Evaluation of Wetland Adaptive Water Quality Management Strategies under a Real-Time Salinity TMDL

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This project has provided scientific support to a larger study of potential impacts to wetland moist soil plant habitat resulting from modification of seasonal wetland drawdown. Specific contributions have been the development of techniques for assessing wetland soil salinity using an electromagnetic sensing device and for developing accurate maps of moist soil plant habitat using high resolution multi-spectral imagery and image processing software.

This project has provided scientific support to a multi-year, interdisciplinary study of potential impacts to wetland moist soil plant habitat resulting from modification of the scheduling of seasonal wetland drawdown within the San Joaquin River Basin. Seasonal wetland drainage contributes salt loading to the San Joaquin River; changing the timing of these wetland contributions, if part of a comprehensive, basin-wide real-time water quality management system, can improve compliance with State salinity objectives and the current salinity TMDL. These wetlands are an important resource for over-wintering waterfowl and shorebirds on the Pacific Flyway, as well as for supporting the local economy through duck hunting and duck clubs.

This research project centers around six pairs of seasonal wetland ponds which range in size from 20 – 100 acres and were selected from State and privately managed wetlands within the 170,000 acre Grasslands Ecological Area. Each pair of matched sites allows traditional wetland drawdown management practices to be compared to those where drawdown is delayed until April 15 each year – with respect to impacts on water quality, wetland soils and moist soil plant habitat. The study aims to answer the question “How long can modified wetland management practices, designed to improve water quality in the San Joaquin River (SJR), be sustained without negatively impacting the biological value of waterfowl habitat?”

The following accomplishments have been made during the two year term of the project:

- The project team assisted in the deployment of 24 telemetered (radio and cellular modem) flow and water quality monitoring stations measuring continuous electrical conductivity, temperature, and stage at the inlet and outlet of the six paired wetland pond sites. Salt fluxes in and out of each pond were measured under both traditional and delayed drawdown schedules. The delayed schedule coincided with high SJR assimilative capacity (between April 15 and May 15 each year) associated with reservoir releases to aid fish migration.
- Three sets of high-resolution multi-spectral images were acquired for the study area (pre-treatment in 2006, and post-treatment 2007, 2008). The project team, with scientists at Berkeley National Laboratory, developed techniques using plant association-specific spectral signatures to identify 29 of the most important wetland plant associations. Of those, 9 were moist soil plant associations that included *Crypsis schoenoides* (swamp timothy), a dominant moist soil plant in the Grasslands Ecological Area. With the signatures, estimates of swamp timothy presence and absence were made across the study area.
- High resolution soil salinity maps were created using a Geonics electromagnetic field instrument (EM-38). Twelve soil samples per field were used for calibration.

- Stationary sensor arrays were deployed to measure wetland pond salinity. The arrays provided continuous monitoring of moist soil conditions in the wetlands from just before drawdown through drainage and the evaporative drying period. Resulting time series for soil parameters include temperature, salinity, and moisture. These results provide a temporal linkage between the spatial EM-38 mapping efforts.
- Methods have been developed for correlating reflectance spectra from aerial imagery with manual swamp timothy productivity survey data and are being applied to the 2008 data sets. These results are also being compared with the EM-based salinity maps, using salinity-moisture time series data to account for any significant time differences in the survey maps. The integrated results will enable us to provide significant input on how long modified wetland management practices, designed to improve water quality in the SJR, can be sustained without negatively impacting the biological value of waterfowl habitat.
- Supplemental funding was acquired through a California Department of Water Resources Prop. 204 grant (PI Quinn, co-PI Harmon) to develop mathematical models of seasonal wetland hydrology and to improve the representation of these wetlands in the current WARMF-SJR model.

Significant scientific outputs from the study include: (a) development of a robust monitoring system platform for measuring real-time flow and water quality data; (b) the finding that moist soil plant vegetation associations vary sufficiently between wildlife management areas and that spectral signatures need to be developed independently for each to achieve accurate representation. Initial classification was performed using e-Cognition software for image segmentation and ERDAS Imagine for classification. We developed a methodology whereby the analysis can all be done within the e-Cognition software. The team developed the first accurate map of major moist soil plant associations for the ponded areas which have provided the first quantification of temporal shifts in wetland plant habitat. (c) Soil salinity surveys revealed a likely mechanism of salt deposition within the wetland soil profile. This has allowed the protocol for sampling bulk soil salinity to be adapted – thus providing a more accurate assessment of soil salinity changes over time.

Publications

Quinn, N.W.T. Environmental decision support system development for seasonal wetland salt management in a river basin subjected to water quality regulation. *Agricultural Water Management*, in press.

Rahilly, Patrick J. (2008). M.S. Thesis: Investigating the Dynamics of Managed Wetland Ecosystems in the Grasslands Ecological Area. University of California, Merced.

Professional Presentations

Rahilly, Patrick, Ricardo Ortega, Nigel Quinn, and Thomas Harmon, New Tools for Ecological Impact Assessment in Managed Seasonal Wetlands (poster), CA Water and Environmental Modeling Forum 14th Annual Meeting, Monterey, CA, Feb. 26-28, 2008.

Harmon, Thomas, Designing Model-Driven Sensor Systems to Close the Loop on Water Resources Management in the West, University of Nevada Reno Fall Colloquium Series, Sept. 26, 2008 (invited).

Collaborative Efforts

This work is part of a larger collaborative effort between the co-investigators and the following agencies: John Beam, William Cook, Lara Sparks, and Ricardo Ortega, *California Department of Fish and Game*; Ernie Taylor and Joe Tapia, *California Department of Water Resources*; and Qinghua Guo, *University of California, Merced & Sierra Nevada Research Institute*.

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