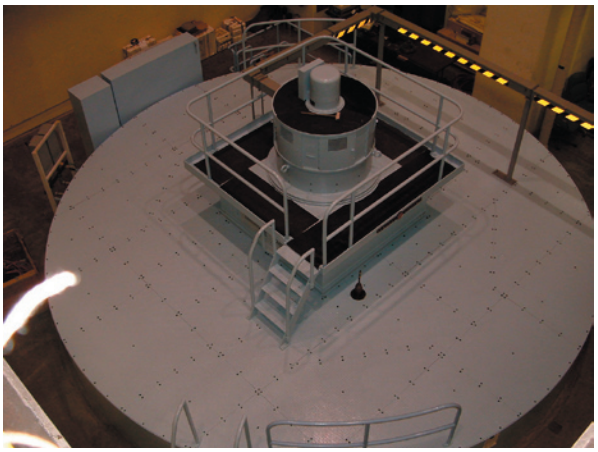
RECLAMATION
Managing Water in the West
Apr.-Jun. 2006

S&T Highlights

Improving Infrastructure Reliability

Generator parameters from small-signal analysis.—In the past, the only means for obtaining the full range of parameters for a given generator was to run it through a series of intensive, and often severe, acceptance tests. These tests are often waived out of concern for preserving the generator. When these tests are not performed, approximate parameters are assumed based on the manufacturer's design. Using these assumed and possibly inaccurate values can result in inaccurate power system stability studies, which could potentially lead to outages and blackouts.

The new small-signal analysis currently being investigated consists of milder, less intensive on-line tests that provide very accurate generator parameters for use in stability studies. Research field tests were conducted at **Crystal Powerplant** using both the traditional and the new small-signal analysis methods. Analysis of the test data is under way to extract the modeling parameters from both test methods. Thus far, the small-signal analysis method has provided parameters in agreement with those of the traditional, more severe test method. The success of this new method could yield greater accuracy in stability studies and thus prevent outages and blackouts. (Phil Atwater, 303-445-2304; Jill Smith 303-445-2307)



35-MVA hydrogenerator at Crystal Powerplant on which both traditional and new small-signal analysis test methods were performed.

U.S. Department of the Interior
Bureau of Reclamation
Science and Technology

Electrical safety enhancements and technology transfer.—The traditional method of calculating worker exposure voltage using the resistance of grounding cables underestimates the actual exposure voltage by about 300 percent. The **Technical Service Center** (TSC) has developed a method that more accurately estimates the worker exposure voltage by including the reactive component. The TSC recently incorporated these advancements into its Facilities Instructions, Standards, and Techniques, Volume 5-1, *Personal Protective Grounding for Electric Power Facilities and Power Lines*.

Efforts are ongoing to transfer this information to the power industry. Several papers and a magazine article have been written in the past. Recently, TSC personnel attended a meeting of the Institute of Electrical and Electronics Engineers (IEEE) Substations Committee and presented information on personal protective grounding reactive exposure voltage calculations. This committee is in the process of revising IEEE Standard 1246™, *IEEE Guide for Temporary Protective Grounding Systems Used in Substations*. TSC personnel also attended a meeting of the Electrical Safety and Maintenance of Lines Committee to present the same information. This committee is in the process of revising IEEE Standard 1048™, *IEEE Guide for Protective Grounding of Power Lines*. The technology transfer goal of participating in these committees is to incorporate Reclamation's research results into the next revisions of these standards. (Phil Atwater, 303- 445-2304; Jim DeHaan, 303-445-2305)

