

S&T Highlights

Improving Infrastructure Reliability

Reduced cost hydroelectric maintenance—complete protection system testing.— As a result of a \$20,000 Science and Technology Program (S&T) effort, many Reclamation facilities are now utilizing RTS, a relay testing software package, from Enoserv. The software package works with various manufacturers' test sets. In the past, each manufacturer's test set had to utilize the manufacturer's software package, requiring relay testers to learn and use new software and hardware for each test set used. With RTS, employees can use one software package and are able to share software test routines specific to Reclamation relays independent of the test set owned by the facility. The software package greatly facilitates working on newer microprocessor-based relays, reducing test time per relay from 5 staff days to less than 1 staff day per relay. This is equivalent to a potential savings of \$250,000 per year. Periodic protective relay testing is required/mandatory to ensure proper protection of Reclamation powerplant equipment, improve system reliability, and avoid regional blackouts, which can cost the U.S. economy several billions of dollars. (Nathan Myers, 303-445-2643)



Using RTS.



Improving Decision Support

Reclamation personnel contribute to geographers' conference.—Members of the Western Water Institutional Solutions (WWIS) research effort, including Reclamation personnel, organized and presented papers on water conflict and cooperation at the National Association of American Geographers conference in **San Francisco** in April of this year. Reclamation's strong presence demonstrated its commitment to leadership in the field of institutional solutions for Western water conflict. The WWIS team is also organizing a workshop for Reclamation managers on water conflict that will be held in Salt Lake City September 24-26, 2007. (Douglas Clark, 303-445-2271)



Reclamation personnel gave presentations at the National Association of American Geographers conference in San Francisco in April

Investigating alternate methods to automate irrigated and natural vegetation classification for water accounting.—The objective of this study is to develop an enhanced consumptive use model for the **Middle Rio Grande**. The model will incorporate an agriculture field level data base containing crop type and growth development stage from large scale aerial imagery, and irrigation status from multi-spectral imagery, which will be transferred to the field level. The research also includes updating riparian communities. Progress is being made in common land unit processing, the field boundary and crop status data base, and irrigation status mapping. The field level agriculture detail will provide more accurate consumptive use estimates, and the enhanced irrigation status mapping will identify shorted and added fields at greater detail to produce better scheduling and overall improved water accounting. (Ronald Miller, 303-445-2279)

Using remote sensing technology to facilitate the detection of river system changes.—The objective of this study is to develop data and techniques to evaluate in-stream sediment/surface changes documented from various mapping sources over time to evaluate the effectiveness of erosion control. The pilot test site is the highly eroded San Simon drainage in southeast **Arizona**. The change evaluation period is 65 years (1935-2001). Progress has been made recently in sediment/surface change evaluation, rectification of the 1935 historic plane table survey, and compensation for plane table data gaps.

The evaluation of the completed stream change will provide feedback in planning for erosion control as well as developing capability in dealing with documenting historical stream conditions, supplementing data limitations, and evaluating stream change at other sites. (Ronald Miller, 303-445-2279)

Investigating alternate methods for extracting hydraulic model measurements.—The objective of this study is to improve the automation, accuracy, and efficiency of hydraulic model measurements to better predict or correlate model operations to their real-world counterparts. Progress has been made recently in velocity measurement and surface change/sediment transport modeling.

Remote velocity measurements are beneficial in that they provide an inexpensive method to measure model hydraulics (velocity and subflow tracking). In addition, preliminary results show the technology could be effective in accurately measuring sediment change. Both techniques have the potential to improve accuracies and reduce costs. (Ronald Miller, 303-445-2279)

Improving Water Delivery Reliability

Arkansas River saltcedar control activities.—Reclamation staff are in their sixth year collecting quantifiable data monitoring the effects of the biocontrol insect, *Diorhabda elongata*, on saltcedar and associated vegetation. The Reclamation site at **Pueblo, Colorado**, was selected as one of eight locations in the U.S. for field research, and a multi-disciplinary team of researchers works on this project. This research will also quantify how quickly the remaining native grasses, forbs, and shrubs will recover once saltcedar is being controlled and will quantify the increase or decrease of other weedy groundcover species.

