18	3	9						
November	0	0	0	0						
December	0	0	0	0						
Totals	96	288	48	144						

You will receive 1 experimental dollar for each ton of crops grown.
At the end of the experiment you will be paid 7.5% of each experimental dollar you obtain from your crop production and trading cash

Kenly_2										
						Stacked Water				
Month	Minimum Water	Crops (tons)	Additional Water	Crops (tons)	Tradeable Left	1869	1870	1880	1893	1894
January	0	0	0	0						
February	0	0	0	0						
March	17	51	8.5	25.5						
April	16	48	8	24						
May	20	60	10	30						
June	22	66	11	33						
July	14	42	7	21						
August	14	42	7	21						
September	26	78	13	39						
October	8	24	4	12						
November	0	0	0	0						
December	0	0	0	0						
Totals	137	411	68.5	205.5						

You will receive 1 experimental dollar for each ton of crops grown.
At the end of the experiment you will be paid 5% of each experimental dollar you obtain from your crop production and trading cash

Heuchling_1										
						Stacked Water				
Month	Minimum Water	Crops (tons)	Additional Water	Crops (tons)	Tradeable Left	1869	1870	1880	1893	1894
January	0	0	0	0						
February	0	0	0	0						
March	0	0	0	0						
April	0	0	0	0						
May	2	6	1	3						
June	3	9	1.5	4.5						
July	3	9	1.5	4.5						
August	3	9	1.5	4.5						
September	5	15	2.5	7.5						
October	0	0	0	0						
November	0	0	0	0						
December	0	0	0	0						
Totals	16	48	8	24						

You will receive 1 experimental dollar for each ton of crops grown.
At the end of the experiment you will be paid 20% of each experimental dollar you obtain from your crop production and trading cash

Heuchling_2										
						Stacked Water				
Month	Minimum Water	Crops (tons)	Additional Water	Crops (tons)	Tradeable Left	1869	1870	1880	1893	1894
January	0	0	0	0						
February	0	0	0	0						
March	2	6	1	3						
April	1	3	0.5	1.5						
May	1	3	0.5	1.5						
June	2	6	1	3						
July	1	3	0.5	1.5						
August	2	6	1	3						
September	2	6	1	3						
October	0	0	0	0						
November	0	0	0	0						
December	0	0	0	0						
Totals	11	33	5.5	16.5						

You will receive 1 experimental dollar for each ton of crops grown.
At the end of the experiment you will be paid 20% of each experimental dollar you obtain from your crop production and trading cash

Heuchling_3										
						Stacked Water				
Month	Minimum Water	Crops (tons)	Additional Water	Crops (tons)	Tradeable Left	1869	1870	1880	1893	1894
January	0	0	0	0						
February	0	0	0	0						
March	0	0	0	0						
April	2	6	1	3						
May	1	3	0.5	1.5						
June	2	6	1	3						
July	1	3	0.5	1.5						
August	1	3	0.5	1.5						
September	2	6	1	3						
October	0	0	0	0						
November	0	0	0	0						
December	0	0	0	0						
Totals	9	27	4.5	13.5						

You will receive 1 experimental dollar for each ton of crops grown.
At the end of the experiment you will be paid 20% of each experimental dollar you obtain from your crop production and trading cash

Heuchling_4										
						Stacked Water				
Month	Minimum Water	Crops (tons)	Additional Water	Crops (tons)	Tradeable Left	1869	1870	1880	1893	1894
January	0	0	0	0						
February	0	0	0	0						
March	3	9	1.5	4.5						
April	5	15	2.5	7.5						
May	6	18	3	9						
June	5	15	2.5	7.5						
July	6	18	3	9						
August	6	18	3	9						
September	5	15	2.5	7.5						
October	1	3	0.5	1.5						
November	0	0	0	0						
December	0	0	0	0						
Totals	37	111	18.5	55.5						

You will receive 1 experimental dollar for each ton of crops grown.
At the end of the experiment you will be paid 10% of each experimental dollar you obtain from your crop production and trading cash

San Lorenzo										
						Stacked Water				
Month	Minimum Water	Crops (tons)	Additional Water	Crops (tons)	Tradeable Left	1869	1870	1880	1893	1894
January	0	0	0	0						
February	0	0	0	0						
March	65	195	32.5	97.5						
April	116	348	58	174						
May	119	357	59.5	178.5						
June	115	345	57.5	172.5						
July	116	348	58	174						
August	119	357	59.5	178.5						
September	119	357	59.5	178.5						
October	20	60	10	30						
November	0	0	0	0						
December	0	0	0	0						
Totals	789	2367	394.5	1183.5						

You will receive 1 experimental dollar for each ton of crops grown.
At the end of the experiment you will be paid 1% of each experimental dollar you obtain from your crop production and trading cash

Casas_Adobes			
		Payout Is For Each Month	
Month	Water Acquired	Water (AF)	Payout ($)
January		0	0
February		1	7
March		2	13.17
April		3	18.80
May		4	24
June		5	28.81
July		6	33.30
August		7	37.47
September		8	41.37
October		9	45
November		10	48.37
December		11	51.51

You will receive 1 experimental dollar for each ton of crops grown.
At the end of the experiment you will be paid 5% of each experimental dollar you obtain from your crop production and trading cash

Misc_Pumping			
		Payout Is For Each Month	
Month	Water Acquired	Water (AF)	Payout ($)
January		0	0
February		1	7
March		2	13.17
April		3	18.80
May		4	24
June		5	28.81
July		6	33.30
August		7	37.47
September		8	41.37
October		9	45
November		10	48.37
December		11	51.51

You will receive 1 experimental dollar for each ton of crops grown.
At the end of the experiment you will be paid 5% of each experimental dollar you obtain from your crop production and trading cash

Appendix 6: Framework Experiment Results

I: Quantity of Water

Initial Allocations of Water by Priority Date

This section provides the starting water amounts that were allocated to each participant in each of the four experiments. These starting water values are obtained from the TBI (To Be Irrigated) that is filed by each ditch at the start of the growing season. We kept these values constant across the four treatments, that is, water allocations did not change for each ditch based upon the scenario that was being conducted (i.e. stacking without a call or no stacking with a call).

Ditch	Priority Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Grijalva	1893	0	0	11	19	20	20	16	22	21	3	0	0
Montoya	1880	0	0	10	16	12	17	11	19	9	5	0	0
Kenly 1	1894	0	0	11	12	14	15	10	10	18	6	0	0
Kenly 2	1894	0	0	17	16	20	22	14	14	26	8	0	0
Heuchling 1	1870	0	0	0	0	2	3	3	3	5	0	0	0
Heuchling 2	1870	0	0	2	1	1	2	1	2	2	0	0	0
Heuchling 3	1870	0	0	0	2	1	2	1	1	2	0	0	0
Heuchling 4	1870	0	0	3	5	6	5	6	6	5	1	0	0
San Lorenzo	1869	0	0	65	116	119	115	116	119	119	20	0	0
Casas Adobes	1895	0	0	0	0	0	0	0	0	0	0	0	0
Supplemental Wells	1895	0	0	0	0	0	0	0	0	0	0	0	0

Call Expectations and Observations

This section details the expectations for a call in Table 1 for the two treatments that we expected to observe a call and the ditches that are expected to be placed under a call. Table 2 presents the effects that trading had upon these expectations for the two treatments that we expected to observe a call in. We find the impacts of a call are minimized through voluntary transactions as only the 1895 and 1894 priorities were not delivered water for two months.

Table 1: Call Expectations

Priority Date	June	July	Aug
1895		X	X
1894		X	X
1893		X	
1880		X	
1870			
1869			

Table 2: Observed Call as Result of Trades

Observed Call In No Stack #1				Observed Call In No Stack #2			
Priority Date	June	July	Aug	Priority Date	June	July	Aug
1895	X	X		1895	X		
1894	X	X		1894	X		
1893				1893			
1880				1880			
1870				1870			
1869				1869			

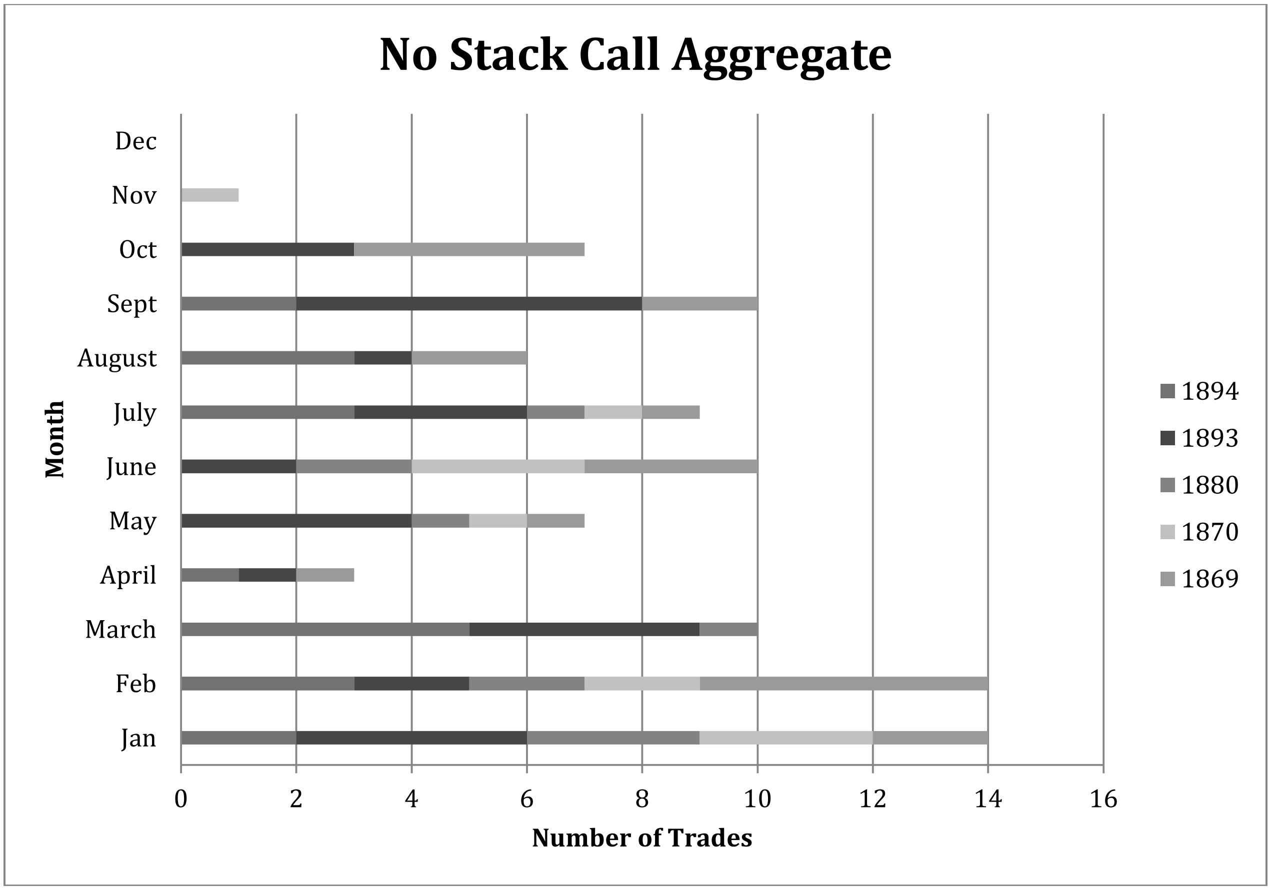
Number of Trades

This section presents the total number of trades that were consummated by the participants for each of the four experiments and also as an aggregate for the two main scenarios (i.e. stacking without a call and no stacking with a call). These trades are presented as the priority date of water that was traded. For example, if an individual received an 1869 priority date of water in a transaction then the trade is recorded as an 1869 trade. In addition the total number of trades in an aggregate fashion is presented by priority date for the two main treatments in subsection A and by individual treatment in subsection B.

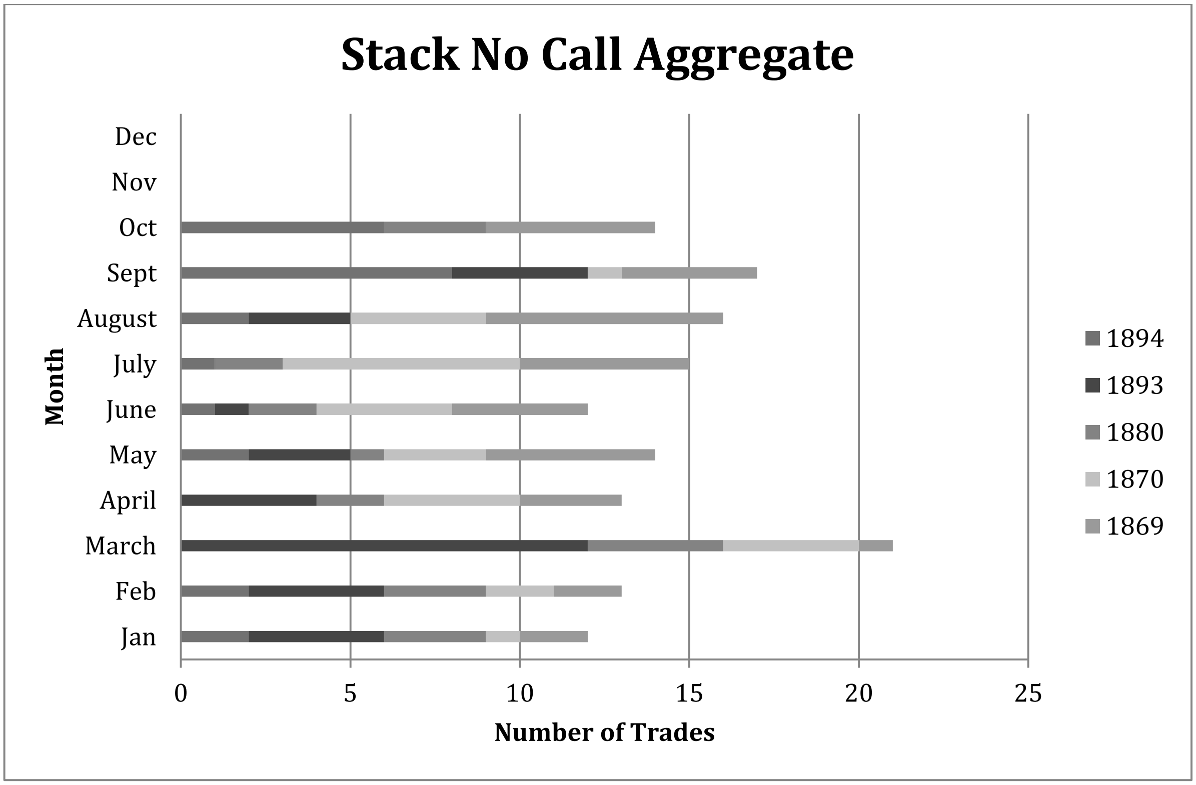
Table3: Summary Total Number of Trades

	Trading Month											
Scenario	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
No Stack / Call #1	6	7	5	1	3	4	3	3	7	5	1	0
1894	1	1	0	0	0	0	1	1	1	0	0	0
1893	2	1	3	0	1	0	0	0	4	1	0	0
1880	1	1	1	0	1	1	1	0	0	0	0	0
1870	1	2	0	0	1	1	1	0	0	0	1	0
1869	1	2	0	1	0	2	1	2	2	4	0	0
No Stack / Call #2	8	6	6	2	4	6	5	3	3	2	0	0
1894	1	2	5	1	0	0	2	2	1	0	0	0
1893	2	1	1	1	3	2	3	1	2	2	0	0
1880	2	1	0	0	0	1	0	0	0	0	0	0
1870	2	0	0	0	0	2	0	0	0	0	0	0
1869	1	3	0	0	1	1	0	0	0	0	0	0
Stack / No Call #1	6	4	7	8	9	8	10	9	14	12	0	0
1894	0	0	0	0	1	1	1	2	6	5	0	0
1893	3	2	1	3	2	1	0	3	3	0	0	0
1880	1	1	2	2	0	2	2	0	0	3	0	0
1870	1	0	3	1	3	2	3	1	1	0	0	0
1869	1	1	1	2	3	2	4	3	4	4	0	0
Stack / No Call #2	6	9	14	5	5	4	5	7	3	2	0	0
1894	2	2	0	0	1	0	0	0	2	1	0	0
1893	1	2	11	1	1	0	0	0	1	0	0	0
1880	2	2	2	0	1	0	0	0	0	0	0	0
1870	0	2	1	3	0	2	4	3	0	0	0	0
1869	1	1	0	1	2	2	1	4	0	1	0	0

Section A: Trades in Aggregate
This section displays the total number of trades by priority date for the two main scenarios that were conducted. In addition the total number of trades that participants engage in by priority date are found in a table below the graphics that display the data.



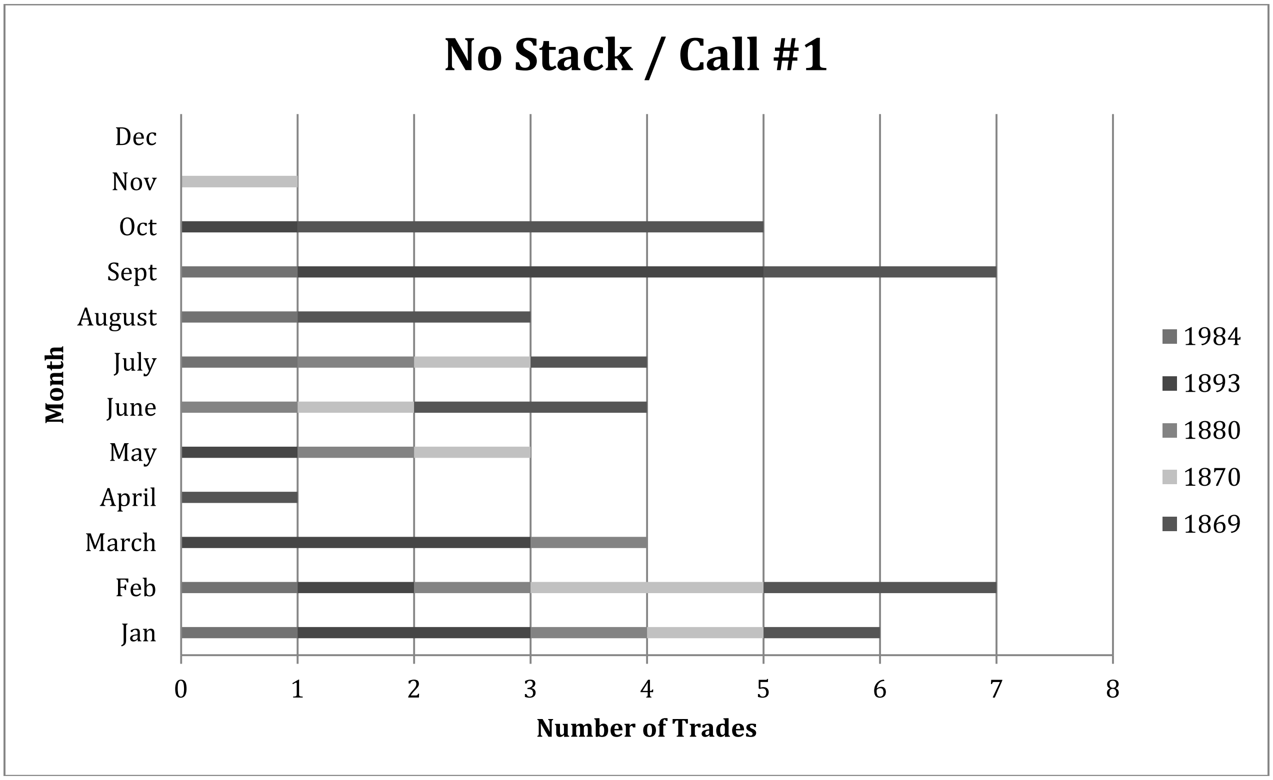
Scenario	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
No Stack Call(Total)	14	13	11	3	7	10	8	6	10	7	1	0
1894	2	3	5	1	0	0	3	3	2	0	0	0
1893	4	2	4	1	4	2	3	1	6	3	0	0
1880	3	2	1	0	1	2	1	0	0	0	0	0
1870	3	2	0	0	1	3	1	0	0	0	1	0
1869	2	5	0	1	1	3	1	2	2	4	0	0