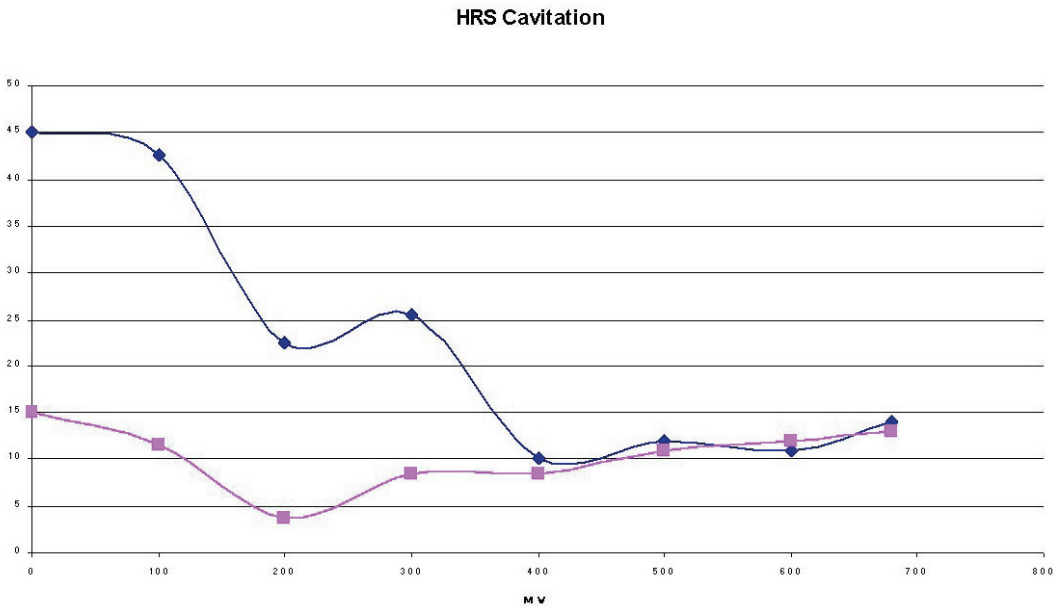
Generator core investigations.—The TSC's generator core research resulted in an informal presentation at a Doble Engineering planning meeting in the fall of 2005. The work and presentation supported the growing consensus that an industry standard is needed for generator core repair and/or replacement. Further, Doble requested that Reclamation present a formal paper on the research findings. TSC personnel wrote the paper and presented it at the Doble Engineering Conference in the spring of 2006. The paper was well received and will prove valuable in the development of an IEEE standard. It was reported that several people from France and Spain were present specifically for this technology transfer presentation. (Bert Milano, 303-445-2300)

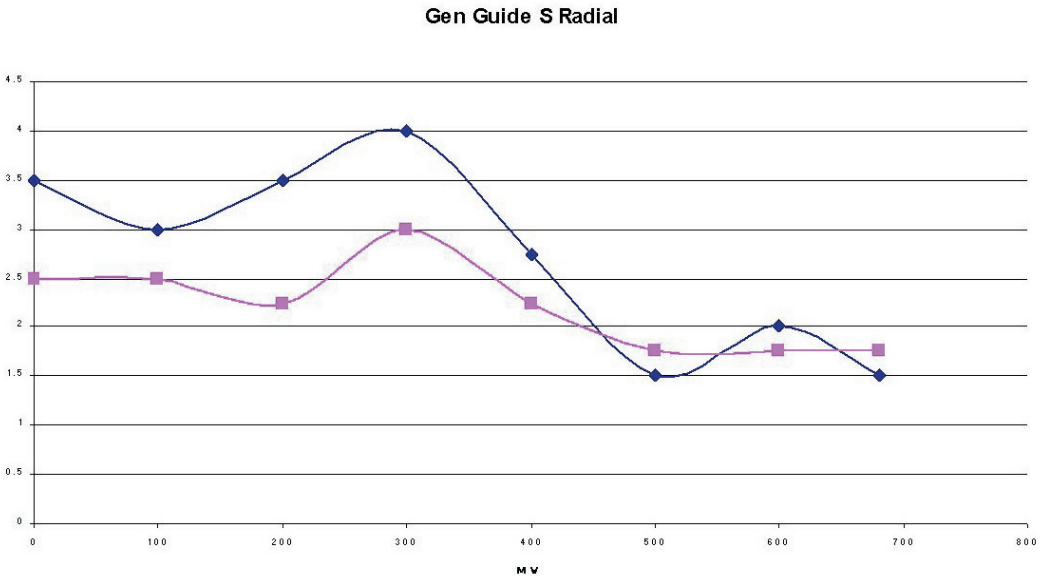
Power system stability improvement.—As a part of a Science and Technology effort to develop powerplant condition monitoring tools, the TSC developed a computer program to acquire, save, and display both analog data and digital data from both a special process control server interface and equipment manufacturers' internal data records. During development, the data acquisition program was used to diagnose a long-standing problem in the digital governor at Crystal Powerplant. This is a good example of the synergy between the Hydroelectric Research Group's Science and Technology efforts and their powerplant troubleshooting work. (J.C. Agee, 303-445-2309; Kyle Clair, 303-445-2813)