This research quantifies the effects of *Diorhabda* on resprouting saltcedar. Tree data and transect data sets have been collected since 2005 and compiled in electronic spreadsheets for future analysis. Biocontrol appears to be a sustainable, effective method of controlling saltcedar. (Denise Hosler, 303-445-2195)



Photos of the resprout study site in July 2006. Left: Monotypic salt cedar stand where 45 mature trees were monitored and GPS location taken. Right: Same site after mulch activity.



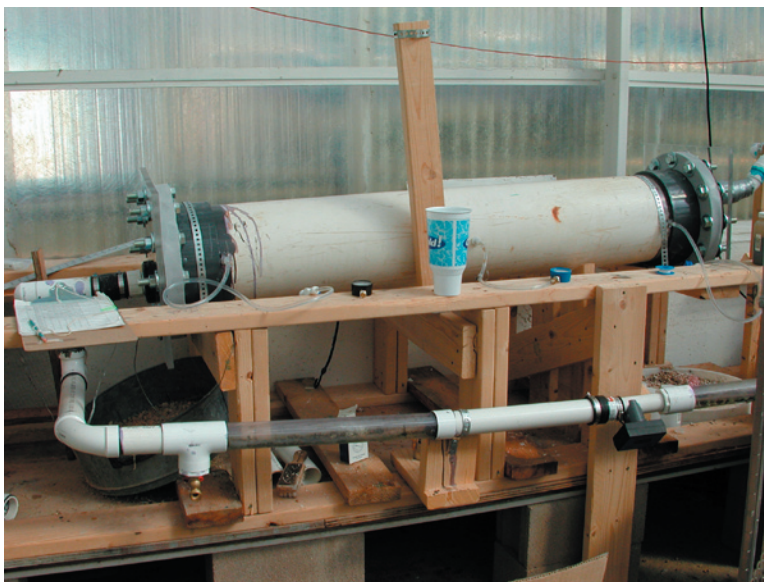
The resprout study site in August 2006 showing *Diorhabda elongata* damage to resprouts.



The resprout study site in June 2007 after the first 2007 data collection work, demonstrates that the site is primarily vegetated with forbs and a closeup of the damaged resprouts.

Drain clogging and prevention research.—Using S&T Program funding, **Technical Service Center** personnel in the Environmental Applications and Research Group continued cooperative work with Smith-Comesky Groundwater Science to evaluate dam drain clogging by simulating the microbiological and geochemical forces in floor models. The model drain systems were constructed using expedient materials and methods and operated with circulating water to approximate the cross-sectional scale of functioning drains. Flow rate, deposit composition, and water quality have been recorded over the time of operation and compared to site investigation results. The models exhibited changes in water quality and deposit compositions analogous to those associated with field studies of dam drains, including changes in water mineral content, deposition of calcite, sulfur-oxidizing, iron and manganese biofouling, and mineral deposits. Clogging-associated head loss changes were also induced. The two models exhibited different results associated with their fill composition and construction details. The model systems have demonstrated that field-type dam drain clogging phenomena and responses can be recreated at the “bench” scale, much as they have been with wells. Periodic video filming of the inner polyvinyl chloride (PVC) pipes in the Denver model has provided visual evidence of the clogging. The clogged models are now available for cleaning tests to plan more effective drain maintenance. Such models can be economically reproduced to resemble specific drain situations and used to calibrate mathematical modeling of such systems.

The data collected from these models will be used for two upcoming professional presentations, one for the Geological Society of America Meeting in October and the second for the Microbial Interest Group at the National Groundwater Association meeting in **Orlando, Florida**. (Denise Hosler, 303-445-2195)



Photograph of the Denver model.