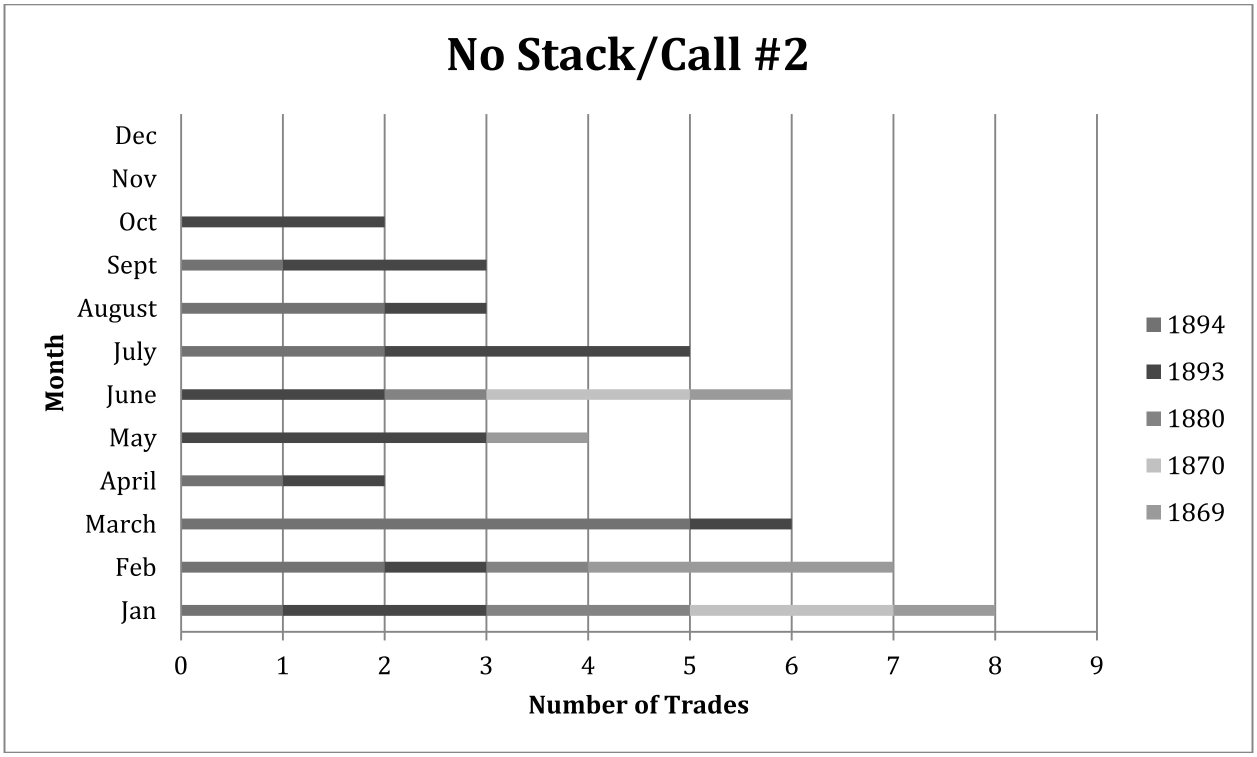
Scenario	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Stack No Call (Total)	12	13	21	13	14	12	15	16	17	14	0	0
1894	2	2	0	0	2	1	1	2	8	6	0	0
1893	4	4	12	4	3	1	0	3	4	0	0	0
1880	3	3	4	2	1	2	2	0	0	3	0	0
1870	1	2	4	4	3	4	7	4	1	0	0	0
1869	2	2	1	3	5	4	5	7	4	5	0	0

Section B: Trades by Treatment

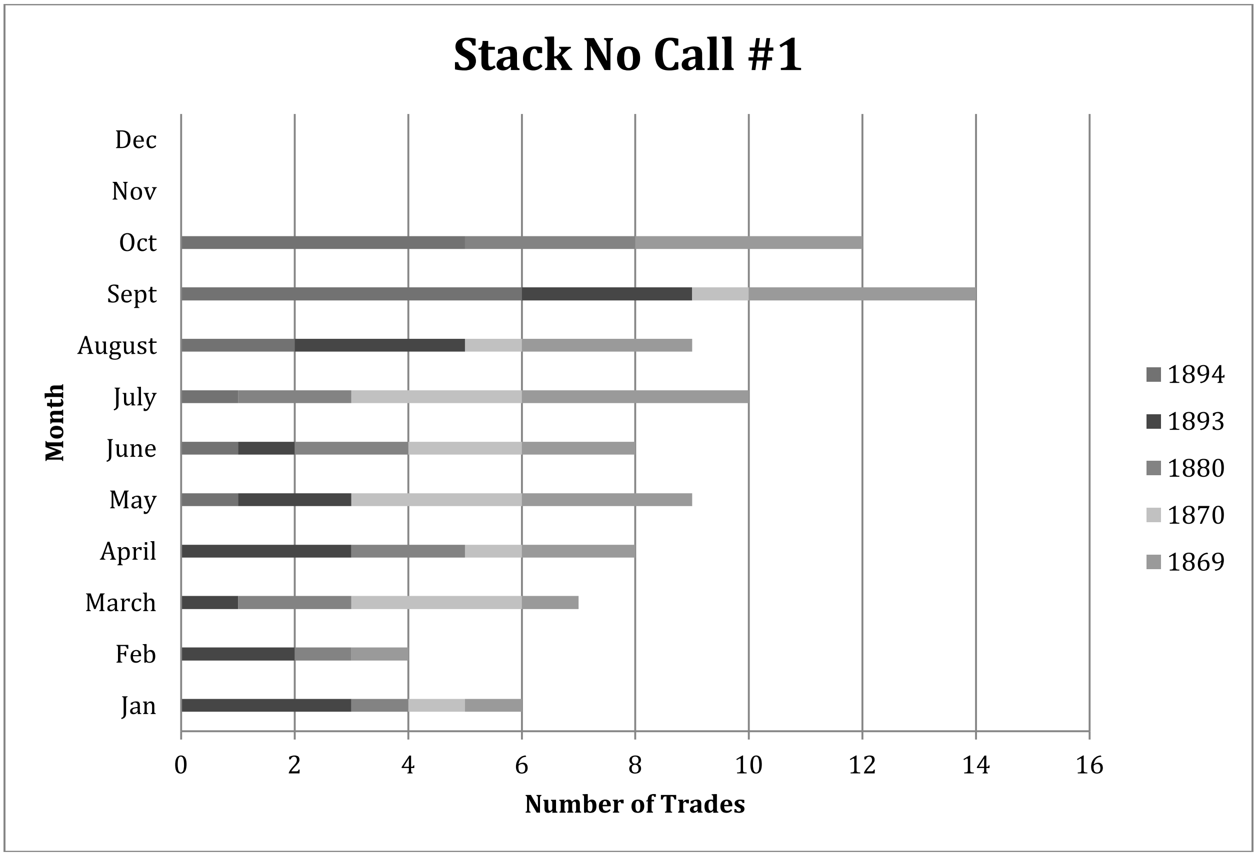
This section displays the total number of trades by priority date for each of the four treatments that were conducted, two treatments for the call without stacking scenario and two treatments for the stacking without a call scenario. In addition the total number of trades that participants engaged in by priority date are found in a table below the graphics that display the data.



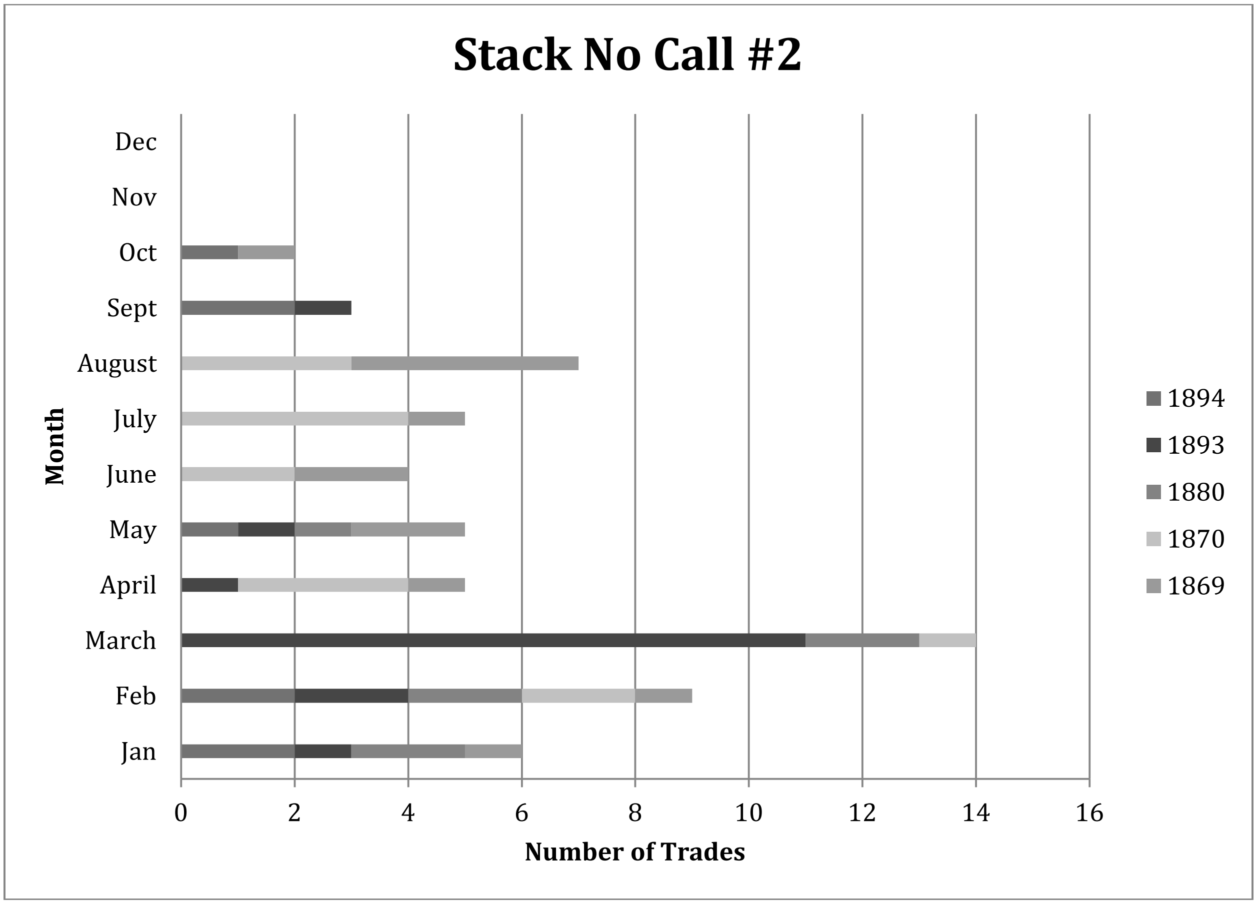
Scenario	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
No Stack / Call#1(total)	6	7	5	1	3	4	3	3	7	5	1	0
1894	1	1	0	0	0	0	1	1	1	0	0	0
1893	2	1	3	0	1	0	0	0	4	1	0	0
1880	1	1	1	0	1	1	1	0	0	0	0	0
1870	1	2	0	0	1	1	1	0	0	0	1	0
1869	1	2	0	1	0	2	1	2	2	4	0	0



Scenario	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
No Stack / Call #2 Totals	8	6	6	2	4	6	5	3	3	2	0	0
1894	1	2	5	1	0	0	2	2	1	0	0	0
1893	2	1	1	1	3	2	3	1	2	2	0	0
1880	2	1	0	0	0	1	0	0	0	0	0	0
1870	2	0	0	0	0	2	0	0	0	0	0	0
1869	1	3	0	0	1	1	0	0	0	0	0	0



Scenario	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Stack / No Call #1 (Total)	6	4	7	8	9	8	10	9	14	12	0	0
1894	0	0	0	0	1	1	1	2	6	5	0	0
1893	3	2	1	3	2	1	0	3	3	0	0	0
1880	1	1	2	2	0	2	2	0	0	3	0	0
1870	1	0	3	1	3	2	3	1	1	0	0	0
1869	1	1	1	2	3	2	4	3	4	4	0	0



Scenario	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Stack / No Call #2 (Total)	6	9	14	5	5	4	5	7	3	2	0	0
1894	2	2	0	0	1	0	0	0	2	1	0	0
1893	1	2	11	1	1	0	0	0	1	0	0	0
1880	2	2	2	0	1	0	0	0	0	0	0	0
1870	0	2	1	3	0	2	4	3	0	0	0	0
1869	1	1	0	1	2	2	1	4	0	1	0	0

Quantity of Water Traded out of a Priority Date Summary

The following tables detail the total amount of water that was traded by month. It also shows the priority date for the trades and the scenario's that the trades were made in. We find that the majority of trades took place during the months of January through June. The scenario of stacking without a call saw the most trade activity. A majority of trades going out were of the least valuable water rights in 1894.

Table #4 Total Quantity of Water Sold (acre/ft)

	Trading Month											
Scenario	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
No Stack / Call #1	18	22	17	2	4	14	4	9	14	18	1	0
1894	2	3	10	0	0	0	3	4	0	0	0	0
1893	4	2	5	0	1	0	0	0	5	2	0	0
1880	7	0	2	0	1	8	1	0	0	0	0	0
1870	2	8	0	0	2	1	1	0	0	0	1	0
1869	3	7	0	2	0	5	2	6	5	16	0	0
No Stack / Call #2	24	11	17	4	6	18	10	5	3	3	0	0
1894	2	2	15	2	0	0	7	4	1	0	0	0
1893	2	1	2	2	4	6	3	1	2	2	0	0
1880	8	3	0	0	0	5	0	0	0	0	0	0
1870	10	0	0	0	0	5	0	0	0	0	0	0
1869	2	5	0	0	2	2	0	0	0	0	0	0
Stack / No Call #1	7	5	1	1	6	9	5	4	14	9	0	0
1894	0	0	0	0	2	3	2	3	12	7	0	0
1893	2	1	1	1	3	2	3	1	2	2	0	0
1880	2	1	0	0	0	1	0	0	0	0	0	0
1870	2	0	0	0	0	2	0	0	0	0	0	0
1869	1	3	0	0	1	1	0	0	0	0	0	0
Stack / No Call #2	6	9	14	5	4	4	5	6	3	2	0	0
1894	2	2	0	0	1	0	0	0	2	1	0	0
1893	1	2	11	1	0	0	0	0	1	0	0	0
1880	2	2	2	0	1	0	0	0	0	0	0	0
1870	0	2	1	3	0	2	4	3	0	0	0	0
1869	1	1	0	1	2	2	1	3	0	1	0	0

Individual Tables by priority date and scenario

These tables show the total water sold per acre foot by priority date, month, and scenario. We find that the higher priority water has a higher demand during the early months of a year as individuals are looking to secure water in case of a call, while the lower priority water right is traded more frequently towards the end of a growing season. Below each graphic there is a table with the total number of trades that were consummated for each priority date.

Figure # 1 Total Quantity of Water Sold (acre/ft) 1894

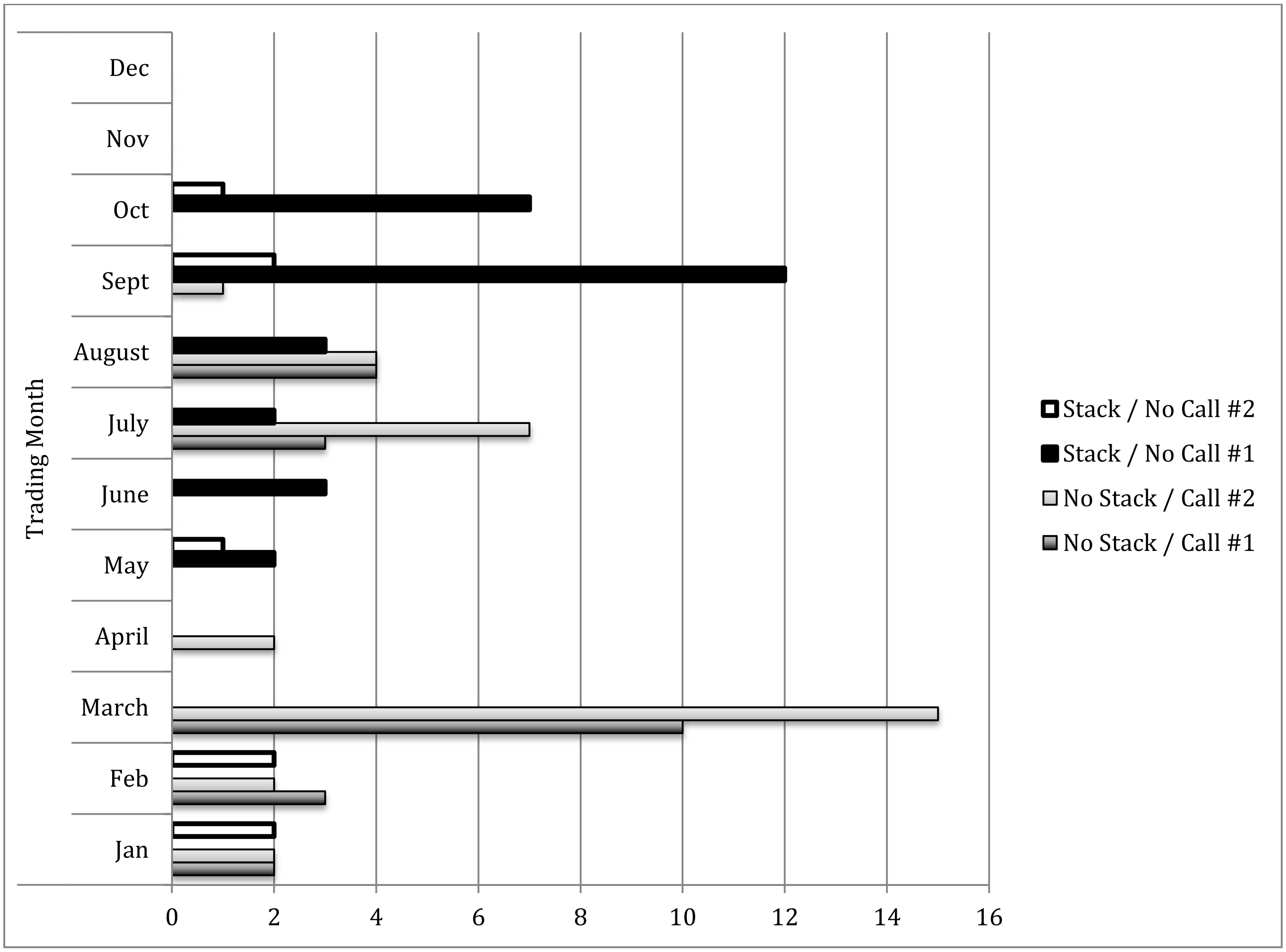


Table # 5Total Quantity of Water Sold (acre/ft) 1894

	Trading Month											
Scenario	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
No Stack / Call #1	2	3	10	0	0	0	3	4	0	0	0	0
No Stack / Call #2	2	2	15	2	0	0	7	4	1	0	0	0
Stack / No Call #1	0	0	0	0	2	3	2	3	12	7	0	0
Stack / No Call #2	2	2	0	0	1	0	0	0	2	1	0	0