Enhancement of hydroturbine operational flexibility for powerplant cost optimization.—The Bonneville Power Administration (BPA) commissioned the TSC to perform a preliminary study on utilizing air injection to help reduce rough zones and cavitation damage on the **Third Powerplant** units at **Grand Coulee Dam**. Drawing upon expertise gained from previous Science and Technology research designed to increase hydroelectric powerplant flexibility and reduce maintenance costs, this preliminary study was performed rapidly with minimal cost to BPA.

The benefit of this potential air injection could be dramatic. According to the preliminary study, excessive cavitation increases (as measured by a cavitation meter on unit G24) were almost completely eliminated when utilizing air injection. The first graph below depicts measured cavitation levels during standard operation without air injection (diamonds), and with air injection (squares). In addition, air injection also appears to cause a slight reduction in magnitude of the generator guide bearing runout as shown in the second graph below.

As a result of the measured improvements from the preliminary air injection study, an indepth investigation has been scheduled for the end of July or early August 2006. The goal of this study is to confirm these findings and recommend potential operational changes at Grand Coulee Third Powerplant. If this new study confirms cavitation and rough zone reductions, then the operational regions of these units could potentially be increased. This would allow for more regulation capability and reduced rough zone boundaries from the larger Third Powerplant units, thus requiring fewer smaller units to operate in support of a large unit. The overall plant efficiency would increase as a result. (Steve Stitt, 303-445-2316; Toby Steves, 303-445-3258)





Improving Decision Support

Improving water operation decision support through water resource data analysis.—This project is developing techniques to streamline georeferencing of high definition video for mapping the extent and type of invasive species and also endangered species habitat by obtaining direct image parameters via global positioning system (GPS) and inertial measurement unit (IMU) integrated sensor orientation.

High resolution imagery is often needed to reduce the amount of field survey when it is desired to gain knowledge of the extent of invasive species infestations along river corridors using remote sensing techniques. Traditional aerial photography projects are costly. Airborne videography has been used for fast acquisition and evaluation with a much lower cost than traditional aerial photography.

Image resolution and feature discrimination have been a limitation for aerial videography; cost savings also are eroded when a georeferencing process is performed. Now, with the availability of uncompressed high definition video formats, image quality equivalent to aerial photography is attainable. This means that high quality imagery can be obtained at a lower cost. This imagery can be used for plant species and geomorphic feature identification and mapping. This research addresses georeferencing of high definition video by employing an integrated GPS/IMU. Field testing of the camera/sensor system is under way. (Ron Miller, 303-445-2279; Bill Goettlicher, 303-445-2275)

GPS/IMU.