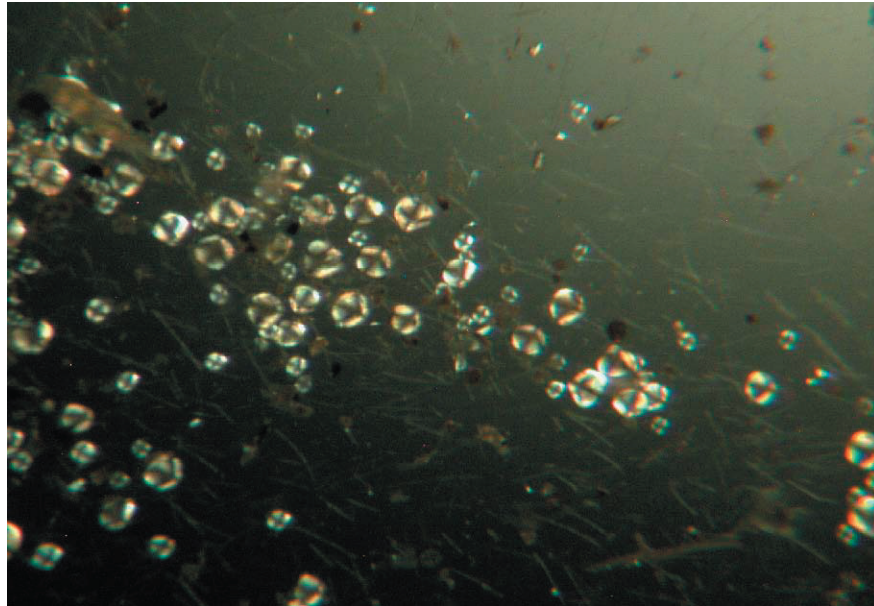


Closeup of the clear outflow pipe demonstrating the biofouling activity that is occurring in the bench scale model. The insert is a photo of the microscopic floc caused by iron bacteria in water systems that result in clogging of drains and wells.

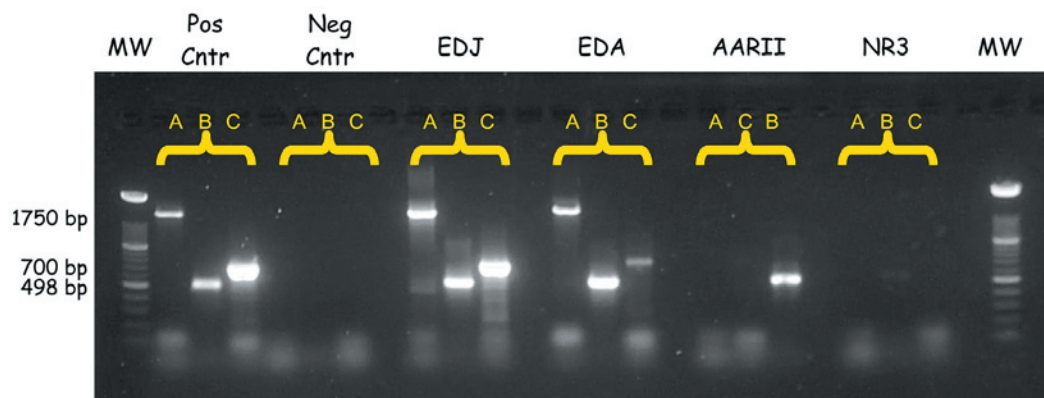
Zebra and quagga mussel monitoring using PCR.—Zebra mussels are a growing problem affecting the operation of municipal and industrial facilities, as well as impacting the natural balance of aquatic ecosystems. With their high reproductive rate and a limited number of natural predators, zebra mussels can rapidly populate freshwater lakes, reservoirs, and rivers. Since first found in Lake St. Claire in 1988, zebra mussels have spread as far south as Louisiana in the Mississippi and as far west as Kansas and Nebraska in the Arkansas and Missouri Rivers. Zebra mussels (*Dreissena polymorpha*) and quagga mussels (*D. bugensis*), a close relative, are capable of attaching to man-made surfaces and other underwater substrates. As a result, they can impede or block water flow and contribute to corrosion of metallic surfaces. These mussels typically spread as planktonic larvae (veligers) drifting downstream from infested bodies of freshwater or are transported overland on boats that have recently been used on infested waterways. Quaggas were recently discovered in **Lake Mead**, Nevada, and they now threaten Reclamation and other water facilities in the lower Colorado River.