Figure # 2 Total Quantity of Water Sold (acre/ft) 1893

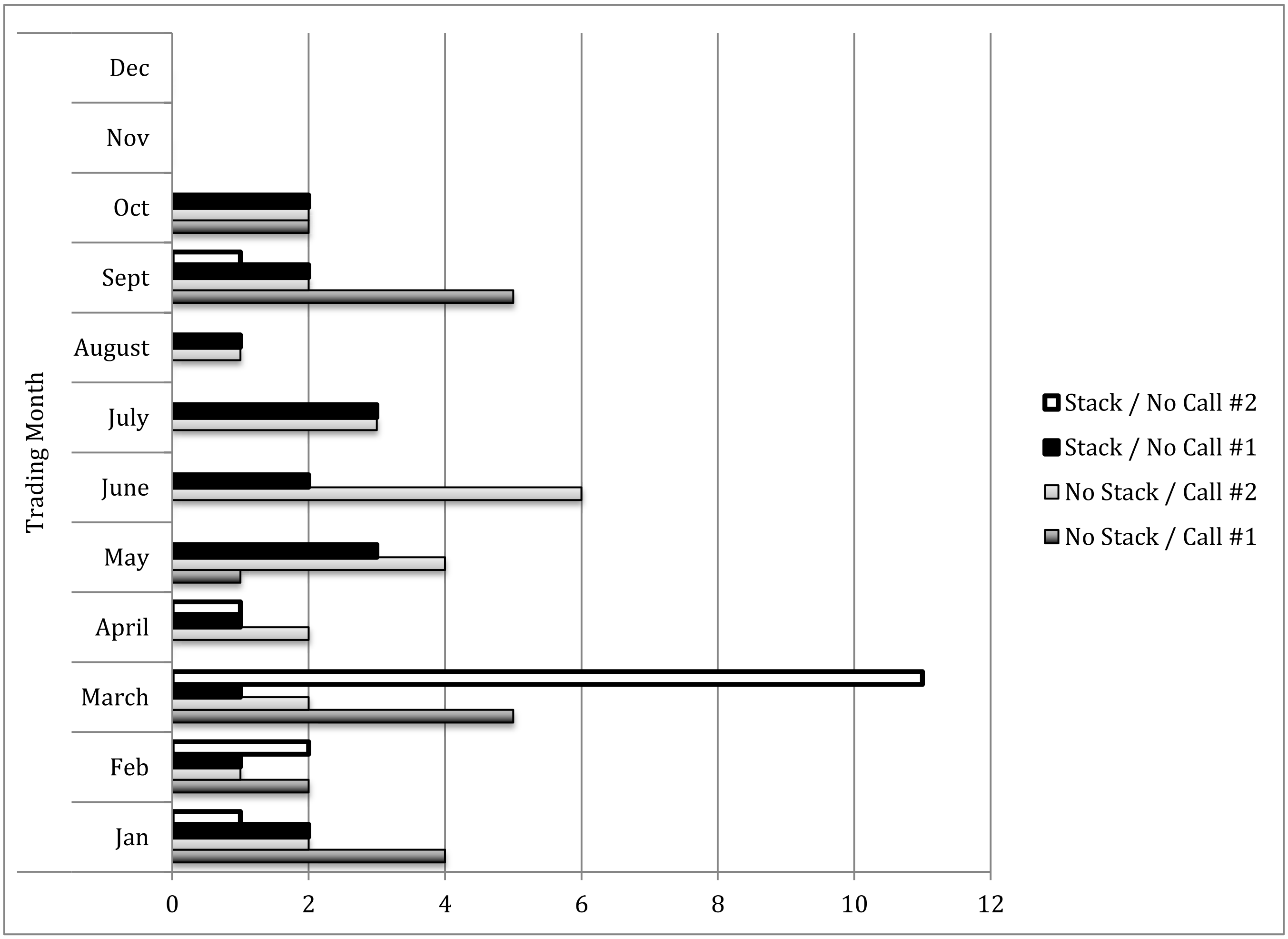


Table # 6Total Quantity of Water Sold (acre/ft) 1893

	Trading Month											
Scenario	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
No Stack / Call #1	4	2	5	0	1	0	0	0	5	2	0	0
No Stack / Call #2	2	1	2	2	4	6	3	1	2	2	0	0
Stack / No Call #1	2	1	1	1	3	2	3	1	2	2	0	0
Stack / No Call #2	1	2	11	1	0	0	0	0	1	0	0	0

Figure # 3 Total Quantity of Water Sold (acre/ft) 1880

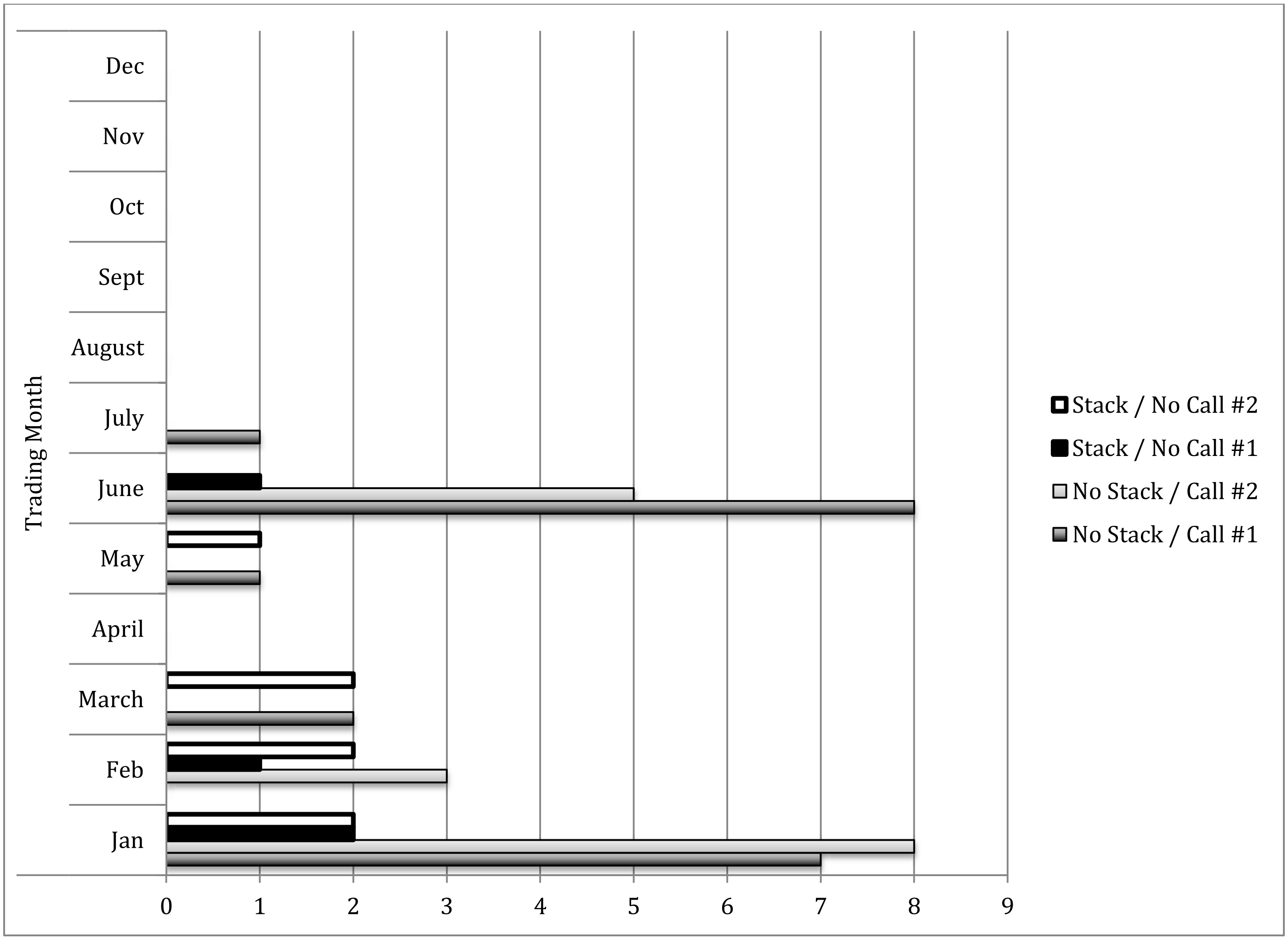


Table # 7 Total Quantity of Water Sold (acre/ft) 1880

	Trading Month											
Scenario	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
No Stack / Call #1	7	0	2	0	1	8	1	0	0	0	0	0
No Stack / Call #2	8	3	0	0	0	5	0	0	0	0	0	0
Stack / No Call #1	2	1	0	0	0	1	0	0	0	0	0	0
Stack / No Call #2	2	2	2	0	1	0	0	0	0	0	0	0

Figure # 4 Total Quantity of Water Sold (acre/ft) 1870

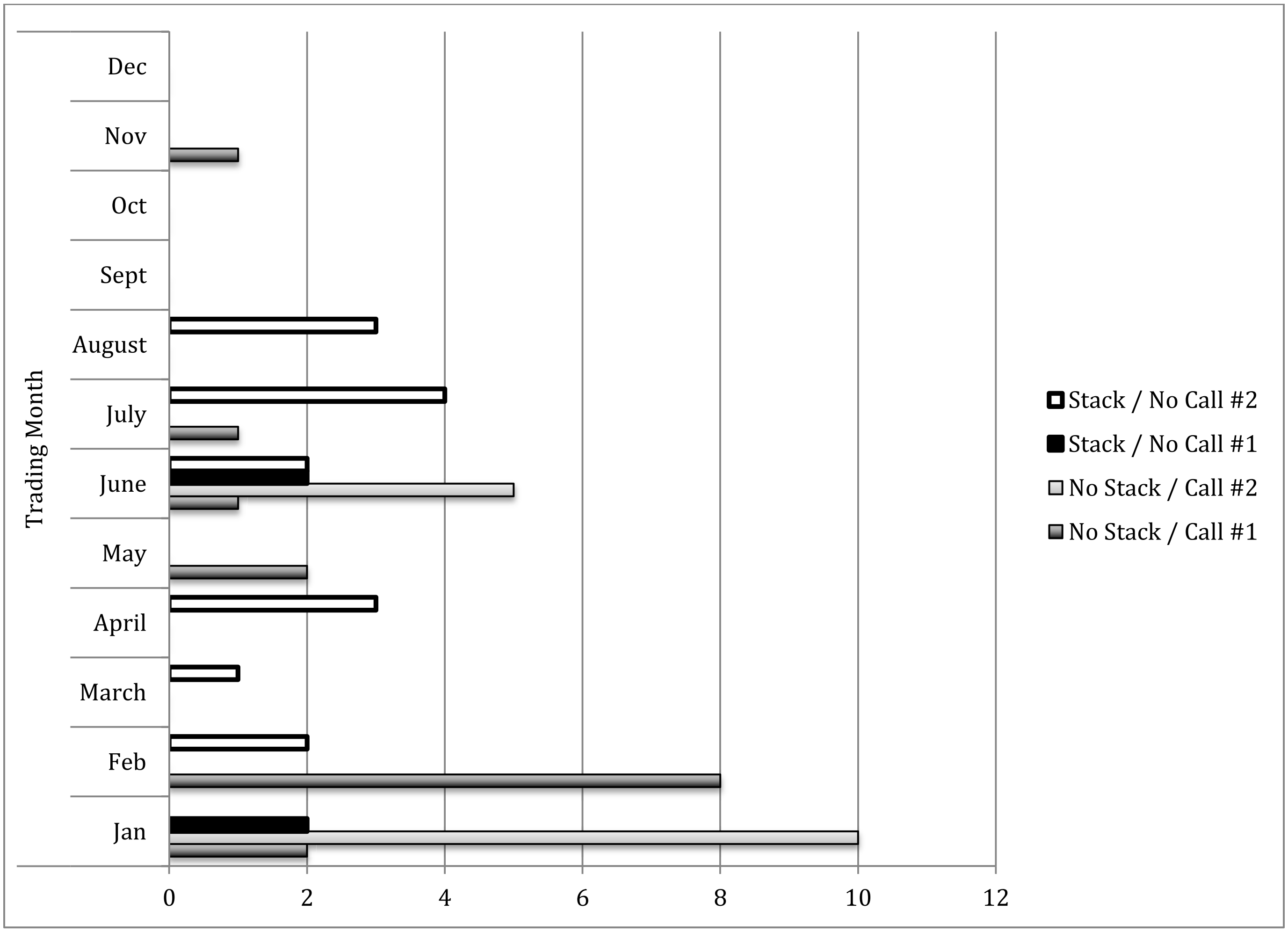


Table # 8 Total Quantity of Water Sold (acre/ft) 1870

	Trading Month											
Scenario	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
No Stack / Call #1	2	8	0	0	2	1	1	0	0	0	1	0
No Stack / Call #2	10	0	0	0	0	5	0	0	0	0	0	0
Stack / No Call #1	2	0	0	0	0	2	0	0	0	0	0	0
Stack / No Call #2	0	2	1	3	0	2	4	3	0	0	0	0

Figure # 5 Total Quantity of Water Sold (acre/ft) 1869

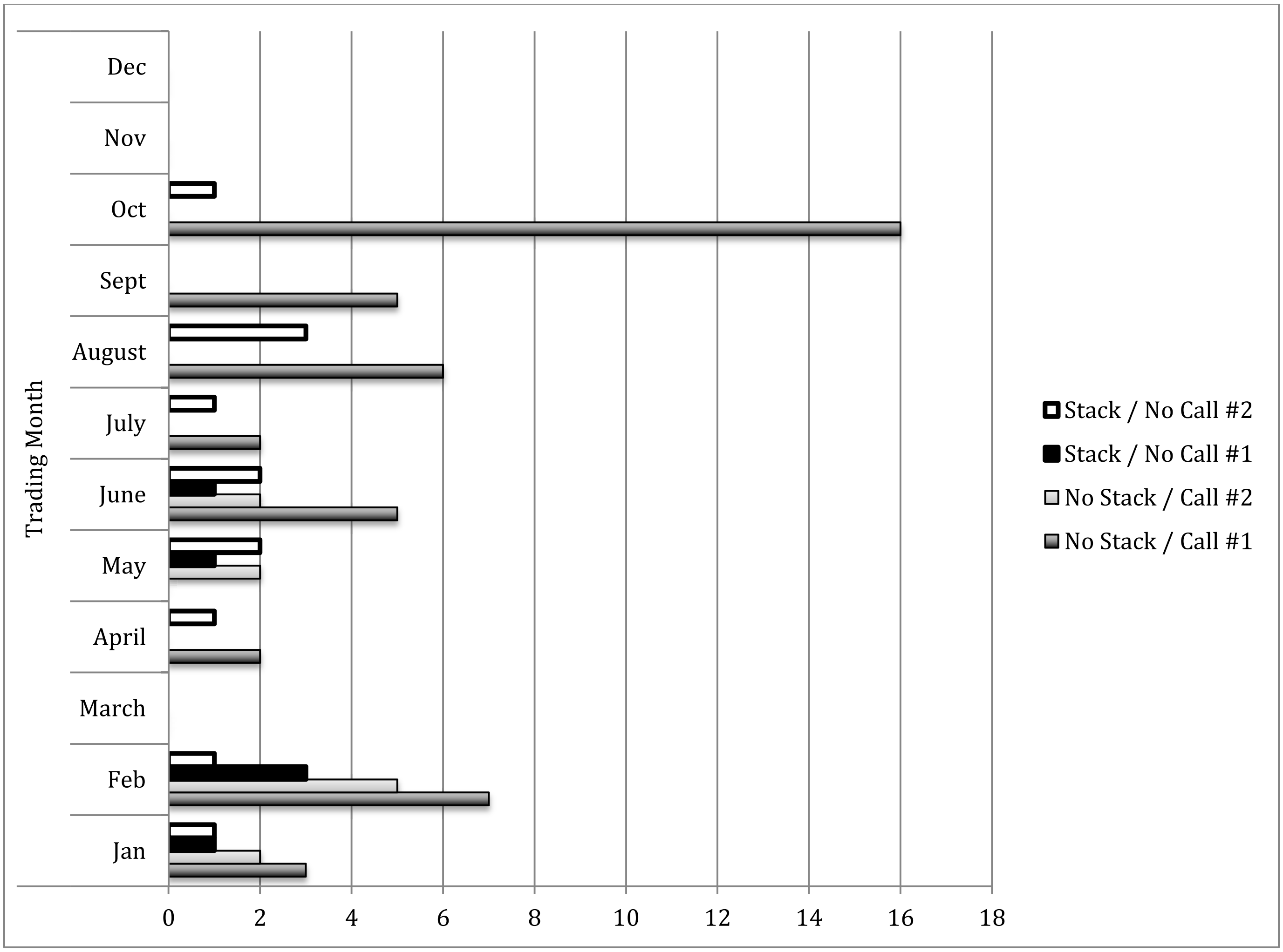


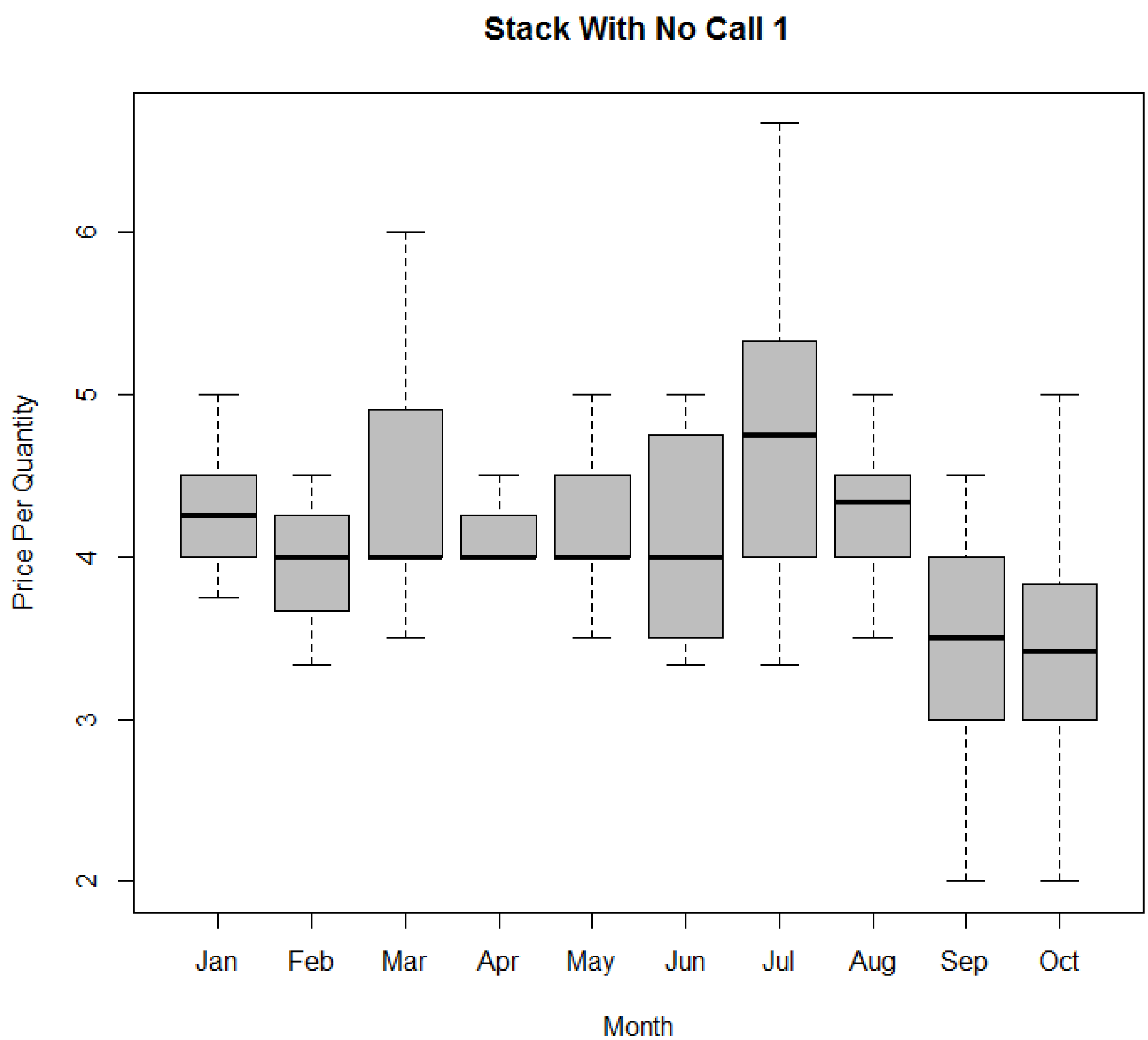
Table # 9 Total Quantity of Water Sold (acre/ft) 1869