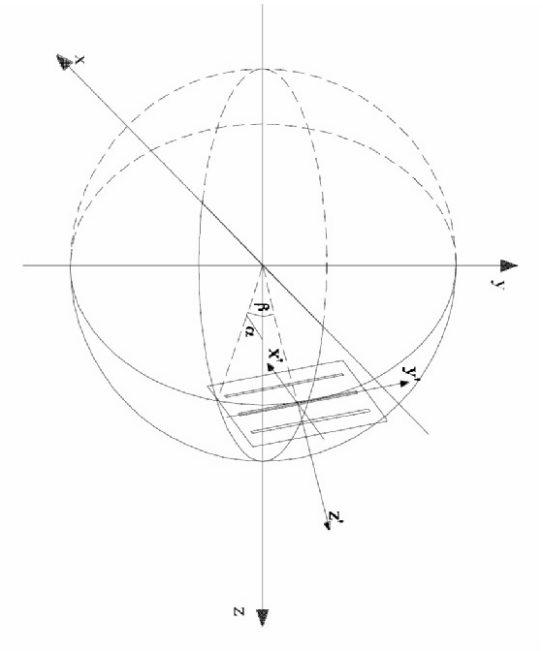


Image orientation parameters.

Example of an integrated GPS/IMU and three dimensional orientation calculation.

Improving Water Delivery Reliability

Saltcedar biocontrol impact research.—Vegetative data collected at a **Pueblo, Colorado** site is part of an ongoing study to determine how the saltcedar biocontrol beetle will impact the plant communities in the area where the beetle was released. Reclamation will use the results of this research to determine if a restoration component will be needed in project management at future sites. The research includes an older established stand of saltcedar as well as some sites where the trees have been removed and the resprouting roots are being monitored.

Monitoring biocontrol beetles at the Pueblo site.

Additionally, this quarter the **Elephant Butte Area Office** transported a mulching machine to the Pueblo site and removed 2.5 acres of a mature saltcedar stand in support of the ongoing resprout research. The goal of this research is to determine how well the biocontrol beetle will keep the population of saltcedar under control. (Debra Eberts 303-445-2217; Denise Hosler, 303-445-2195)

Removing saltcedar in Pueblo.

Dam drain clogging and prevention research.—The TSC continued cooperative work with Smith-Comesky Groundwater Science to evaluate dam drain clogging by simulating microbiological and geochemical activity in floor models. Natural biofouling and geochemical processes can be induced and drain effects reproduced at the floor-model scale, which will provide information needed for Reclamation operation and maintenance to prevent drains from clogging, as well as treatments for drain clogging that will work in particular geological circumstances. During this quarter, a limestone matrix model was built and is in the process of building up a measurable biofoul. By adjusting the geochemical components of the floor models, more data on the prevention and clogging drain problems will be collected for a future Reclamation comprehensive operation and maintenance manual.

The Association of State Dam and Safety Officials (ASDSO) has accepted an article titled *Current Research in Dam Drain Clogging and Its Prevention*, and the research team is currently working on the presentation for a September 2006 conference. (Denise Hosler, 303-445-2195)

Drain effects being produced at the floor-model scale.

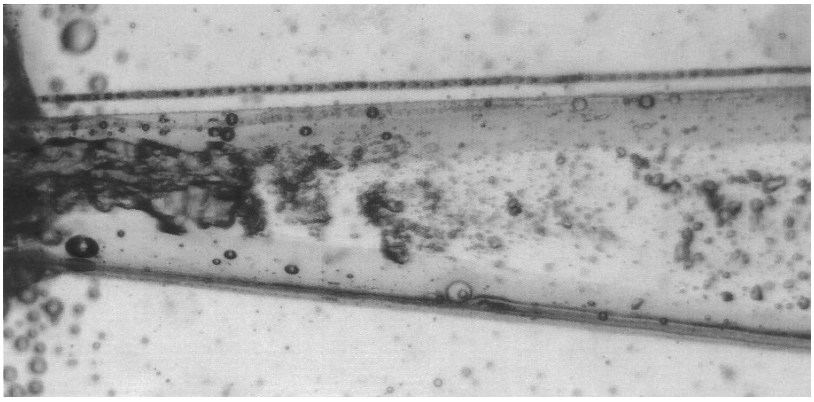
Microbubble production via venturi concept to degas supersaturated water.— The TSC Water Treatment Engineering and Research Group has teamed with Johns Hopkins University to develop a promising method to reduce dissolved supersaturated gas by injecting small microbubbles into the water. The microbubbles provide a surface area across which the dissolved gases can leave the liquid. When the bubbles reach the surface and pop, the dissolved gas is returned to the atmosphere.