A key issue for the management of zebra and quagga mussels is an ongoing vigilant monitoring program with accurate and early detection. With early detection, preventative or accommodating measures for the protection of dams and other structures may be implemented in a timely fashion. Until now, resource managers have relied on artificial substrates and plankton samples for detection. Substrates are slow to show reliable results, and microscopic examination of plankton to locate veligers is often difficult and uncertain.

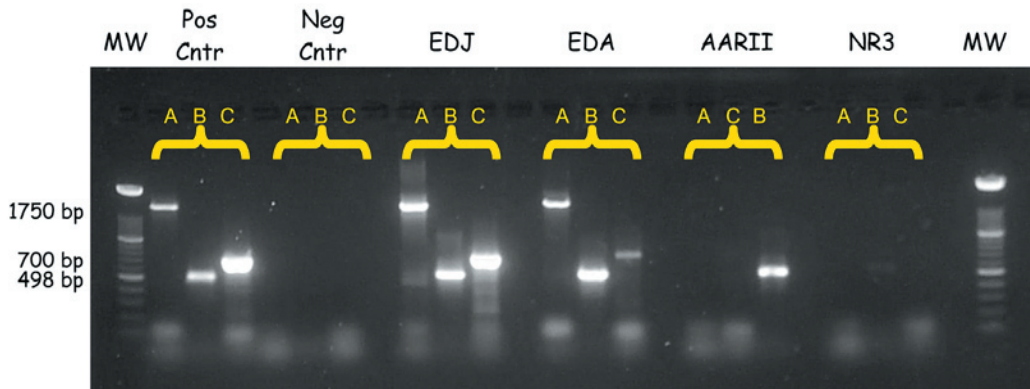
Our investigations are incorporating an established molecular biology method called Polymerase Chain Reaction (PCR) for the sensitive and unambiguous detection of DNA from zebra and quagga mussel larvae. It may be possible to detect veligers years earlier and at lower numbers than with previous methods alone. Implementation of the PCR capability, along with a plankton sample collection program, may be incorporated into the overall early detection strategy to minimize the impact of these mussels on Reclamation water delivery structures. (Kevin Kelly, 303-445-2017; Fred Nibling, 303-445-2202, Denise Hosler, 303-445-2195)



Zebra mussel veligers (bright round shape with “Maltese Cross” pattern) displayed under cross-polarized light microscopy. They are approximately 100µm in diameter. This sample was taken from **El Dorado Reservoir, Kansas**, on July 25, 2006.



Gel electrophoresis image for plankton tow samples collected from El Dorado Reservoir, Kansas, in July (EDJ) and August (EDA) of 2006. Samples were collected from the public boat dock at Shady Creek Marina. Zebra mussels were detected (Column C) in both July (EDJ) and August (EDA). The band in Column C of EDA is fainter than the corresponding band for EDJ. This indicates spawning has already peaked for the year.



Gel electrophoresis image for plankton tow samples collected from **Cheney Reservoir, Kansas**, in July and August of 2006. Samples were collected from the Sailboat Marina (CSBMJ and CSBMA), the intake for the Outlet Works (COWJ and COWA), and at the public Boat Dock (CDBJ and CBDA). For each sample, three separate sets of primers are used in this PCR analysis. No zebra mussels were detected at any of the three locations at Cheney (Column C).

Improving Water Supply Technologies

Geospatial technology integration with HydroGeoSphere.—Integration of geospatial tools to support data preparation, model input, and visualization of model output from the HydroGeoSphere (HGS) model accomplished a lot in the last quarter. Continued integration and refinement of the subsurface is ongoing. Training in the EarthVision software was completed, and research has started on how to integrate this with the modeling efforts. Model development is going well, and the HGS modeling staff spent a week in **Sacramento** assisting and integrating additional databases from a geographic information system. Research also continues on the groundwater model efforts from the University of Texas, **Austin**, and the groundwater modeling system (GMS). The GMS staff did a combined presentation at the ESRI International Users Conference in June on the status and future releases expected from GMS. Numerous important and critical integration tools will be released this fall that will support the ongoing efforts of this project.