	Trading Month											
Scenario	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
No Stack / Call #1	3	7	0	2	0	5	2	6	5	16	0	0
No Stack / Call #2	2	5	0	0	2	2	0	0	0	0	0	0
Stack / No Call #1	1	3	0	0	1	1	0	0	0	0	0	0
Stack / No Call #2	1	1	0	1	2	2	1	3	0	1	0	0

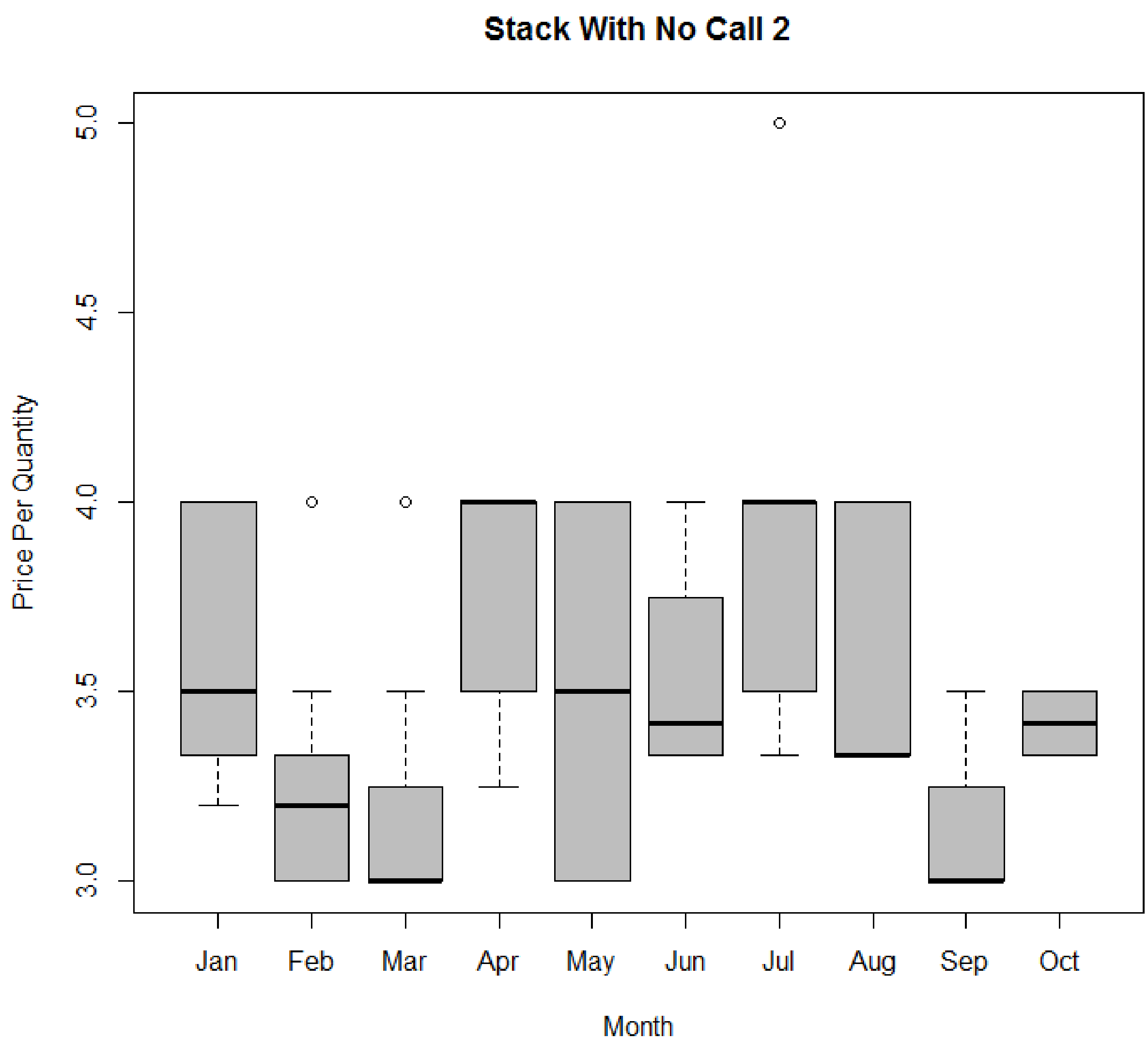
II: Price Effects

This section shows how prices change with the market according to various scenarios, priority dates and months throughout the year. The first main price effect that we display here is the weighted average price for each treatment and on an aggregate fashion (i.e. call/no stacking and a no call/stacking scenario). Below each plot is a table with the raw data for each experiment.

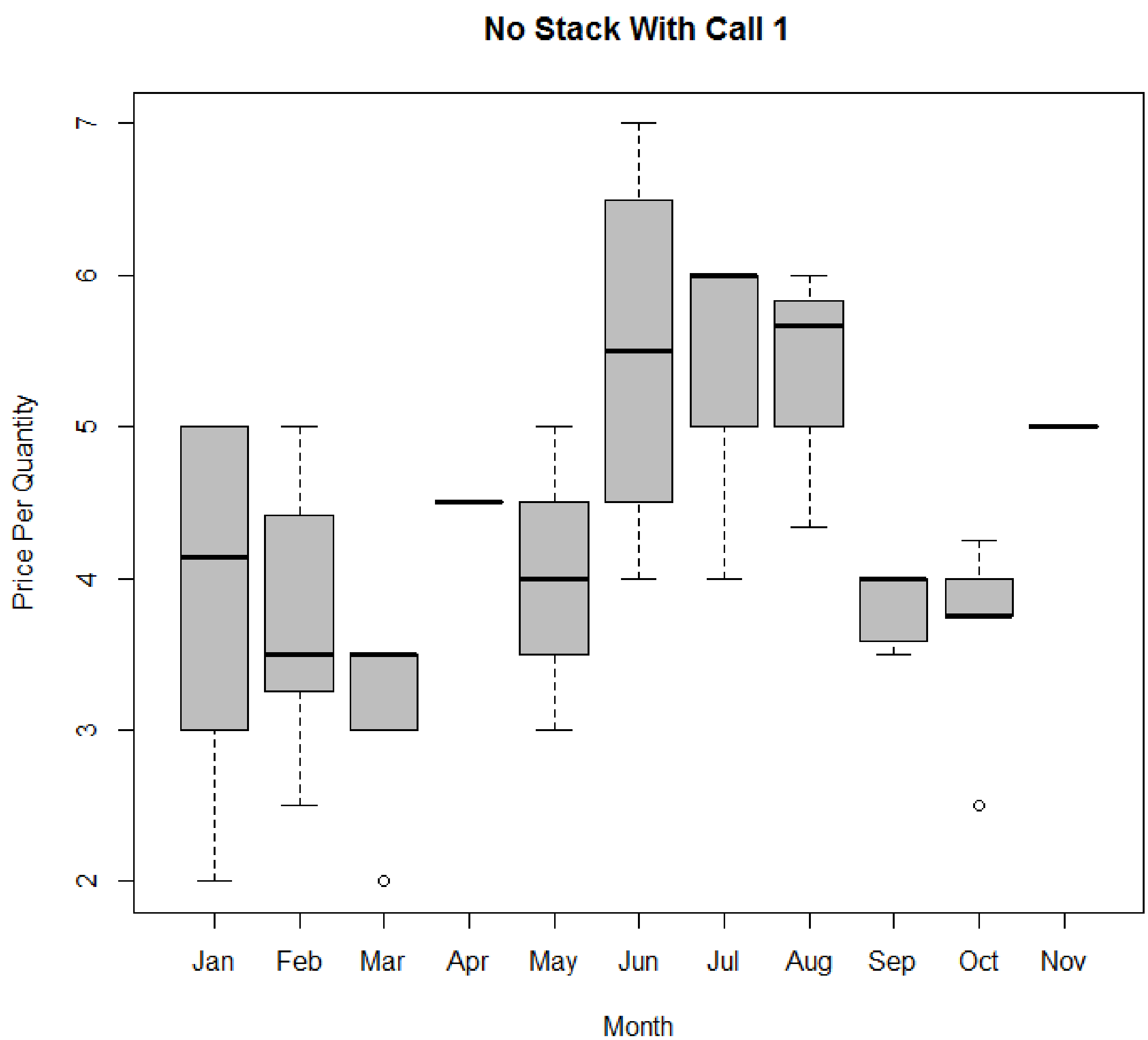
Box and Whisker Plots for the Four Experimental Treatments
Below are the box and whisker plots that show the price per quantity for each month by all priority dates, the highest price per quantity, the lowest price per quantity, and one standard deviation around the mean price per quantity for the four treatments, two stacking without a call treatments and two no stacking with a call treatments.



Month	High	Low	Average	Standard Deviation
1	5	3.75	4.291667	0.458711965
2	4.5	3.333333	3.958333	0.478713554
3	6	3.5	4.471429	0.849929969
4	4.5	4	4.125	NA
5	5	3.5	4.240741	0.457279934
6	5	3.333333	4.104167	0.666294539
7	6.666667	3.333333	4.7	1.03875519
8	5	3.5	4.314815	0.496126975
9	4.5	2	3.452381	0.651850002
10	5	2	3.411111	0.768618508

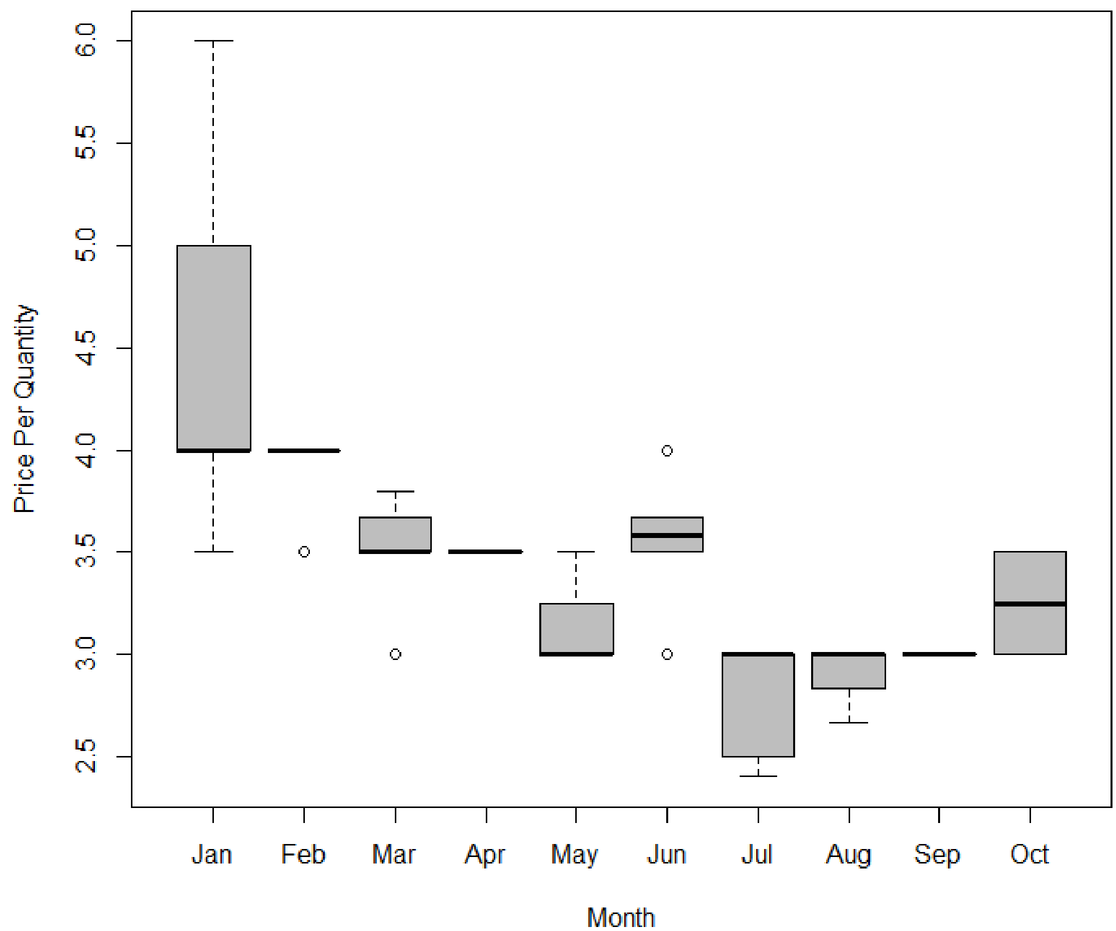


Month	High	Low	Average	Standard Deviation
1	4	3.2	3.588889	0.337748537
2	4	3	3.290476	0.333518467
3	4	3	3.14881	0.292678778
4	4	3.25	3.75	0.353553391
5	4	3	3.5	0.5
6	4	3.333333	3.541667	0.315494908
7	5	3.333333	3.966667	0.64978629
8	4	3.333333	3.619048	0.356348323
9	3.5	3	3.166667	0.288675135
10	3.5	3.333333	3.416667	0.11785113



Month	High	Low	Average	Standard Deviation
1	5	2	3.880952	1.182928454
2	5	2.5	3.761905	0.88640526
3	3.5	2	3.1	0.651920241
4	4.5	4.5	4.5	NA
5	5	3	4	1
6	7	4	5.5	1.290994449
7	6	4	5.333333	1.154700538
8	6	4.333333	5.333333	0.881917104
9	4	3.5	3.809524	0.243975018
10	4.25	2.5	3.65	0.675462804
11	5	5	5	NA

No Stack With Call 2



Month	High	Low	Average	Standard Deviation
1	6	3.5	4.4375	0.821040281
2	4	3.5	3.916667	0.204124145
3	3.8	3	3.494444	0.271142985
4	3.5	3.5	3.5	0
5	3.5	3	3.125	0.25
6	4	3	3.555556	0.327730693
7	3	2.4	2.78	0.303315018
8	3	2.666667	2.888889	0.19245009
9	3	3	3	0
10	3.5	3	3.25	0.353553391

T-Tests

T-Tests were conducted in order to determine the significance of the trades in each month, scenario, and priority date. The formula used was as follows:

=(Weighted Average-Expected Price)/(Standard Error/Sqrt(Number of Trades for that Month))

P-Values were calculated to determine if the observed price differed from the expected price.

Variables Defined:

Weighted Average Price:=Total price of trades/total quantity of trades for that month, scenario, and priority date.

Expected Price: =Average Price of all trades for all scenarios and priority dates.

Standard Error:=STDEV(price/quantity) for all trades in that month, scenario and priority date.

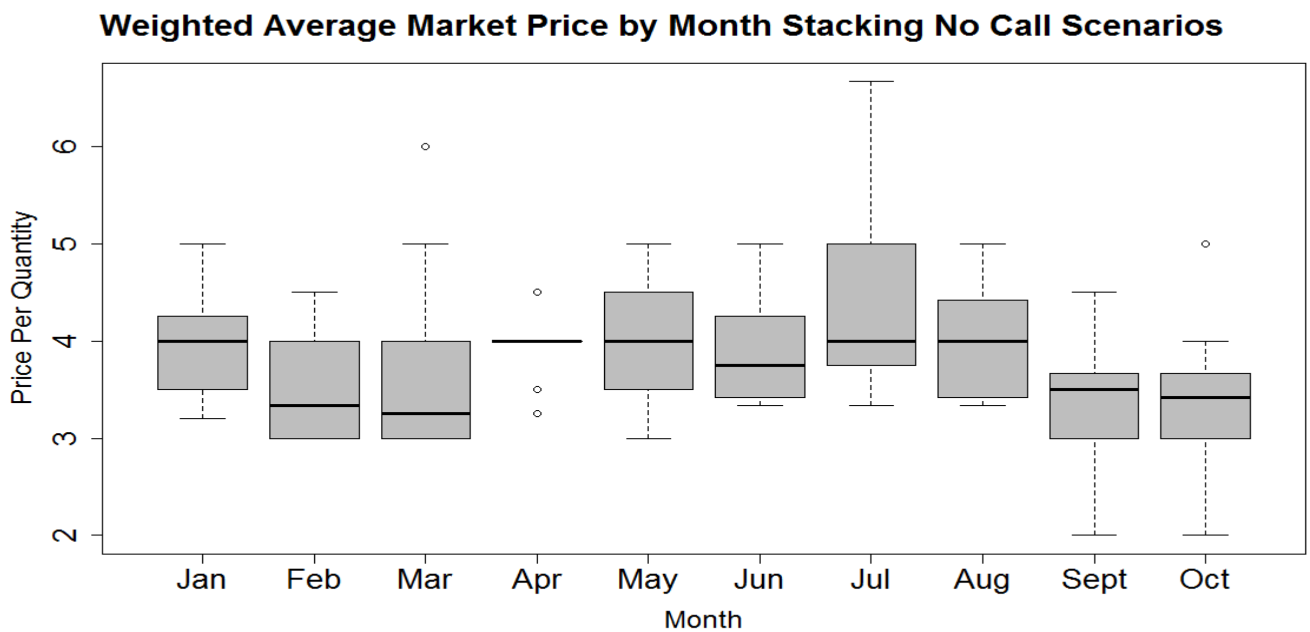
Number of Trades: =Sum of all transactions that were completed for that month, priority date, and scenario.