Dissolved gas supersaturation has been a concern for Reclamation particularly on the Columbia River and its tributaries. Gas supersaturation reaches high

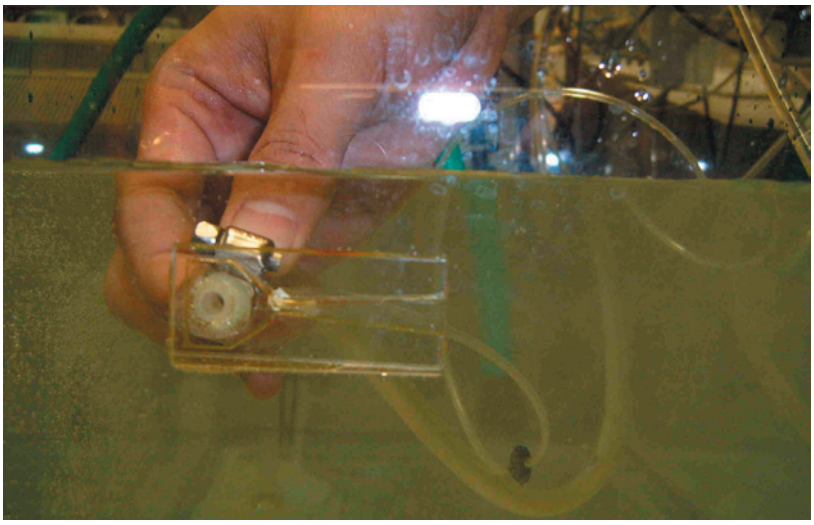
levels after leaving dams either by the transfer of water already supersaturated, or by air being entrained in water falling from dam spillways and plunging into pools at the base of the dam. Fish hatcheries also experience gas supersaturated water caused by airlift aeration or air injection to increase the carrying capacity of the hatchery. Long term or high exposure to dissolved supersaturated gas can cause severe bubble formation in fish behind the eyes or in the gills, mouths, and cardiovascular system. Secondary infections usually occur in these areas, which lead to death.

Results of a bench scale (10-gallon) venturi system were presented to Reclamation staff in May 2006. Implosion of larger bubbles inside the venturi throat caused microbubble generation, creating a very large number of fine bubbles per volume of water. The efficiency of the process depends strongly on the bubble size. Bubbles that are too large rise to the surface quickly and do not provide much time for the gas to diffuse into them. If the bubble radius is too small, the bubbles may either shrink due to surface tension, leading to an increase in gas content in the liquid, or rise so slowly that they have a negligible effect. The most effective bubble size for removing dissolved supersaturated gas had a radius of 100 micrometers or less. Using microbubbles of this size, the percentage of dissolved oxygen saturation was reduced from 130 percent to about 116 percent, with additional improvements likely.