Geospatial tools being researched also include:

- Groundwater modeling database designed at the University of Texas, Austin to provide a format through which the various models can communicate more easily.
- EarthVision to develop comprehensive coordinated geologic databases in coordination with the U.S. Geology Survey (USGS), Water Discipline.
- Groundwater modeling system (GMS) construction, visualization and model design for display and integration into the University of Texas database design.

(Lorri Peltz-Lewis, 916-978-5271)

*Modeling and field experimentation to determine the effects of terracing and small reservoirs on water supplies in the **Republican River Basin** above **Hardy, Nebraska**.*—Progress by the research team continues on several fronts in a study to quantify the effects of land terracing and small reservoirs on water supply. Data collection continues at five terrace sites with a new weir established at one of the terrace sites to collect data on the amount of water that flows from the terrace channel; the other terrace sites had closed ends, preventing discharge from the channels. Analysis of data collected at the terrace sites is under way. Data collected from 25-foot soil cores clearly indicated increased water content of the soil under the terrace channel as compared to the upslope contributing area. Data collection also continues at 32 small reservoir sites. Area-capacity-water level relations were developed through field surveys for the 11 small reservoirs in **Kansas** and for some of the small reservoirs in **Nebraska** during the past year. Some initial work has been done using the data collected at the small reservoirs to partition the water lost from the small reservoirs between evaporation and seepage. This work will continue to be refined as more reservoir water level data are collected.

Some initial work has been done to quantify water transmission losses in small streams in the basin. Data from two USGS gauging stations were used for selected runoff events to determine water losses in the stream reach between the gauge stations.

A more precise method to simulate the water balance for terraces has been developed. The original model used the runoff curve number method for the entire field using the upslope contributing area and the terrace channel area. The new approach uses a three-area system to model the operation of a terrace. These three defined areas allow for a more complete water balance calculation for the terraced area by operating a separate water balance for each of the areas. The model has been tested for different terrace type, cross-section dimensions, functioning conditions, and cropping pattern. These tests indicate that getting reasonable estimates of the areas of, types of, and condition of terraces in the various subwatersheds will be important in making reasonable estimates of the effects of terraces on runoff and percolation. A plan is in place to collect this critical information. Mapping of terraced lands in the Republican River Basin was completed in May 2007. There are 2.3 million acres of terraced land in the basin, between 300,000 and 600,000 acres more than previously estimated.

Reclamation manages the water supply at eight reservoirs in the Republican River Basin that supply irrigation water to about 137,360 acres as well as supplying municipal water, fish and wildlife benefit, and flood control. This research will improve the understanding of how land terracing and small reservoirs affect the water supply so Reclamation can properly manage and allocate the water supply and develop more useful and reliable river and reservoir operating plans. (Scott Guenther, 406-247-7736)

Testing of subgridding and subtiming schemes incorporated into HydroGeoSphere.—Reclamation and HydroGeoLogic (HGL) staff worked

together in Sacramento, California, to review existing hydrological and water-quality data in the **San Joaquin River Basin** (large scale) and drainage-water re-use system at Red Rock Ranch (small scale), Westside, San Joaquin River Basin. Activities accomplished during the visit by HGL staff included: review of large and small conceptual model reports submitted by HGL; site visits to the San Joaquin River Basin and Red Rock Ranch to familiarize HGL staff with main hydrologic and hydraulic features within the basin and at Red Rock Ranch; and a meeting of researchers and professionals from Federal and State agencies, universities, and private firms to exchange experience and information gained from the basin and Red Rock Ranch. Following these activities, site conceptual models were constructed, and various scenarios developed as the basis for testing the subgridding and subtiming schemes and evaluation of capability of the drainage-water reuse system at Red Rock Ranch to control drainage water and salinity. The results from the testing and evaluation will facilitate application of HGL to large watersheds and long simulation periods and design of optimal drainage-water reuse systems by Reclamation and other agencies. (George Matanga, 916-978-5084)

Radio-telemetered canal monitoring and control, field demonstration installations.—Water Resources Research Laboratory (WRRL) researchers, with funding support from Reclamation's S&T Program, have been working in cooperation the **Dakota Area Office (DKAO)**, the **Nebraska-Kansas Area Office (NKAO)** local irrigation districts to establish multiple geographically distributed field demonstration projects integrating radio/control technology into canal operations. In cooperation with the DKAO, a project including three gate automation and flow monitoring field sites is being established at the Angostura Irrigation District in southwestern **South Dakota**. All sites are being automated to maintain target discharge rates. Target values will be adjustable either through onsite keypad entry, or by radio telemetry from the district office via a PC connected to a base radio.