T-Values/ P-Values for Observed Weighted Average Prices by Treatment													
Scenario	Test	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Call / No Stack #1	T Val	2.06	2.71	-1.41	0	1.73	2.66	3.75	4.58	7.75	2.02	0	0
	P Val	0.09	0.03	0	0	0.02	0.08	0.06	0.04	0.0002	0.11	0	0
Call / No Stack #2	T Val	5.6	10.9	5.31	0	1.33	4.57	-2.95	-1.8	0	1.33	0	0
	P Val	0.0008	0.0001	0.003	0	0.27	0.006	0.01	0.04	0	0.14	0	0
No Call / Stack #1	T Val	6.07	3.71	3.89	13.58	7.94	4.25	5.07	7.83	3	3.47	0	0
	P Val	0.002	0.034	0.008	2.76	4.6	0.004	0.0007	5.12	0.01	0.005	0	0
No Call / Stack #2	T Val	4.03	3.52	2.57	3.51	2.24	2.82	3.06	3.71	1.5	4.8	0	0
	P Val	0.01	0.008	0.02	0.02	0.09	0.07	0.04	0.01	0.27	0.13	0	0

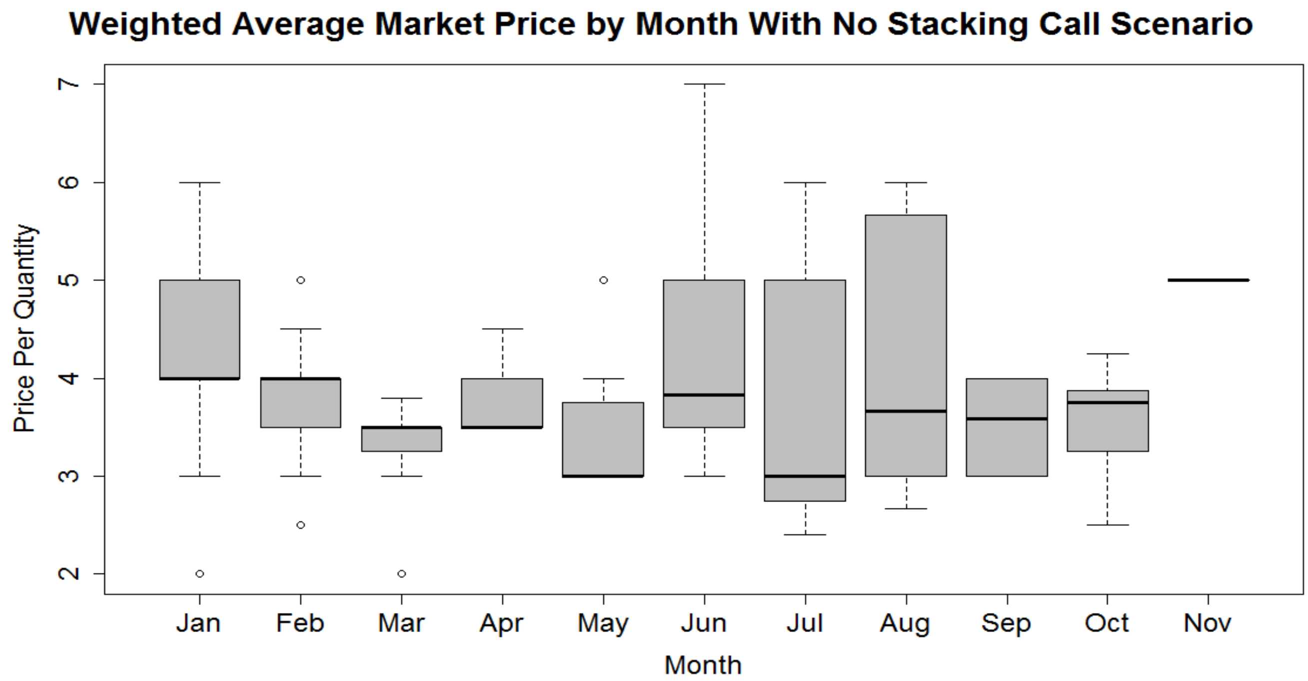
T-Values/ P-Values for Market Weighted Average Price for Stacked Data													
Scenario	Test	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Call / No Stack	T Val	5.08	5.08	0.59	2.5	1.73	2.71	0.82	2.4	4.24	15.26	0	0
	P Val	0.0002	0.00027	0.57	0.13	0.13	0.024	0.44	0.061	0.0022	4.99	0	0
No Call / Stack	T Val	5.705	3.885	4.027	10.11	6.66	4.578	16.26	6.54	3.294	3.84	0	0
	P Val	0.00014	0.0022	0.00066	3.17	1.561	0.00079	1.74	9.356	0.0046	0.002	0	0

Grouped Prices
This section displays the weighted average price for the two main treatments (i.e. we combined the two treatments for each scenario).

Box and Whisker Plots for Combined Experiments
Below are the box and whisker plots that show the price per quantity for each month by all priority dates, the highest price per quantity, the lowest price per quantity, and one standard deviation around the mean price per quantity for the two scenarios, stacking without a call and no stacking with a call.



	Stacking No Call			
Month	Highest	Lowest	Average	Standard Deviation
1	5	3.2	3.940278	0.53122
2	4.5	3	3.476923	0.492985
3	6	3	3.589683	0.824966
4	4.5	3.25	3.980769	0.330113
5	4.666667	3	3.97619	0.584183
6	5	3.333333	3.916667	0.621582
7	6.666667	3.333333	4.455556	0.970736
8	5	3.333333	4.010417	0.556007
9	4.5	2	3.401961	0.606844
10	5	2	3.411905	0.707784



	Combined Date No Stack			
Month	High	Low	Average	Standard Deviation
1	6	2	4.270408	0.964918
2	4.5	2.5	3.833333	0.645497
3	3.8	2	3.315152	0.499191
4	4.5	3.5	3.833333	0.57735
5	5	3	3.5	0.763763
6	7	3	4.3333333	1.274149
7	6	2.4	3.7375	1.476422
8	6	2.66666667	4.1111111	1.455513
9	4	3	3.566667	0.438854
10	4.25	2.5	3.535714	0.602574
11	5	5	5	none

Wilcoxian Rank Sum Tests

This section calculates an alternative to the t-test known as the Wilcoxon rank-sum test that is distribution free or a non-parametric test. The Wilcoxon Rank Sum test can be used to test our null hypothesis of $3.00 per acre foot to see if our two combined scenarios (stack no call and no stacking with a call) are statistically different from this expectation. All of the following tests evaluate how accurate the experiment was for each scenario.

T Val: It represents the difference between the mean or average scores of two groups.

M: Represents the maximum probability that in that specified scenario and month a high trade volume will occur.

Sigma: It is defined as a measuring method used to measure the capability of a process. It tells us the range of the distribution. The higher the number the more accurate the results are.

Summary

Rank Sum for Combined no Stacking with a Call

Scenario	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T Val	273	234	154	12	49	145	52	39	125	63	2	0
M	203	175.5	126.5	10.5	52.5	105	68	39	105	52.5	1.5	0
Sigma	21.76	19.5	15.23	2.29	7.83	13.23	9.52	6.24	21.76	21.76	0.5	0

Rank Sum for Combined Stacking without a Call

Scenario	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T Val	222	208	462	260	301	222	345	392	340	245	0	0
M	150	175.5	451.5	175.5	203	150	232.5	264	297.5	203	0	0
Sigma	17.32	19.5	39.75	19.5	21.76	17.32	21.56	26.53	29.03	21.76	0	0

III: Welfare Effects

Expected and Observed Economic Welfare (in dollars)

This section presents the expected welfare that each ditch in the upper Mimbres basin would receive if market trading was not allowed and the economic welfare that was observed when market trading was allowed. This allows for a calculation of welfare gains or losses as a result of trading.

Table 10: Expected and Observed Economic Welfare

Ditch	Expected Welfare (no Call)	Expected Welfare (call)	Call / No stack 1	Call / No Stack 2	No Call / Stack 1	No Call / Stack 2
Grijalva	$396.00	$348.00	$376.01	$334.59	$l366.09	$361.50
Montoya	$297.00	$264.00	$210.00	$253.59	$195.00	$192.00
Kenly 1	$288.00	$228.00	$288.00	$288.00	$300.00	$298.50
Kenly 2	$411.00	$327.00	$399.00	$411.00	$411.00	$421.50
Heuchling 1	$48.00	$48.00	$49.01	$48.00	$48.00	$42.00
Heuchling 2	$33.00	$33.00	$33.00	$33.00	$33.00	$36.00
Heuchling 3	$27.00	$27.00	$27.00	$27.00	$33.75	$34.50
Heuchling 4	$111.00	$111.00	$111.00	$54.00	$48.00	$49.50
San Lorenzo	$2,367.00	$2,367.00	$2,229.00	2,307.00	$2,234.55	2,234.55
Casas Adobes	$0.00	$0.00	$162.75	$174.65	$168.48	$175.09
Supplemental Wells	$0.00	$0.00	$144.80	$156.78	$141.27	$161.10
Total	**$3,978.00**	**$3,753.00**	**$4,029.56**	**$4,087.62**	**$3,979.14**	**$4,006.24**

Economic Welfare Gains and Losses as a Percentage

This section present the economic welfare as a percentage gain or loss from the expected welfare in the previous section. We observe greater economic welfare gains when market trading in allowed in times of a call with small gains from a market if stacking is allowed.

Table 11: Percentage Welfare Gains / Losses from Trading

Ditch	**Call / No stack 1**	**Call / No Stack 2**	**No Call / Stack 1**	**No Call / Stack 2**
Grijalva	8.05%	-3.85%	-7.55%	-8.71%
Montoya	-20.45%	-3.94%	-34.34%	-35.35%
Kenly 1	26.32%	26.32%	4.17%	3.65%
Kenly 2	22.02%	25.69%	0.00%	2.55%
Heuchling 1	2.09%	0.00%	0.00%	-12.50%
Heuchling 2	0.00%	0.00%	0.00%	9.09%
Heuchling 3	0.00%	0.00%	25.00%	27.78%
Heuchling 4	0.00%	-51.35%	-56.76%	-55.41%
San Lorenzo	-5.83%	-2.53%	-5.60%	-5.60%
Casas Adobes	163.00%	175.00%	168%	175%
Supplemental Wells	145.00%	157.00%	141%	161%
Total	**7.37%**	**8.92%**	**0.03%**	**0.71%**

IV: Raw Data

This section presents the raw data for each of the four treatments. This is the data used to conduct the previous analyses.

No Stack with Call 1

Month	accepted	acceptedTime	from	id	price	pricePerQuantity	priority	quantity	submittedTime	to	transactionId
1											
1	TRUE		grijalva	1	5	2.5	1893	2	2012-9-28-10:53:23 AM		
1	TRUE	2012-9-28-10:56:13 AM	kenly_2	2	4	2	1894	2	2012-9-28-10:53:26 AM	misc_pumping	5
1				3	12	2.4	1894	5	2012-9-28-10:53:39 AM	casas_adobes	
1				4	28	4	1870	7	2012-9-28-10:53:40 AM	kenly_1	
1	TRUE	2012-9-28-10:54:5 AM	heuchling_1	5	10	5	1870	2	2012-9-28-10:53:49 AM	kenly_2	1
1				6	20	2	1870	10	2012-9-28-10:53:53 AM	montoya	
1	TRUE		grijalva	7	10	5	1893	2	2012-9-28-10:53:58 AM		
1	TRUE	2012-9-28-10:54:42 AM	san_lorenzo	8	12	4	1869	3	2012-9-28-10:54:36 AM	heuchling_1	2
1	TRUE		grijalva	9	8	4	1893	2	2012-9-28-10:54:40 AM		
1				10	15	3	1880	5	2012-9-28-10:55:5 AM	heuchling_4	
1				12	15	3	1893	5	2012-9-28-10:55:9 AM	casas_adobes	
1	TRUE	2012-9-28-10:55:33 AM	montoya	13	30	4.285714286	1880	7	2012-9-28-10:55:27 AM	kenly_1	3
1	TRUE	2012-9-28-10:55:44 AM	grijalva	14	6	3	1893	2	2012-9-28-10:55:37 AM	casas_adobes	4
1				15	9	3	1870	3	2012-9-28-10:55:53 AM	kenly_2	
1	TRUE	2012-9-28-10:56:19 AM	grijalva	16	8	4	1893	2	2012-9-28-10:56:11 AM	heuchling_2	6
1	TRUE		san_lorenzo	17	10	5	1869	2	2012-9-28-10:56:13 AM		
1				18	9	1.8	1894	5	2012-9-28-10:56:37 AM	misc_pumping	
1				19	18	3.6	1894	5	2012-9-28-10:56:57 AM	casas_adobes	

1				20	12	3	1869	4	2012-9-28-10:57:5 AM	heuchling_1	
2	TRUE		grijalva	21	10	5	1893	2	2012-9-28-10:58:26 AM		
2				22	10	2	1894	5	2012-9-28-10:58:31 AM	misc_pumping	
2				23	20	2.857142857	1880	7	2012-9-28-10:58:34 AM	montoya	
2				24	15	3	1894	5	2012-9-28-10:58:35 AM	casas_adobes	
2	TRUE	2012-9-28-10:59:40 AM	heuchling_1	25	14	3.5	1870	4	2012-9-28-10:58:40 AM	kenly_2	8
2	TRUE	2012-9-28-11:1:47 AM	heuchling_1	26	20	5	1870	4	2012-9-28-10:58:45 AM	kenly_1	13
2	TRUE	2012-9-28-10:59:14 AM	san_lorenzo	27	13	4.333333333	1869	3	2012-9-28-10:59:5 AM	grijalva	7
2				28	10	3.333333333	1894	3	2012-9-28-10:59:29 AM	heuchling_2	
2				29	9	3	1869	3	2012-9-28-10:59:56 AM	heuchling_4	
2	TRUE	2012-9-28-11:0:6 AM	grijalva	30	5	2.5	1893	2	2012-9-28-10:59:59 AM	casas_adobes	9
2				31	25	5	1869	5	2012-9-28-11:0:29 AM	heuchling_1	
2				32	16	2	1894	8	2012-9-28-11:0:45 AM	misc_pumping	
2	TRUE	2012-9-28-11:0:53 AM	kenly_2	33	9	3	1894	3	2012-9-28-11:0:46 AM	casas_adobes	10
2	TRUE	2012-9-28-11:1:33 AM	san_lorenzo	35	18	4.5	1869	4	2012-9-28-11:1:16 AM	heuchling_1	11
2	TRUE	2012-9-28-11:1:38 AM	montoya	36	7	3.5	1880	2	2012-9-28-11:1:30 AM	heuchling_2	12
2	TRUE		heuchling_2	37	7	3.5	1870	2	2012-9-28-11:2:3 AM		
3	TRUE	2012-9-28-11:4:54 AM	kenly_2	38	20	2	1894	10	2012-9-28-11:3:37 AM	misc_pumping	15
3				39	27	3	1880	9	2012-9-28-11:3:40 AM	montoya	
3				40	12	3	1880	4	2012-9-28-11:3:44 AM	casas_adobes	
3	TRUE	2012-9-28-11:3:57 AM	heuchling_1	41	7	3.5	1880	2	2012-9-28-11:3:49 AM	heuchling_2	14
3	TRUE		heuchling_2	42	3	3	1893	1	2012-9-28-11:4:17 AM		
3				43	20	2.222222222	1880	9	2012-9-28-11:4:21 AM	montoya	
3				44	10	2	1893	5	2012-9-28-11:4:27 AM	kenly_2	
3				45	3	3	1880	1	2012-9-28-11:4:44 AM	heuchling_2	
3				46	6	3	1893	2	2012-9-28-11:5:0 AM	casas_adobes	

3	TRUE		grijalva	47	8	4	1893	2	2012-9-28-11:5:4 AM		
3				48	40	4	1869	10	2012-9-28-11:5:24 AM	heuchling_1	
3	TRUE		san_lorenzo	49	14	4.666666667	1869	3	2012-9-28-11:5:28 AM		
3				50	19	1.9	1894	10	2012-9-28-11:5:28 AM	misc_pumping	
3	TRUE	2012-9-28-11:5:50 AM	grijalva	51	7	3.5	1893	2	2012-9-28-11:5:38 AM	casas_adobes	16
3				52	14	2.8	1893	5	2012-9-28-11:5:44 AM	kenly_2	
3	TRUE	2012-9-28-11:5:59 AM	montoya	53	7	3.5	1893	2	2012-9-28-11:5:45 AM	casas_adobes	17
3				54	25	5	1869	5	2012-9-28-11:6:36 AM	heuchling_1	
3				55	9	3	1880	3	2012-9-28-11:6:54 AM	kenly_2	
3	TRUE	2012-9-28-11:7:12 AM	heuchling_1	56	3	3	1893	1	2012-9-28-11:6:57 AM	heuchling_2	18
4				57	19	1.9	1894	10	2012-9-28-11:8:47 AM	misc_pumping	
4				58	30	3	1870	10	2012-9-28-11:8:51 AM	montoya	
4				59	5	2.5	1880	2	2012-9-28-11:8:53 AM	casas_adobes	
4				60	30	3	1880	10	2012-9-28-11:9:15 AM	montoya	
4				61	30	3	1870	10	2012-9-28-11:9:29 AM	heuchling_1	
4				62	3	3	1870	1	2012-9-28-11:9:49 AM	heuchling_2	
4				63	24	2	1894	12	2012-9-28-11:10:8 AM	kenly_2	
4				64	5	2.5	1894	2	2012-9-28-11:10:24 AM	casas_adobes	
4				65	15	3	1870	5	2012-9-28-11:10:32 AM	heuchling_1	
4	TRUE	2012-9-28-11:11:8 AM	san_lorenzo	66	9	4.5	1869	2	2012-9-28-11:10:52 AM	heuchling_1	19
4				67	7	3.5	1894	2	2012-9-28-11:11:24 AM	casas_adobes	
4				68	21	2.1	1894	10	2012-9-28-11:11:28 AM	kenly_2	
4	TRUE		heuchling_1	69	5	5	1870	1	2012-9-28-11:12:24 AM		
5				70	20	2	1894	10	2012-9-28-11:13:43 AM	misc_pumping	
5				71	6	3	1870	2	2012-9-28-11:13:43 AM	casas_adobes	
5	TRUE	2012-9-28-11:14:51 AM	heuchling_1	72	8	4	1870	2	2012-9-28-11:14:38 AM	casas_adobes	20
5				73	20	2	1894	10	2012-9-28-11:14:49	kenly_2	

									AM		
5				74	25	5	1870	5	2012-9-28-11:15:25 AM	heuchling_1	
5				75	15	3	1869	5	2012-9-28-11:15:26 AM	san_lorenzo	
5				76	9	3	1869	3	2012-9-28-11:15:29 AM	heuchling_4	
5	TRUE	2012-9-28-11:16:35 AM	heuchling_2	77	5	5	1893	1	2012-9-28-11:15:58 AM	grijalva	21
5	TRUE		heuchling_1	78	6	6	1870	1	2012-9-28-11:16:31 AM		
5	TRUE	2012-9-28-11:17:22 AM	heuchling_1	79	3	3	1880	1	2012-9-28-11:17:2 AM	heuchling_2	22
5				80	11	2.2	1894	5	2012-9-28-11:17:12 AM	kenly_2	
6				81	12	2.4	1894	5	2012-9-28-11:19:20 AM	casas_adobes	
6				82	30	3	1870	10	2012-9-28-11:19:21 AM	montoya	
6				83	20	2	1894	10	2012-9-28-11:19:22 AM	misc_pumping	
6				84	20	5	1870	4	2012-9-28-11:19:25 AM	heuchling_1	
6	TRUE		heuchling_2	85	6	6	1893	1	2012-9-28-11:19:37 AM		
6	TRUE	2012-9-28-11:20:6 AM	san_lorenzo	86	15	5	1869	3	2012-9-28-11:19:58 AM	casas_adobes	23
6	TRUE	2012-9-28-11:20:26 AM	montoya	87	32	4	1880	8	2012-9-28-11:20:8 AM	kenly_1	24
6				88	23	2.3	1893	10	2012-9-28-11:20:13 AM	kenly_2	
6	TRUE		grijalva	89	5	5	1893	1	2012-9-28-11:20:24 AM		
6	TRUE	2012-9-28-11:20:41 AM	heuchling_2	90	7	7	1870	1	2012-9-28-11:20:33 AM	heuchling_1	25
6	TRUE	2012-9-28-11:21:3 AM	san_lorenzo	91	12	6	1869	2	2012-9-28-11:20:57 AM	heuchling_1	26
6				92	9	2.25	1893	4	2012-9-28-11:21:1 AM	kenly_2	
6	TRUE		grijalva	94	9	4.5	1893	2	2012-9-28-11:21:28 AM		
6				95	3	3	1880	1	2012-9-28-11:21:38 AM	casas_adobes	
6				96	23	2.3	1894	10	2012-9-28-11:21:59 AM	misc_pumping	