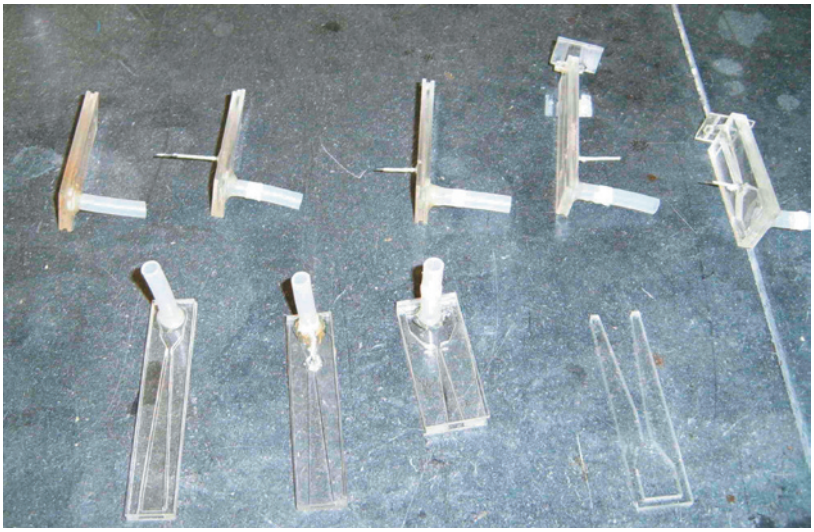
Future research involves scaling the venturi nozzle system to applications in the field. Potential applications are at fish hatcheries and downstream of dams. If the system can be successfully scaled, benefits could be provided to the Federal Columbia River Power System (FCRPS). The FCRPS is a group of 14 hydropower projects owned and operated by Reclamation and the U.S. Army Corps of Engineers with the hydropower marketed by Bonneville Power Administration. (Ken Yokoyama, 303-445-2014)



Microbubble formation in venturi nozzle.



Venturi nozzle in test tank.



Other examples of venturi nozzles.

Improving Water Supply Technologies

Real-time open-water/wetted-sands evaporation quantification for water operations.—Reclamation will be conducting field data collection in August with the Los Alamos field portable Raman light detection and ranging (LIDAR) device. Reclamation will measure the evaporation on selected sites within the Middle Rio Grande using state-of-the-art eddy covariance, LIDAR, and airborne remote sensing systems to quantify the spatial and temporal properties of the open-water/wetted-sands evaporation. The data will be analyzed and correlated to commonly acquired weather data so that Reclamation can more accurately predict evaporative losses from the Rio Grande active channel and irrigation distribution system. The resulting model will replace the existing model in the ET Toolbox, providing more accurate predictions for users and the Upper Rio Grande water operation model (URGWOM). (Steve Bowser, 505-462-3592)

The Affordable Desalination Collaboration's seawater reverse osmosis demonstration.—The Affordable Desalination Collaboration (ADC), composed of twelve commercial entities, three federal government agencies, five California water departments, and two California State agencies, completed the second of three tests and achieved a world record for seawater desalination by reverse osmosis. Located at the U.S. Navy's Seawater Desalination Test Facility in Port Hueneme, California, the ADC has built a demonstration plant that utilizes a unique combination of proven technologies and equipment to create an ultraefficient seawater reverse osmosis (SWRO) system.