The NKAO and the Ainsworth Irrigation District are cooperators in a demonstration project in north-central Nebraska. The Ainsworth project will feature gate automation at the Airport Lateral headworks to maintain target discharge across a recently installed long-throated flume. Target flow rate will be adjustable via onsite keypad entry, remote keypad entry via the base radio/control unit located in the ditch rider's room at the district's shop/office facility, or using a PC in the district office connected to the base radio control unit. The existing gates have been motorized and the radio/control unit is programmed to update discharge readings every 60 seconds. A modified program for gate automation is planned for installation during July. Another field site is planned for the fall of 2007 installation at Ainsworth, also offering flow control for another lateral.

The DKAO and the Buford-Trenton Irrigation District (BTID) are cooperators in a demonstration project in northwestern **North Dakota**. The Buford-Trenton project will include automation of a spillway gate at the end-of-delivery point on the main canal to maintain canal pool level within a target range. Near mid-reach of the delivery system (4.8 lateral headworks), an existing gate is being motorized

and a radio/control unit installed to maintain a target discharge rate from the main canal into the lateral. The third Buford-Trenton site will be the spill at the end of the 4.8 lateral. Initially, the spill site is being set up for flow monitoring. Remote monitoring of level and flow conditions at the respective sites, as well as remote adjustment of set points will be viable using the PC linked to a base radio in the District Office. Additionally, these functions will be possible using keypad-entered instructions on a mobile “ditch rider” unit. The ditch rider unit will consist of a radio/control unit with a 4x20 LCD display and a 4x4 keypad. The unit will be powered using a cigarette lighter plug and will be equipped with a magnetic base antenna. This configuration will allow the unit to readily be transferred from vehicle to vehicle as may be desired. Equipment installation at BTID will be initiated in mid July. (Tom Gill, 303-445-2201)



Upstream and downstream stilling wells retrofitted into the constant head orifice structure at the head of the 7.2 lateral at Angostura Irrigation District. A “homemade” float and pulley sensor is seen installed in the downstream 6-inch diameter well.



The motorization modifications on a gate at the Airport Lateral headworks at the Ainsworth Irrigation District. The chain drive system was installed by district personnel using methods jointly concocted by the district staff and WRRL researchers.



The recently installed long-throated flume in the Airport Lateral at Ainsworth Irrigation District. A solar-charged radio/control unit is housed in the building at left of the flume.



The end of delivery system site. The spill gate (to the right of the check) is being motorized and will be automated to maintain canal pool level within a target range.

How much water does turfgrass need?—The Northern Colorado Water Conservancy District recently began installing test plots and equipment to evaluate a low cost approach to determine how much water different grasses need to maintain good health and appearance. About 31 million people living in cities and towns throughout the Western U.S. receive water from Reclamation projects. Past studies show that landscape irrigators (professionals and homeowners) are using up to twice as much water as the grass requires. This means that one-fourth to one-third of the water delivered from Reclamation projects to cities and towns may be wasted. The goal of the study is to more accurately measure lawn water requirements to help professionals and homeowners maintain attractive landscapes, including using other types of grasses compared to the usual

Kentucky Bluegrass. The study will record daily turfgrass water consumption utilizing relatively low cost soil moisture sensing equipment that utilizes time domain reflectometry (TDR) type of technology. This equipment is available in the irrigation industry and will be calibrated to collect the data. The water needed by the grass will be recorded, and a weather station will record climate data to identify the variation in water consumption throughout the year. (Fredrick Liljegren, 801-524-3765)