7				97	23	2.3	1894	10	2012-9-28-11:24:8 AM	misc_pumping	
7				98	25	5	1870	5	2012-9-28-11:24:23 AM	heuchling_1	
7				99	7	3.5	1869	2	2012-9-28-11:24:38 AM	casas_adobes	
7	TRUE		heuchling_2	100	6	6	1893	1	2012-9-28-11:24:57 AM		
7	TRUE	2012-9-28-11:25:49 AM	heuchling_2	101	6	6	1870	1	2012-9-28-11:25:43 AM	heuchling_1	27
7	TRUE	2012-9-28-11:25:55 AM	san_lorenzo	102	12	6	1869	2	2012-9-28-11:25:49 AM	heuchling_1	28
7	TRUE		heuchling_2	103	7	7	1880	1	2012-9-28-11:26:17 AM		
7	TRUE	2012-9-28-11:26:46 AM	montoya	104	4	4	1880	1	2012-9-28-11:26:32 AM	casas_adobes	29
7				105	15	5	1870	3	2012-9-28-11:27:0 AM	heuchling_1	
7	TRUE		kenly_2	106	20	4	1870	5	2012-9-28-11:27:7 AM		
7	TRUE		heuchling_2	107	7	7	1880	1	2012-9-28-11:27:30 AM		
7	TRUE		kenly_2	108	26	5.2	1870	5	2012-9-28-11:27:33 AM		
8				109	24	2.4	1894	10	2012-9-28-11:29:24 AM	misc_pumping	
8				110	25	5	1870	5	2012-9-28-11:29:27 AM	heuchling_1	
8				111	6	3	1893	2	2012-9-28-11:29:38 AM	casas_adobes	
8	TRUE		heuchling_2	112	7	7	1880	1	2012-9-28-11:29:41 AM		
8	TRUE	2012-9-28-11:30:39 AM	san_lorenzo	113	17	5.666666667	1869	3	2012-9-28-11:30:32 AM	heuchling_1	30
8				114	10	2	1893	5	2012-9-28-11:30:46 AM	kenly_2	
8	TRUE	2012-9-28-11:31:11 AM	san_lorenzo	115	18	6	1869	3	2012-9-28-11:31:4 AM	heuchling_1	31
8	TRUE		heuchling_2	116	7	7	1870	1	2012-9-28-11:31:4 AM		
8	TRUE		san_lorenzo	117	20	6.666666667	1869	3	2012-9-28-11:31:44 AM		
8	TRUE	2012-9-28-11:32:9 AM	montoya	118	13	4.333333333	1894	3	2012-9-28-11:31:55 AM	casas_adobes	32
8				119	12	3	1893	4	2012-9-28-11:32:15 AM	kenly_2	
8	TRUE		heuchling_2	120	6	6	1870	1	2012-9-28-11:32:28 AM		
8	TRUE		heuchling_1	121	7	7	1869	1	2012-9-28-11:32:35 AM		

9				122	10	2.5	1894	4	2012-9-28-11:34:39 AM	kenly_2	
9	TRUE		grijalva	123	10	5	1893	2	2012-9-28-11:34:44 AM		
9	TRUE		heuchling_2	124	21	7	1870	3	2012-9-28-11:34:45 AM		
9	TRUE		heuchling_1	125	6	6	1869	1	2012-9-28-11:34:45 AM		
9				126	6	3	1894	2	2012-9-28-11:34:53 AM	misc_pumping	
9				127	13	3.25	1894	4	2012-9-28-11:35:14 AM	kenly_2	
9	TRUE		san_lorenzo	128	10	5	1869	2	2012-9-28-11:35:17 AM		
9	TRUE	2012-9-28-11:35:49 AM	montoya	129	8	4	1893	2	2012-9-28-11:35:17 AM	casas_adobes	34
9	TRUE		heuchling_2	130	15	5	1870	3	2012-9-28-11:35:19 AM		
9	TRUE	2012-9-28-11:35:43 AM	grijalva	131	4	4	1893	1	2012-9-28-11:35:38 AM	casas_adobes	33
9	TRUE		heuchling_2	132	12	4	1870	3	2012-9-28-11:35:52 AM		
9	TRUE		heuchling_1	133	5	5	1869	1	2012-9-28-11:35:58 AM		
9	TRUE	2012-9-28-11:36:29 AM	grijalva	134	4	4	1893	1	2012-9-28-11:36:14 AM	kenly_2	35
9	TRUE		heuchling_4	135	10	10	1870	1	2012-9-28-11:36:27 AM		
9	TRUE		san_lorenzo	136	7	3.5	1869	2	2012-9-28-11:36:32 AM		
9	TRUE	2012-9-28-11:36:48 AM	grijalva	137	4	4	1893	1	2012-9-28-11:36:42 AM	kenly_2	36
9	TRUE		heuchling_2	138	11	3.666666667	1870	3	2012-9-28-11:36:47 AM		
9	TRUE		heuchling_1	139	4	4	1869	1	2012-9-28-11:36:50 AM		
9	TRUE	2012-9-28-11:37:23 AM	san_lorenzo	140	7	3.5	1869	2	2012-9-28-11:37:0 AM	misc_pumping	37
9	TRUE		grijalva	141	4	4	1893	1	2012-9-28-11:37:2 AM		
9	TRUE	2012-9-28-11:37:29 AM	montoya	142	14	3.5	1894	4	2012-9-28-11:37:22 AM	kenly_2	38
9	TRUE		heuchling_2	143	10	3.333333333	1870	3	2012-9-28-11:37:29 AM		
9	TRUE	2012-9-28-11:38:6 AM	san_lorenzo	144	11	3.666666667	1869	3	2012-9-28-11:37:50 AM	misc_pumping	39
9				145	14	3.5	1894	4	2012-9-28-11:37:53 AM	kenly_2	
10				146	6	3	1893	2	2012-9-28-11:39:34 AM	casas_adobes	

10	TRUE		heuchling_4	147	10	10	1870	1	2012-9-28-11:39:34 AM		
10				148	19	2.375	1894	8	2012-9-28-11:39:38 AM	misc_pumping	
10	TRUE		heuchling_2	149	4	4	1870	1	2012-9-28-11:39:40 AM		
10	TRUE		heuchling_2	150	5	5	1870	1	2012-9-28-11:39:57 AM		
10	TRUE		kenly_1	151	25	6.25	1894	4	2012-9-28-11:40:1 AM		
10	TRUE		grijalva	152	5	5	1893	1	2012-9-28-11:40:3 AM		
10	TRUE		kenly_2	153	15	3	1870	5	2012-9-28-11:40:17 AM		
10	TRUE	2012-9-28-11:40:24 AM	san_lorenzo	154	17	4.25	1869	4	2012-9-28-11:40:19 AM	misc_pumping	40
10	TRUE	2012-9-28-11:41:1 AM	grijalva	155	8	4	1893	2	2012-9-28-11:40:48 AM	casas_adobes	41
10	TRUE		san_lorenzo	156	18	4.5	1869	4	2012-9-28-11:40:52 AM		
10	TRUE		heuchling_2	157	5	2.5	1893	2	2012-9-28-11:41:11 AM		
10	TRUE	2012-9-28-11:42:5 AM	san_lorenzo	158	10	2.5	1869	4	2012-9-28-11:41:56 AM	misc_pumping	42
10				159	20	2.5	1894	8	2012-9-28-11:41:58 AM	misc_pumping	
10	TRUE		kenly_2	160	3	1.5	1893	2	2012-9-28-11:42:6 AM		
10	TRUE		heuchling_2	161	2	2	1870	1	2012-9-28-11:42:19 AM		
10	TRUE	2012-9-28-11:42:39 AM	san_lorenzo	162	15	3.75	1869	4	2012-9-28-11:42:26 AM	misc_pumping	43
10	TRUE	2012-9-28-11:43:9 AM	san_lorenzo	163	15	3.75	1869	4	2012-9-28-11:42:55 AM	grijalva	44
10	TRUE		heuchling_2	164	3	1.5	1893	2	2012-9-28-11:43:7 AM		
10				165	16	2	1894	8	2012-9-28-11:43:15 AM	misc_pumping	
11				166	5	2.5	1894	2	2012-9-28-11:45:8 AM	misc_pumping	
11	TRUE		heuchling_2	167	2	1	1893	2	2012-9-28-11:45:8 AM		
11	TRUE		kenly_2	168	2	1	1893	2	2012-9-28-11:45:15 AM		
11	TRUE		kenly_1	169	32	2	1880	16	2012-9-28-11:45:16 AM		
11				170	3	3	1894	1	2012-9-28-11:46:4 AM	misc_pumping	
11	TRUE		heuchling_2	171	2	1	1880	2	2012-9-28-11:46:40 AM		
11				172	4	4	1894	1	2012-9-28-11:47:6 AM	misc_pumping	
11	TRUE	2012-9-28-11:48:17	heuchling_1	173	5	5	1870	1	2012-9-28-11:47:16	casas_adobes	45

	AM						AM	
11		174	5	5	1894	1	2012-9-28-11:47:40 AM	misc_pumping

No Stack with Call 2

month	accepted	acceptedTime	from	id	price	pricePerQuantity	priority	quantity	submittedTime	to
1				3	5	2.5	1894	2	2012-10-5-10:53:24 AM	misc_pumping
1				4	5	2.5	1894	2	2012-10-5-10:53:25 AM	casas_adobes
1				7	14	2.8	1880	5	2012-10-5-10:53:47 AM	kenly_2
1				8	6	3	1894	2	2012-10-5-10:53:50 AM	casas_adobes
1				14	15	3	1894	5	2012-10-5-10:55:37 AM	heuchling_4
1				16	5	2.5	1894	2	2012-10-5-10:55:52 AM	heuchling_2
1				17	20	4	1869	5	2012-10-5-10:56:18 AM	heuchling_1
1	TRUE		grijalva	6	9	4.5	1893	2	2012-10-5-10:53:36 AM	
1	TRUE		san_lorenzo	12	14	4.666666667	1869	3	2012-10-5-10:55:6 AM	
1	TRUE		grijalva	18	4	4	1893	1	2012-10-5-10:56:52 AM	
1	TRUE		heuchling_1	19	13	4.333333333	1870	3	2012-10-5-10:56:54 AM	
2				21	14	2.8	1894	5	2012-10-5-10:58:21 AM	misc_pumping
2				22	5	2.5	1894	2	2012-10-5-10:58:22 AM	heuchling_2
2				24	6	3	1893	2	2012-10-5-10:58:27 AM	casas_adobes
2				25	10	3.333333333	1870	3	2012-10-5-10:58:53 AM	heuchling_1
2				29	15	3	1894	5	2012-10-5-10:59:55	misc_pumping

								AM	
2			30	15	3	1894	5	2012-10-5-11:0:20 AM	heuchling_4
2			33	18	3.6	1894	5	2012-10-5-11:1:17 AM	misc_pumping
2	TRUE	montoya	28	50	5	1880	10	2012-10-5-10:59:49 AM	
3			35	7	2.333333333	1893	3	2012-10-5-11:3:29 AM	casas_adobes
3			36	10	3.333333333	1870	3	2012-10-5-11:3:29 AM	heuchling_1
3			43	5	2.5	1894	2	2012-10-5-11:4:36 AM	heuchling_4
3			46	3	3	1894	1	2012-10-5-11:5:18 AM	casas_adobes
3			47	3	3	1870	1	2012-10-5-11:5:23 AM	heuchling_1
3			48	3	3	1894	1	2012-10-5-11:5:38 AM	heuchling_4
3	TRUE	san_lorenzo	38	12	4	1869	3	2012-10-5-11:3:45 AM	
3	TRUE	grijalva	39	8	4	1893	2	2012-10-5-11:3:54 AM	
3	TRUE	montoya	40	100	5	1880	20	2012-10-5-11:3:55 AM	
3	TRUE	montoya	49	100	4.166666667	1869	24	2012-10-5-11:6:28 AM	
3	TRUE	heuchling_4	50	12	4	1870	3	2012-10-5-11:6:30 AM	
3	TRUE	grijalva	51	7	3.5	1893	2	2012-10-5-11:6:30 AM	
4			53	3	3	1870	1	2012-10-5-11:8:31 AM	heuchling_1
4			56	5	2.5	1894	2	2012-10-5-11:8:42 AM	misc_pumping
4	TRUE	grijalva	54	4	4	1893	1	2012-10-5-11:8:35 AM	
4	TRUE	heuchling_4	55	13	4.333333333	1870	3	2012-10-5-11:8:37 AM	
4	TRUE	montoya	57	100	4.166666667	1869	24	2012-10-5-11:8:44 AM	
4	TRUE	san_lorenzo	58	8	4	1869	2	2012-10-5-11:8:45 AM	
4	TRUE	heuchling_4	60	12	4	1870	3	2012-10-5-11:9:33 AM	
4	TRUE	montoya	62	100	4	1869	25	2012-10-5-11:10:6 AM	
4	TRUE	grijalva	63	7	3.5	1893	2	2012-10-5-11:10:17 AM	
4	TRUE	san_lorenzo	64	14	3.5	1869	4	2012-10-5-11:10:59 AM	
5			67	5	2.5	1894	2	2012-10-5-11:13:38 AM	misc_pumping
5			69	6	3	1894	2	2012-10-5-11:13:41 AM	casas_adobes

5			72	3	3	1894	1	2012-10-5-11:14:21 AM	casas_adobes
5			74	2	2	1870	1	2012-10-5-11:14:34 AM	heuchling_1
5			75	3	3	1894	1	2012-10-5-11:15:2 AM	heuchling_4
5	TRUE	grijalva	66	7	3.5	1893	2	2012-10-5-11:13:35 AM	
5	TRUE	montoya	70	100	4	1869	25	2012-10-5-11:14:3 AM	
5	TRUE	heuchling_4	71	4	4	1870	1	2012-10-5-11:14:4 AM	
5	TRUE	san_lorenzo	73	7	3.5	1869	2	2012-10-5-11:14:29 AM	
5	TRUE	montoya	78	100	3.703703704	1869	27	2012-10-5-11:16:12 AM	
5	TRUE	grijalva	79	7	3.5	1893	2	2012-10-5-11:16:18 AM	
5	TRUE	heuchling_4	81	99	99	1870	1	2012-10-5-11:17:11 AM	
6			82	5	2.5	1894	2	2012-10-5-11:18:53 AM	misc_pumping
6			85	3	3	1870	1	2012-10-5-11:19:2 AM	heuchling_1
6	TRUE	grijalva	83	12	4	1893	3	2012-10-5-11:18:58 AM	
6	TRUE	montoya	84	100	4	1869	25	2012-10-5-11:19:2 AM	
6	TRUE	san_lorenzo	87	4	4	1869	1	2012-10-5-11:19:4 AM	
6	TRUE	montoya	89	70	3.5	1869	20	2012-10-5-11:19:30 AM	
6	TRUE	heuchling_1	90	5	5	1870	1	2012-10-5-11:19:34 AM	
6	TRUE	heuchling_1	94	4	4	1870	1	2012-10-5-11:20:34 AM	
6	TRUE	san_lorenzo	96	11	3.666666667	1869	3	2012-10-5-11:20:43 AM	
6	TRUE	grijalva	97	12	4	1893	3	2012-10-5-11:20:51 AM	

6	TRUE	grijalva	98	9	3	1893	3	2012-10-5-11:21:50 AM	
7			99	3	3	1870	1	2012-10-5-11:24:24 AM	heuchling_1
7			101	8	2.666666667	1894	3	2012-10-5-11:24:31 AM	misc_pumping
7			103	3	3	1893	1	2012-10-5-11:24:44 AM	casas_adobes
7	TRUE	grijalva	100	7	3.5	1893	2	2012-10-5-11:24:28 AM	
7	TRUE	montoya	102	70	3.5	1869	20	2012-10-5-11:24:32 AM	
7	TRUE	san_lorenzo	105	10	3.333333333	1869	3	2012-10-5-11:24:53 AM	
7	TRUE	grijalva	110	3	3	1893	1	2012-10-5-11:26:30 AM	
7	TRUE	heuchling_4	111	16	4	1870	4	2012-10-5-11:27:27 AM	
7	TRUE	kenly_1	112	300	6	1894	50	2012-10-5-11:27:57 AM	
7	TRUE	heuchling_4	113	15	3.75	1870	4	2012-10-5-11:28:7 AM	
8			115	3	3	1870	1	2012-10-5-11:29:50 AM	heuchling_1
8			116	5	2.5	1893	2	2012-10-5-11:29:55 AM	casas_adobes
8	TRUE	san_lorenzo	117	11	3.666666667	1869	3	2012-10-5-11:30:11 AM	
8	TRUE	montoya	118	70	3.5	1880	20	2012-10-5-11:30:13 AM	
8	TRUE	grijalva	120	7	3.5	1893	2	2012-10-5-11:31:3 AM	
8	TRUE	san_lorenzo	121	10	3.333333333	1869	3	2012-10-5-11:31:4 AM	
8	TRUE	grijalva	123	3	3	1893	1	2012-10-5-11:32:21 AM	
8	TRUE	heuchling_1	124	4	4	1870	1	2012-10-5-11:32:29	

								AM	
8	TRUE	heuchling_4	125	11	3.666666667	1870	3	2012-10-5-11:32:59 AM	
9			128	8	2.666666667	1893	3	2012-10-5-11:35:16 AM	casas_adobes
9	TRUE	kenly_1	129	20	4	1880	5	2012-10-5-11:35:24 AM	
9	TRUE	montoya	130	70	3.5	1869	20	2012-10-5-11:35:26 AM	
9	TRUE	san_lorenzo	131	10	3.333333333	1869	3	2012-10-5-11:35:31 AM	
9	TRUE	san_lorenzo	133	13	3.25	1869	4	2012-10-5-11:37:34 AM	
9	TRUE	grijalva	134	3	3	1893	1	2012-10-5-11:38:35 AM	
10			137	8	2.666666667	1894	3	2012-10-5-11:40:25 AM	casas_adobes
10			144	4	2	1894	2	2012-10-5-11:42:19 AM	casas_adobes
10	TRUE	kenly_1	135	15	3.75	1894	4	2012-10-5-11:40:16 AM	
10	TRUE	grijalva	136	4	4	1893	1	2012-10-5-11:40:18 AM	
10	TRUE	san_lorenzo	138	7	3.5	1869	2	2012-10-5-11:40:26 AM	
10	TRUE	montoya	139	70	3.5	1869	20	2012-10-5-11:40:34 AM	
10	TRUE	grijalva	142	7	3.5	1893	2	2012-10-5-11:41:13 AM	
10	TRUE	grijalva	145	3	3	1893	1	2012-10-5-11:42:30 AM	
11	TRUE	montoya	147	100	3.703703704	1869	27	2012-10-5-11:46:6 AM	
11	TRUE	heuchling_4	148	100000	100000	1894	1	2012-10-5-11:46:15 AM	

Stacking without Call 1

Month	accepted	acceptedTime	from	id	price	pricePerQuantity	priority	quantity	submittedTime	to
1				1	10	2	1894	5	2012-9-28-11:56:48 AM	misc_pumping
1				3	23	2.3	1893	10	2012-9-28-11:56:50 AM	kenly_2
1				5	15	3	1880	5	2012-9-28-11:57:2 AM	montoya
1				6	10	2	1880	5	2012-9-28-11:57:3 AM	heuchling_2
1				7	8	2	1870	4	2012-9-28-11:57:3 AM	heuchling_1
1				9	14	2.8	1894	5	2012-9-28-11:57:14 AM	heuchling_4
1				11	6	3	1894	2	2012-9-28-11:57:25 AM	casas_adobes
1				13	7	3.5	1869	2	2012-9-28-11:57:57 AM	casas_adobes
1				14	8	2	1870	4	2012-9-28-11:58:3 AM	heuchling_1
1				15	20	3.333333333	1893	6	2012-9-28-11:58:10 AM	kenly_2
1				16	7	2.333333333	1893	3	2012-9-28-11:58:15 AM	heuchling_2
1				17	10	3.333333333	1893	3	2012-9-28-11:59:24 AM	kenly_2
1				19	8	2.666666667	1893	3	2012-9-28-11:59:49 AM	heuchling_2
1				20	3	3	1869	1	2012-9-28-11:59:56 AM	casas_adobes