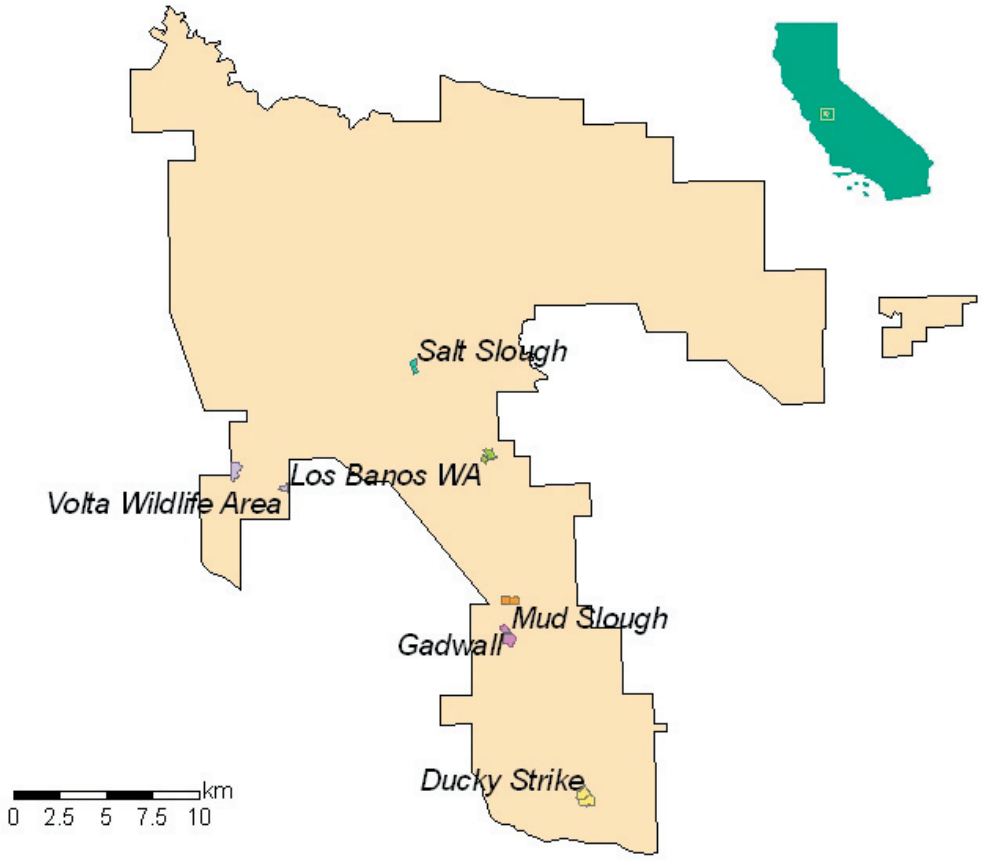
The goals of the ADC are to demonstrate the minimum energy requirement for desalting seawater using the best combination of existing technology, and to demonstrate the effects of recovery, total dissolved solids in the feed water, boron rejection, product water quality, and feed pressure on energy consumption. (Steve Dundorf, 303-445-2263)

Habitat mapping and assessment using remote sensing.—The Grassland Ecological Area is comprised of 65,000 hectares of seasonal wetlands, permanent wetlands, and uplands in the **San Joaquin Valley in California**. These lands lie on the Pacific Flyway and are an important source of food and habitat for migrating and local bird populations. The water regime in these managed wetlands is largely artificial, with surface water inflows and outflows designed to replace a natural wetland hydrologic cycle, balanced with an increasing demand for irrigation water. Any change in water management practices that can impact the wetlands' ecological health or distribution of habitat requires a means of estimating these impacts accurately.