1	21	3	3	1894	1	2012-9-28-0:0:9 PM	heuchling_4
1	22	2	0.5	1870	4	2012-9-28-0:0:28 PM	heuchling_1
2	23	5	2.5	1880	2	2012-9-28-0:2:1 PM	heuchling_2
2	24	5	2.5	1894	2	2012-9-28-0:2:7 PM	heuchling_4
2	25	25	5	1870	5	2012-9-28-0:2:7 PM	heuchling_1
2	26	12	2.4	1894	5	2012-9-28-0:2:9 PM	misc_pumping
2	28	28	2.8	1880	10	2012-9-28-0:2:18 PM	montoya
2	30	12	3	1893	4	2012-9-28-0:2:27 PM	kenly_2
2	31	25	5	1870	5	2012-9-28-0:2:29 PM	heuchling_1
2	33	10	3.333333333	1880	3	2012-9-28-0:2:41 PM	kenly_1
2	34	10	3.333333333	1869	3	2012-9-28-0:2:49 PM	casas_adobes
2	35	14	3.5	1880	4	2012-9-28-0:3:2 PM	kenly_2
2	36	10	3.333333333	1894	3	2012-9-28-0:3:14 PM	casas_adobes
2	38	5	2.5	1894	2	2012-9-28-0:3:36 PM	heuchling_2
2	39	15	3	1894	5	2012-9-28-0:4:10 PM	misc_pumping
2	40	10	5	1870	2	2012-9-28-0:4:21 PM	heuchling_1
2	41	6	3	1894	2	2012-9-28-0:4:37 PM	heuchling_4
2	42	5	2.5	1893	2	2012-9-28-0:5:11 PM	heuchling_2
3	44	15	3	1894	5	2012-9-28-0:7:35 PM	misc_pumping
3	45	15	3	1894	5	2012-9-28-0:7:38 PM	heuchling_4
3	46	14	2.8	1880	5	2012-9-28-0:7:39 PM	montoya
3	47	5	2.5	1893	2	2012-9-28-0:7:42 PM	heuchling_2
3	51	7	3.5	1870	2	2012-9-28-0:8:17 PM	casas_adobes
3	54	5	2.5	1894	2	2012-9-28-0:8:41 PM	heuchling_2
3	56	8	2.666666667	1893	3	2012-9-28-0:10:21 PM	heuchling_2
3	57	6	3	1893	2	2012-9-28-0:10:29 PM	heuchling_4

3	58	24	4.8	1870	5	2012-9-28-0:10:52 PM	heuchling_1
3	59	3	3	1894	1	2012-9-28-0:10:52 PM	heuchling_2
3	60	6	2	1894	3	2012-9-28-0:11:14 PM	kenly_2
4	61	26	2.6	1894	10	2012-9-28-0:13:8 PM	misc_pumping
4	62	5	2.5	1880	2	2012-9-28-0:13:19 PM	heuchling_2
4	64	28	2.8	1880	10	2012-9-28-0:13:29 PM	montoya
4	69	9	3	1894	3	2012-9-28-0:13:56 PM	heuchling_4
4	70	7	3.5	1893	2	2012-9-28-0:14:2 PM	casas_adobes
4	72	5	2.5	1894	2	2012-9-28-0:14:34 PM	heuchling_2
4	73	15	3	1880	5	2012-9-28-0:15:2 PM	heuchling_1
4	76	6	3	1894	2	2012-9-28-0:15:53 PM	heuchling_2
4	77	6	3	1880	2	2012-9-28-0:16:25 PM	heuchling_2
5	78	26	2.6	1894	10	2012-9-28-0:18:42 PM	misc_pumping
5	80	6	3	1870	2	2012-9-28-0:18:53 PM	grijalva
5	81	6	3	1894	2	2012-9-28-0:18:55 PM	heuchling_4
5	82	10	3.333333333	1893	3	2012-9-28-0:18:56 PM	kenly_2
5	83	3	3	1894	1	2012-9-28-0:18:58	casas_adobes

						PM	
5	85	29	2.9	1880	10	2012-9-28-0:19:15 PM	montoya
5	89	3	3	1894	1	2012-9-28-0:19:50 PM	heuchling_2
5	92	12	3	1880	4	2012-9-28-0:21:6 PM	heuchling_1
6	95	27	2.7	1894	10	2012-9-28-0:23:53 PM	misc_pumping
6	96	29	2.9	1880	10	2012-9-28-0:23:57 PM	montoya
6	97	15	3	1894	5	2012-9-28-0:24:12 PM	heuchling_4
6	98	5	2.5	1893	2	2012-9-28-0:24:12 PM	heuchling_2
6	103	7	3.5	1869	2	2012-9-28-0:24:54 PM	grijalva
6	104	18	3	1880	6	2012-9-28-0:25:15 PM	heuchling_1
6	108	8	2.666666667	1894	3	2012-9-28-0:25:44 PM	heuchling_2
6	110	9	3	1894	3	2012-9-28-0:25:55 PM	misc_pumping
6	111	8	2.666666667	1893	3	2012-9-28-0:26:48 PM	heuchling_2
6	112	8	2.666666667	1894	3	2012-9-28-0:27:31 PM	heuchling_2
7	113	6	3	1894	2	2012-9-28-0:29:25 PM	casas_adobes
7	115	30	3	1894	10	2012-9-28-0:29:30 PM	misc_pumping
7	11	40	2	1880	20	2012-9-28-0:29:36	montoya

	6					PM	
7	11 7	12	3	1880	4	2012-9-28-0:29:36 PM	heuchling_4
7	12 3	4	4	1869	1	2012-9-28-0:31:8 PM	grijalva
7	12 4	9	3	1880	3	2012-9-28-0:31:8 PM	kenly_2
7	12 6	33	3.3	1894	10	2012-9-28-0:31:26 PM	misc_pumpin g
8	13 0	33	3.3	1894	10	2012-9-28-0:34:36 PM	misc_pumpin g
8	13 1	6	3	1894	2	2012-9-28-0:34:37 PM	casas_adobes
8	13 2	30	3	1880	10	2012-9-28-0:34:42 PM	montoya
8	13 5	5	2.5	1894	2	2012-9-28-0:35:1 PM	heuchling_2
8	14 3	35	3.5	1894	10	2012-9-28-0:36:43 PM	misc_pumpin g
8	14 4	13	3.25	1894	4	2012-9-28-0:38:6 PM	misc_pumpin g
9	14 5	13	3.25	1894	4	2012-9-28-0:39:37 PM	misc_pumpin g
9	14 8	10	3.333333333	1894	3	2012-9-28-0:39:53 PM	casas_adobes
9	14 9	30	3	1893	10	2012-9-28-0:39:53 PM	montoya
9	15 6	4	4	1880	1	2012-9-28-0:41:37 PM	grijalva
9	16 1	8	2	1894	4	2012-9-28-0:42:42 PM	misc_pumpin g

10	165	8	2	1894	4	2012-9-28-0:45:43 PM	misc_pumping
10	168	25	2.5	1893	10	2012-9-28-0:46:8 PM	montoya
10	173	6	3	1894	2	2012-9-28-0:47:38 PM	casas_adobes
10	178	1	0.1	1894	10	2012-9-28-0:49:1 PM	casas_adobes
11	180	1	1	1894	1	2012-9-28-0:50:55 PM	casas_adobes
11	181	5	5	1894	1	2012-9-28-0:51:9 PM	misc_pumping
12							

Stacking without Call 2

month	accepted	acceptedTime	from	id	price	pricePerQuantity	priority	quantity	submittedTime	to
1				2	15	3	1894	5	2012-10-5-11:53:33 AM	heuchling_4
1				4	15	3	1880	5	2012-10-5-11:53:33 AM	kenly_2
1				5	15	3	1894	5	2012-10-5-11:53:33 AM	misc_pumping
1				9	16	2.666666667	1894	6	2012-10-5-11:53:41 AM	heuchling_2
1				10	9	3	1870	3	2012-10-5-11:53:49 AM	heuchling_3
1				11	3	3	1880	1	2012-10-5-11:53:52 AM	grijalva
1				14	15	3	1894	5	2012-10-5-11:55:5 AM	heuchling_4
1				15	4	4	1869	1	2012-10-5-11:55:24 AM	san_lorenzo
1				16	13	3.25	1880	4	2012-10-5-11:55:47 AM	kenly_2
1				17	15	3	1880	5	2012-10-5-11:55:50 AM	kenly_1
1				21	14	3.5	1880	4	2012-10-5-11:56:56 AM	kenly_2
1	TRUE		san_lorenzo	3	8	4	1869	2	2012-10-5-11:53:33 AM	
1	TRUE		montoya	7	100	5	1880	20	2012-10-5-11:53:37 AM	
1	TRUE		montoya	12	100	4	1880	25	2012-10-5-11:54:31 AM	
1	TRUE		san_lorenzo	18	7	3.5	1869	2	2012-10-5-11:56:0 AM	
2				25	5	1.666666667	1894	3	2012-10-5-11:58:30 AM	heuchling_2

2			26	3	3	1894	1	2012-10-5-11:58:31 AM	heuchling_4
2			27	5	1.25	1894	4	2012-10-5-11:58:37 AM	heuchling_1
2			31	8	2.666666667	1894	3	2012-10-5-11:58:53 AM	heuchling_2
2			34	8	2.666666667	1894	3	2012-10-5-11:59:3 AM	misc_pumping
2			38	11	2.75	1880	4	2012-10-5-0:0:27 PM	kenly_2
2			40	5	2.5	1894	2	2012-10-5-0:0:58 PM	heuchling_1
2	TRUE	san_lorenzo	29	11	3.666666667	1869	3	2012-10-5-11:58:43 AM	
2	TRUE	montoya	37	100	3.571428571	1880	28	2012-10-5-0:0:21 PM	
2	TRUE	san_lorenzo	39	7	3.5	1869	2	2012-10-5-0:0:38 PM	
2	TRUE	san_lorenzo	41	10	3.333333333	1869	3	2012-10-5-0:1:39 PM	
3			42	11	2.75	1894	4	2012-10-5-0:3:45 PM	misc_pumping
3			45	8	2.666666667	1894	3	2012-10-5-0:3:55 PM	casas_adobes
3			46	9	3	1894	3	2012-10-5-0:3:55 PM	heuchling_4
3			47	5	2.5	1894	2	2012-10-5-0:4:0 PM	heuchling_1
3			50	3	3	1880	1	2012-10-5-0:4:6 PM	grijalva
3			58	9	3	1880	3	2012-10-5-0:5:35 PM	kenly_2
3	TRUE	montoya	43	100	3.846153846	1880	26	2012-10-5-0:3:49 PM	
3	TRUE	san_lorenzo	49	10	3.333333333	1869	3	2012-10-5-0:4:2 PM	
3	TRUE	montoya	52	70	3.684210526	1880	19	2012-10-5-0:4:25 PM	
3	TRUE	san_lorenzo	60	13	3.25	1869	4	2012-10-5-0:6:11 PM	
3	TRUE	montoya	65	60	3.75	1880	16	2012-10-5-0:7:15 PM	
4			67	5	2.5	1893	2	2012-10-5-0:9:12 PM	casas_adobes
4			68	11	2.75	1894	4	2012-10-5-0:9:16 PM	misc_pumping
4			78	12	3	1894	4	2012-10-5-0:10:57 PM	misc_pumping
4	TRUE	heuchling_2	71	4	4	1893	1	2012-10-5-0:9:26 PM	
4	TRUE	grijalva	72	7	3.5	1893	2	2012-10-5-0:9:45 PM	
4	TRUE	heuchling_4	73	12	4	1870	3	2012-10-5-0:9:55 PM	
4	TRUE	montoya	76	70	3.5	1880	20	2012-10-5-0:10:19 PM	
4	TRUE	san_lorenzo	77	10	3.333333333	1869	3	2012-10-5-0:10:22 PM	

4	TRUE	grijalva	80	4	4	1893	1	2012-10-5-0:11:54 PM	
4	TRUE	montoya	81	70	3.5	1880	20	2012-10-5-0:12:0 PM	
4	TRUE	heuchling_4	82	4	4	1870	1	2012-10-5-0:12:30 PM	
5			83	8	2.666666667	1894	3	2012-10-5-0:14:46 PM	casas_adobes
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5	TRUE	montoya	85	70	3.5	1880	20	2012-10-5-0:14:54 PM	
5	TRUE	san_lorenzo	86	13	3.25	1869	4	2012-10-5-0:14:56 PM	
5	TRUE	grijalva	88	7	3.5	1893	2	2012-10-5-0:15:6 PM	
5	TRUE	heuchling_4	93	4	4	1870	1	2012-10-5-0:18:11 PM	
6			94	9	3	1894	3	2012-10-5-0:20:6 PM	misc_pumping
6			96	6	3	1894	2	2012-10-5-0:20:12 PM	casas_adobes
6			98	3	3	1880	1	2012-10-5-0:20:21 PM	kenly_2
6	TRUE	montoya	97	20	0.285714286	1880	70	2012-10-5-0:20:13 PM	
6	TRUE	grijalva	100	7	3.5	1893	2	2012-10-5-0:20:49 PM	
6	TRUE	montoya	101	70	3.5	1880	20	2012-10-5-0:20:50 PM	
6	TRUE	heuchling_4	104	4	4	1870	1	2012-10-5-0:22:31 PM	
6	TRUE	san_lorenzo	105	11	3.666666667	1869	3	2012-10-5-0:22:32 PM	
6	TRUE	san_lorenzo	106	10	3.333333333	1869	3	2012-10-5-0:22:53 PM	
7			107	9	3	1894	3	2012-10-5-0:25:25 PM	misc_pumping
7			109	30	3	1869	10	2012-10-5-0:25:38 PM	montoya
7	TRUE	san_lorenzo	108	11	3.666666667	1869	3	2012-10-5-0:25:36 PM	
7	TRUE	heuchling_1	111	10	10	1870	1	2012-10-5-0:25:57 PM	
7	TRUE	heuchling_1	113	6	6	1870	1	2012-10-5-0:26:27 PM	
7	TRUE	heuchling_4	116	9	4.5	1870	2	2012-10-5-0:26:44 PM	
7	TRUE	heuchling_1	117	5	5	1870	1	2012-10-5-0:27:0 PM	
7	TRUE	heuchling_4	119	4	4	1870	1	2012-10-5-0:27:56 PM	
7	TRUE	san_lorenzo	120	10	3.333333333	1869	3	2012-10-5-0:28:12 PM	
8			121	6	3	1894	2	2012-10-5-0:30:49 PM	misc_pumping
8	TRUE	heuchling_1	123	5	5	1870	1	2012-10-5-0:31:4 PM	
8	TRUE	montoya	124	70	3.5	1880	20	2012-10-5-0:31:12 PM	
8	TRUE	heuchling_4	125	4	4	1870	1	2012-10-5-0:31:18 PM	
8	TRUE	san_lorenzo	129	11	3.666666667	1869	3	2012-10-5-0:32:2 PM	
8	TRUE	san_lorenzo	133	10	3.333333333	1869	3	2012-10-5-0:34:33 PM	

9			134	6	3	1894	2	2012-10-5-0:36:16 PM	casas_adobes
9			135	9	3	1894	3	2012-10-5-0:36:18 PM	misc_pumping
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9	TRUE	san_lorenzo	136	10	3.333333333	1869	3	2012-10-5-0:36:23 PM	
9	TRUE	montoya	137	70	3.5	1880	20	2012-10-5-0:36:28 PM	
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Appendix 7: Water Leasing Market Rules for the Mimbres Basin Active Water Resource Management Areas

I. **Authorization**

These rules are promulgated pursuant to the authority granted the New Mexico State Engineer in section19.25.13 of the New Mexico Administrative Code(NMAC) to implement Active Water Resources Management, specifically water markets in the State of New Mexico. Provisions for Expedited Marketing and Leasing in the Mimbres Basin are stipulated in section 19.25.22.516 of the NMAC.

II. **Scope, Purpose and Application**

a. **Scope**: These rules apply to the establishment and operation of a water leasing market for water rights holders in the Upper, Middle and Lower Mimbres Active Water Resource Management Areas.

b. **Purpose**: The purpose of these rules is to implement a water leasing market that simplifies and facilitates the exchange of water between senior and junior water rights holders (see Figure A1). These rules are also intended to increase the availability of water-related information and assist water rights holders by developing a mechanism to realize the value of their water right assets without forcing the permanent severance of those water rights from the land. The ultimate purpose of the water leasing market is to promote the beneficial use of water within the Mimbres River Basin.

The water leasing market is consistent with the Water Banking provisions set forth in Chapter 73-2-55-1 of the 2011 New Mexico Statutes (NMS) that allows water rights owners who are temporarily not using some or all of their water rights to benefit by protecting those rights from loss for non-use. The water leasing market provides an alternative for water rights owners to lease rather than bank their rights.

c. **Application**: The proposed market is intended to support the following applications:

i. Provide an expedited mechanism to transfer water from senior to junior water rights holders in time of priority administration of the basin.

ii. Provide an expedited mechanism for a water user to acquire additional water for beneficial use purposes above the rights currently held.

III. **Definitions**

a. **Active Water Resource Management Area**: A stream section managed according to the principles of Active Water Resource Management, 19.25.13 of the NMAC.

b. **Beneficial Use:** The basis, measure and limit of a water right under New Mexico State Constitution Article XVI Section 3. Beneficial Use, as defined, shall apply to the operations of the Water Leasing Bank.

c. **Crop irrigation requirement (CIR):** The quantity of irrigation water, expressed as a depth or volume, exclusive of effective rainfall, that is consumptively used by plants or is evaporated from the soil surface during one calendar year. The CIR may be numerically determined by subtracting effective rainfall from the consumptive use.

d. **Community ditch:** An irrigation ditch managed and maintained by the local community it serves. Community ditch associations are considered legal subdivisions of the state pursuant to Chapter 73-2-28 of the NMS.
e. **Ditch Commission:** The primary administration body of an irrigation ditch.
f. **Duty of water (farm delivery requirement):** The average quantity of water that is delivered on an annual basis to the farm headgate or is diverted from a source of water that originates on the farm itself - such as a well or spring - to satisfy the consumptive irrigation requirement of crops grown on a farm. In practice, the farm delivery requirement is estimated by dividing the crop irrigation requirement by the irrigation efficiency.
g. **Irrigation efficiency:** The portion of the duty of water, expressed as a percentage, consumed to meet the crop irrigation requirement.
h. **Mimbres Markey Authority:** An elected private partnership that administers the water leasing market and is entitled to charge a transaction fee to cover the market‘s administrative costs.
i. **Priority administration:** provision of New Mexico law in which the State Engineer or water master appointed by the State Engineer is legally authorized in times of shortage to allocate water in accordance with the different priority dates, if necessary by curtailing the use of junior water users.
j. **Priority date:** The applicable administration date associated with a water right, which is generally related to the date the water right was first put to beneficial use.
k. **Stacked water**: Water applied to a particular parcel of land that is above the currently approved CIR but still meets the definition of beneficial use.
l. **State engineer:** The New Mexico state engineer, or his designated appointee.
m. **Transit loss:** Losses realized in delivering water from the point of diversion to a ditch headgate. The difference between the Farm Delivery Requirement and the Crop Irrigation Requirement.
n. **Waste:** Diversion of water in excess of that amount reasonably necessary to supply a beneficial use in accordance with accepted water use practices that are consistent with considerations of water conservation.
o. **Water leasing market:** Any process within a district in which water rights are subject to priority administration whereby changes in use or place of use of water may be effected so as to minimize costly and time-consuming administrative procedures.
p. **Water master:** An official duly appointed by, and under the general supervision of, the state engineer, pursuant to Chapter 72-3-2 of the NMS, who shall have immediate charge of the diversions and distribution of waters in the water master district.
q. **Water right:** The right to divert and beneficially use the public waters of the state of New Mexico.

IV. **Owner may Lease Use of Water (from Chapter 72-6-3 NMS 2011)**

a. An owner may lease all or any part of the water use due him under his water right, and the owner's water right shall not be affected by the lease of the use. The use to which the owner is entitled under his right shall, during the exercise of the lease, be reduced by the amount of water so leased. Upon termination of the lease, the water use and location of use subject to the lease shall revert to the owner's original use and location of use.

b. The lease may be effective for immediate use of water or may be effective for future use of the water covered by the lease; however, the lease shall not be effective to cumulate water from year to year or to substantially enlarge the use of the water in such manner that it would injure other water users. The lease shall not toll any forfeiture of water rights for nonuse, and the owner shall not, by reason of the lease, escape the forfeiture for nonuse prescribed by law; provided, however, that the state engineer shall notify both the owner and the lessee of declaration of nonuser as provided in Chapters 72-5-28 and 72-12-8 NMS 2011.
c. A water use deriving from an acequia or community ditch organized pursuant to Chapter 73, Article 2 or 3 NMS 2011, whether owned by a water right owner under the acequia or community ditch or by the acequia or community ditch may be leased for a term not to exceed ten years.