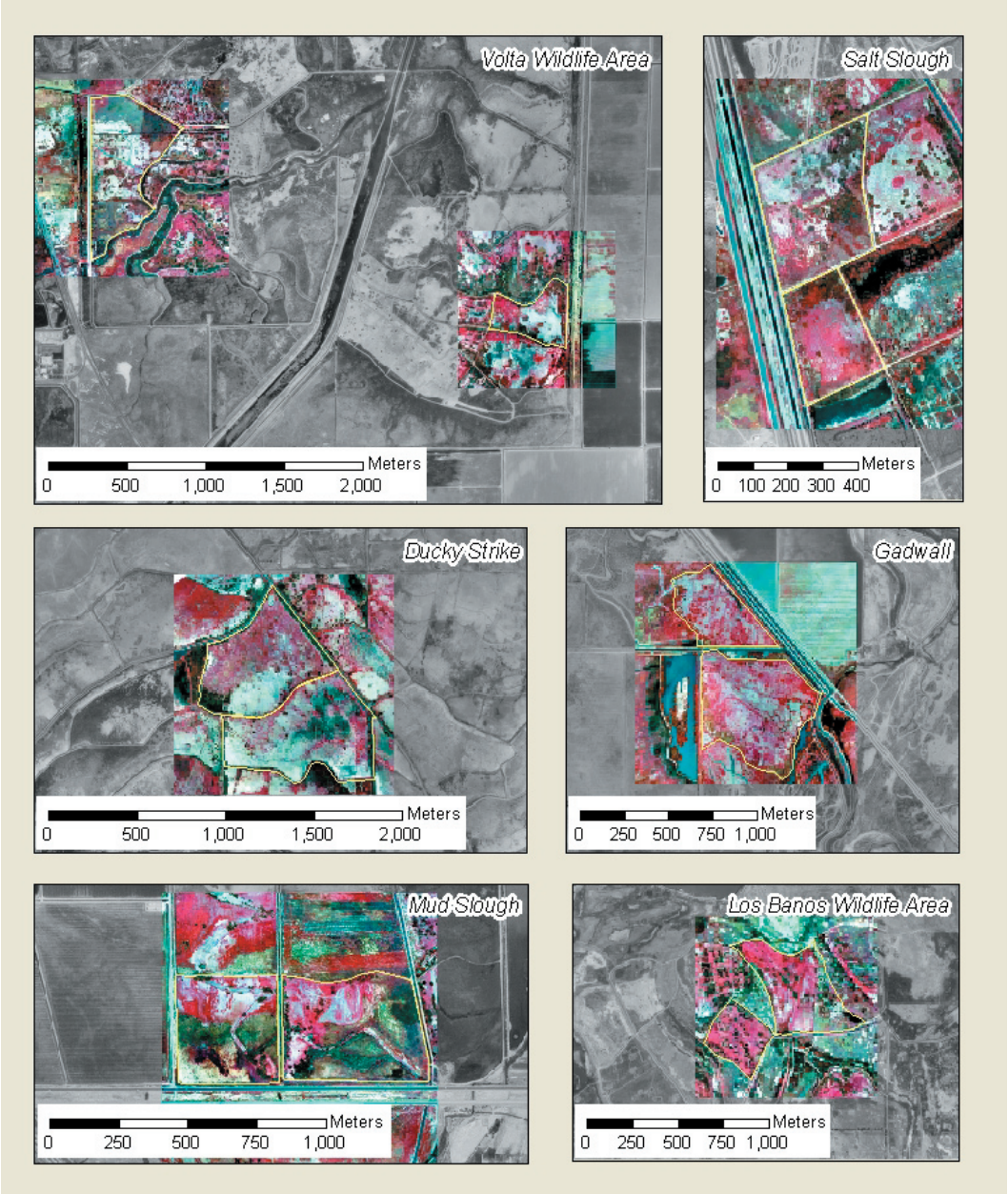
Remote sensing has great potential to fulfill this assessment requirement. Six study sites representing an ecological gradient across the Grassland Ecological Area were selected to study experimental water management practices and to extend a basic methodology for using high-resolution imagery to map wetlands land cover. Remotely sensed aerial imagery is used to capture the spectral reflectance values of different land cover classes. By combining high-resolution imagery and image processing tools with environmental field survey methods, it is possible to accurately and efficiently estimate the abundance of wetland vegetation species over large regions.

Compared to traditional vegetation survey techniques, a remote sensing methodology requires significantly less time and labor, while covering a larger area. While field surveys are still required in order to analyze remotely sensed imagery, the scope of field work is greatly reduced. This project studies ways to improve the effectiveness of both imagery and field surveys. In addition, a methodology is being developed for estimating water losses from these wetlands through the processes of evaporation and plant transpiration. Satellite imagery will be used in addition to the high-resolution aerial imagery to estimate evapotranspiration in the wetlands.

Armed with an understanding of the distribution of plant communities and regional evapotranspiration fluxes, scientists could provide improved estimates of water needs and water usage for managed wetlands in the San Joaquin Valley. (Tracy Slavin, 916-978-5202)



Study sites in the Grassland Ecological Area. The sites for the experimental water management study are shown within. The insert shows the location of the Ecological Area within California.



Project imagery from May 11, 2006. The image is displayed using a contrast stretch to enhance ease of viewing.