V. **Limitations on the Water Leasing Market**

a. Nothing in these rules is intended to restrict the ability of the holder of a water right to sell, lease, option or exchange that water right in any other manner that is currently permitted under New Mexico law (Chapter 72 NMS 2011).
b. Participation in the water leasing market is completely voluntary.
c. The market shall operate within the existing requirements of New Mexico water law (Chapter 72 NMS 2011).
d. The market shall operate in accordance with the by-laws of the participating ditch associations.
e. The lease of water cannot lead to waste of Mimbres Basin water resources. Toward this end, the New Mexico State Engineer will establish limits to the quantity of stackable water, which will vary by crop, number of croppings per year, and prevailing climate conditions.
f. Leased water will retain its original priority date. Thus junior water rights holders who lease water with a senior priority will continue to have access to their leased water (but not to their junior water) in times of priority administration.
g. These rules shall not permit any expansion in the consumptive use of existing water rights in the Mimbres Basin beyond that promulgated under the 1993 Final Decree, *Mimbres Valley Irrigation Co. vs. Salopek et al*.
h. The water leasing market shall not be used to export water out of the Mimbres Basin.

VI. **Listing and Bidding Process**

a. All bids and offers are posted through the Mimbres Market Authority. Prior to posting the Authority will verify that a perspective offerer has current ownership of the water right, while perspective bidders will be verified in terms of their ability to put the desired water to beneficial use.
b. Bids and offers to lease water will be centrally posted at a location that is equally accessible to residents of the three Mimbres AWRM areas.
c. Listing of current bids and offers will also be available on the Authority‘s web site and at the NMOSE‘s Deming Office.

d. The listing shall include, at a minimum, the amount of water for lease, its current point of diversion, the priority date, length of lease, and the minimum acceptable price.
e. Proposed leases must stipulate the proposed timing of water use. That is, will the leased water be put to immediate use or will the water be used only in the event of a priority call.
f. Leases must reflect appropriate transit losses as defined in Section VIII.c. of this rule set.
g. Bids and offers that go unclaimed after a period of 30 days will be dropped from the list.

VII. **Transaction Procedures**

a. Once a lease agreement has been negotiated between the leasor and leasee, a signed agreement will be submitted to the Mimbres Market Authority describing the transaction, including but not limited to the amount of water, the original place of use, the proposed place of use, and the proposed time of use.
b. If the proposed lease is negotiated between members of the same ditch, the ditch commission or delegate will review the request for potential impacts on other water users on the ditch. This review will consider the criteria established in Section VIII.d. of this rule set. If approved the lessor and lessee shall provide written consent of the ditch commission or delegate, including any terms or conditions related to the lease. Review of the request is to be accomplished within 10 days of submittal.
c. If the proposed lease shall require delivery of water into a different ditch system, each ditch commission or delegate will review the request for potential impacts on other water users on their respective ditches. In addition, the Mimbres Market Authority will review the request for potential impacts on other ditches. These reviews will consider the criteria established in Section VIII.d. of this rule set. Review of the request is to be accomplished within 10 days of submittal.
d. If the proposed lease shall require delivery of water from a ditch to a domestic well, the ditch commission or delegate will review the request for potential impacts on other water users on the ditch. In addition, the Mimbres Market Authority will review the request for potential impacts on other ditches. These reviews will consider the criteria established in Section VIII.d. of this rule set. Review of the request is to be accomplished within 10 days of submittal.
e. Upon approval of the lease, the Mimbres Market Authority will finalize the agreement between the leasor and leasee. Once the agreement is finalized and all parties, including the Mimbres Market Authority, have been properly compensated, the Mimbres Market Authority will notify the respective ditch commissions or delegates and the AWRM Water Master of the completion of the transaction.

VIII. **Evaluation of Delivery Restrictions**

a. The ditch commission or delegate shall apply the criteria described below in approving and developing terms and conditions for proposed leases of water as set forth in Section VII above.
b. Only that portion of each unit of leased water determined to be consumable shall be deliverable less any amount deducted by the State Engineer for transit loss.

c. For proposed leases that will result in water delivery to another ditch, consideration of transit losses will be made. Transit losses will be determined by differences in individual ditch efficiencies. Transfers from a ditch of high efficiency to lower efficiency will result in a net reduction of deliverable leased water. The lessee will bear the loss. Loss factors for transfers between ditches are given in Table A1.
d. Leases will be approved if (see Chapter 72-6-5 NMS 2011):
    1. The applicant has reasonably shown that his proposed use and location of use is a beneficial use,
    2. The proposed use and location of use will not be contrary to the conservation of water within the state or detrimental to the public welfare of the state, or
    3. The proposed use and location of use will not impair any existing right to a greater degree than such right is, or would be, impaired by the continued use and location of use by the owner. Potential for impairment will be evaluated as needed using the Mimbres River Water Leasing Model.
e. Leases of water outside of an Active Water Resource Management area are not allowed.

IX. **Notice, Protest and Hearings (from Chapter 72-6-6 and 72-6-7 NMS 2011).**

a. Upon approval of the lease, the state engineer shall cause a notice of the filing to be published in a newspaper of general circulation in the county in which the water right is situated.
b. Any owner who believes his water rights will be adversely affected by the granting of the application may file a protest. The protest shall be specific as to how the granting of the application will adversely affect his water rights. The protest shall be filed in writing with the state engineer and a copy sent to the applicant by certified mail within ten days after the publication of notice of application.
c. If a protest is filed, the state engineer shall hold a hearing on the granting of the application, and the applicant and protestants shall be notified by the state engineer as to the date and place of the hearing.
d. If no objections are filed, the state engineer may grant the application without hearing. If no objections are filed and the state engineer denies the application, the state engineer shall hold a hearing if requested to do so by the applicant. The request shall be filed with the state engineer within ten days after the denial of the application.
e. If the state engineer grants the application but allows the applicant to use less water than the amount of water the owner would be allowed to use, the state engineer shall hold a hearing on the matter if requested to do so by the applicant. The request shall be filed with the state engineer within ten days after the granting of the application.
f. In a hearing before the state engineer, a full record and transcript of the proceeding shall be kept by him.
g. The final ruling of the engineer on such hearing may be appealed by either the applicant or a protestant. Such appeal shall be governed by the provisions of Chapter 72-7-1 through Chapter 72-7-3 NMS 2011.

X. **Procedures for Water Delivery**

a. The Mimbres Market Authority is responsible for notifying the affected ditch commission or delegate and the AWRM Water Master of an approved water lease transaction.
b. Where a transaction occurs between members of the same ditch it will be the responsibility of that ditch commission or delegate to administer the water lease.
c. Where a transaction occurs between different ditches or between a ditch and domestic well, the Water Master will determine the required adjustments to water deliveries at the headgates of the affected ditches.
d. Because of the limited reservoir capacity within the basin, no storage of leased water will be allowed.

XI. **Damages**

a. In the event that a water lease causes the non-delivery of water to another user, the lease will be immediately suspended. Delivery will be continued once hydrologic conditions allow (as determined by the Water Master [multi-ditch leases] or ditch commission [single ditch leases]).
b. The lessee bears the full risk of hydrologic events that prevent the full delivery of leased water. In such cases, all lessees will share equally in the shortage. The under delivery will be rectified as soon as Mimbres River flows are in excess of daily demands. Delivery criteria as defined in Section VIII are designed to limit the occurrence of under delivery.

XII. **Administration of the Water Leasing Market**

a. The Mimbres Market Authority will be responsible for basic administration and operation of the water leasing market.
b. The Mimbres Market Authority will be comprised of 3 members, one from each AWRM area. Each member will be appointed by the Ditch Commissions from the respective AWRM areas. Terms will be limited to 2 years.
c. The Mimbres Market Authority is authorized to charge transaction fees sufficient to cover the water leasing market‘s administration costs.

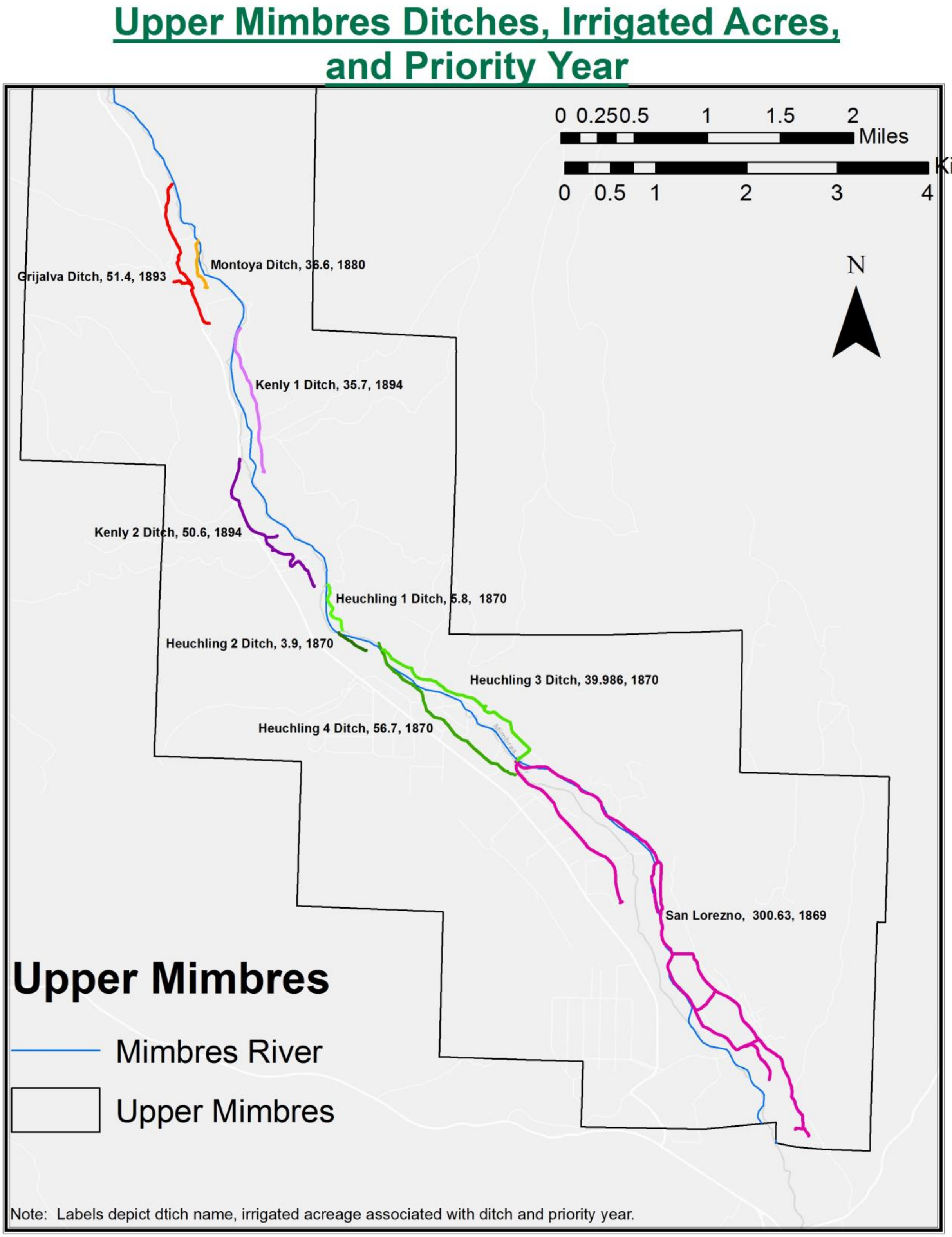

Figure A1a: Map of Upper Mimbres River, community ditches and their adjudicated acreage and priority date.

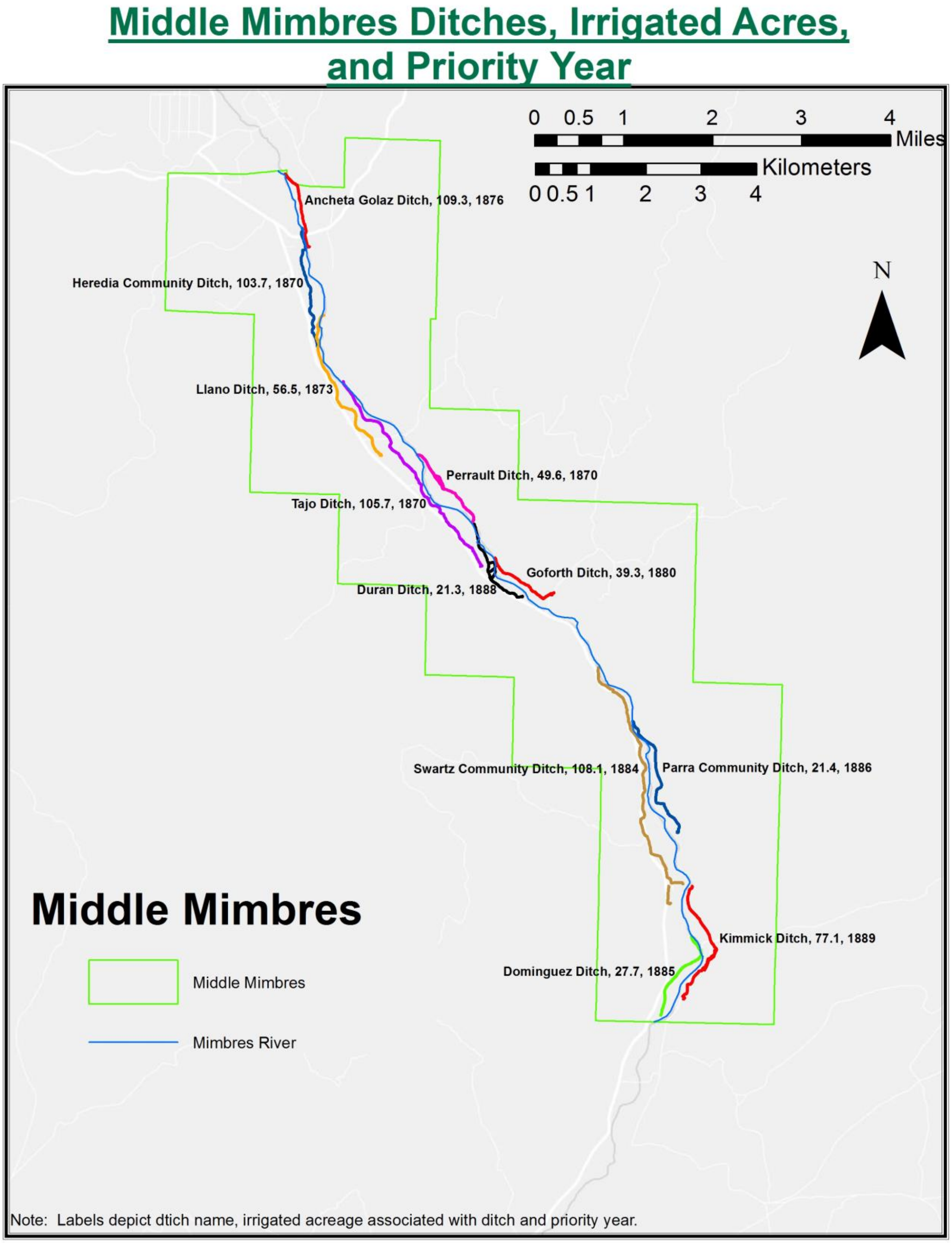

Figure A1b: Map of Middle Mimbres River, community ditches and their adjudicated acreage and priority date.

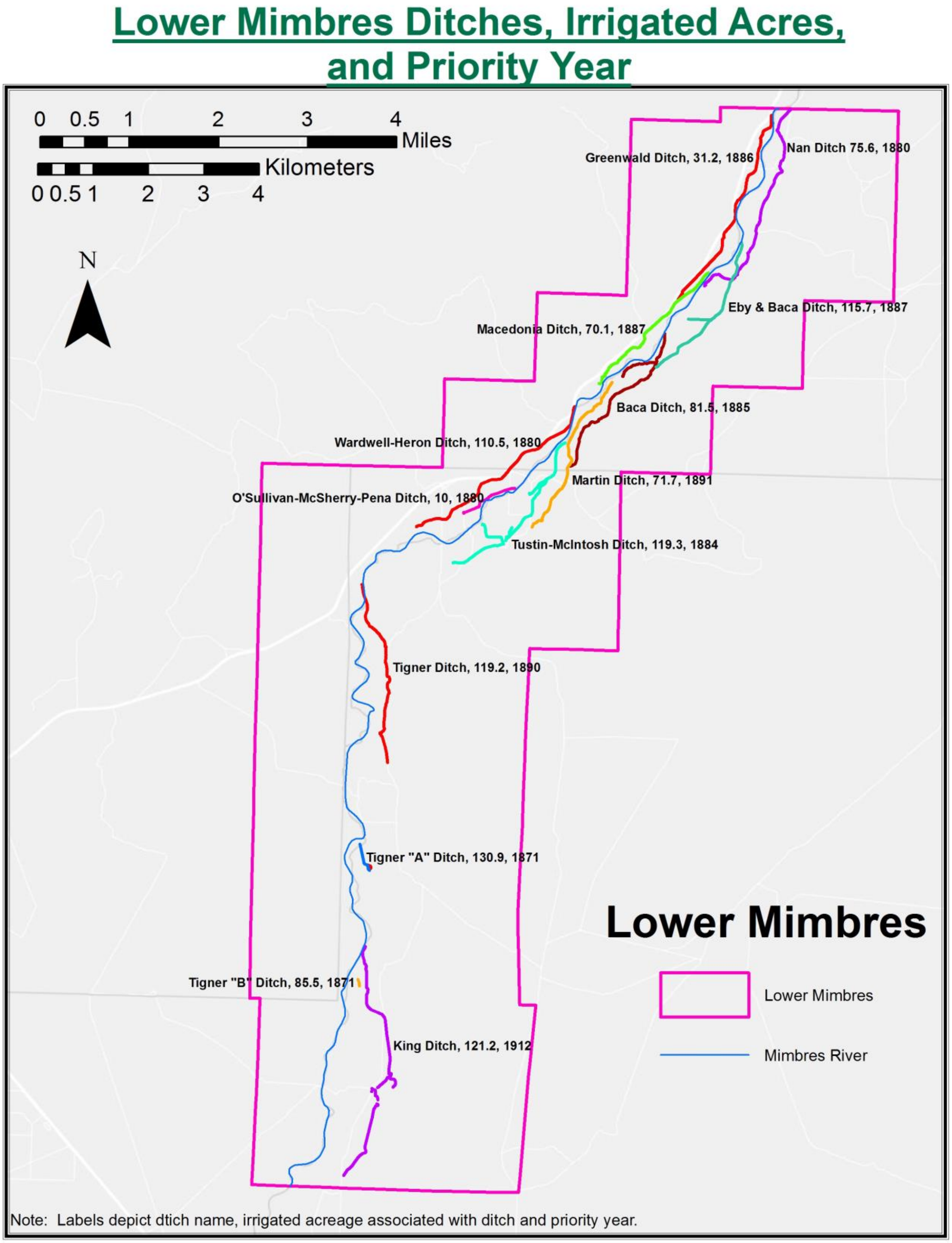

Figure A1c: Map of Lower Mimbres River, community ditches and their adjudicated acreage and priority date.

Table A1: Transit loss factors for the Upper, Middle and Lower Mimbres AWRM areas. Values represent the ratio of the CIR to CIR plus transit losses. The rows are the lessor and the columns the lessee.

Ditch	Grijalva	Montoya	Kenly	Heuchling	San Lorenzo
Grijalva	1	1	1	1	1
Montoya	1	1	1	1	1
Kenly	1	1	1	1	1
Heuchling	1	1	1	1	1
San Lorenzo	0.74	0.74	0.74	0.74	1

Note that all ditches have equivalent transit loss factors on the Middle and Lower reaches thus no tables are necessary.

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