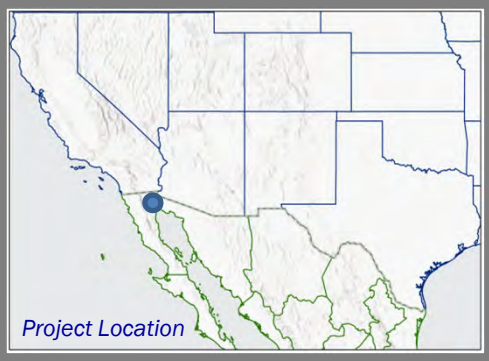
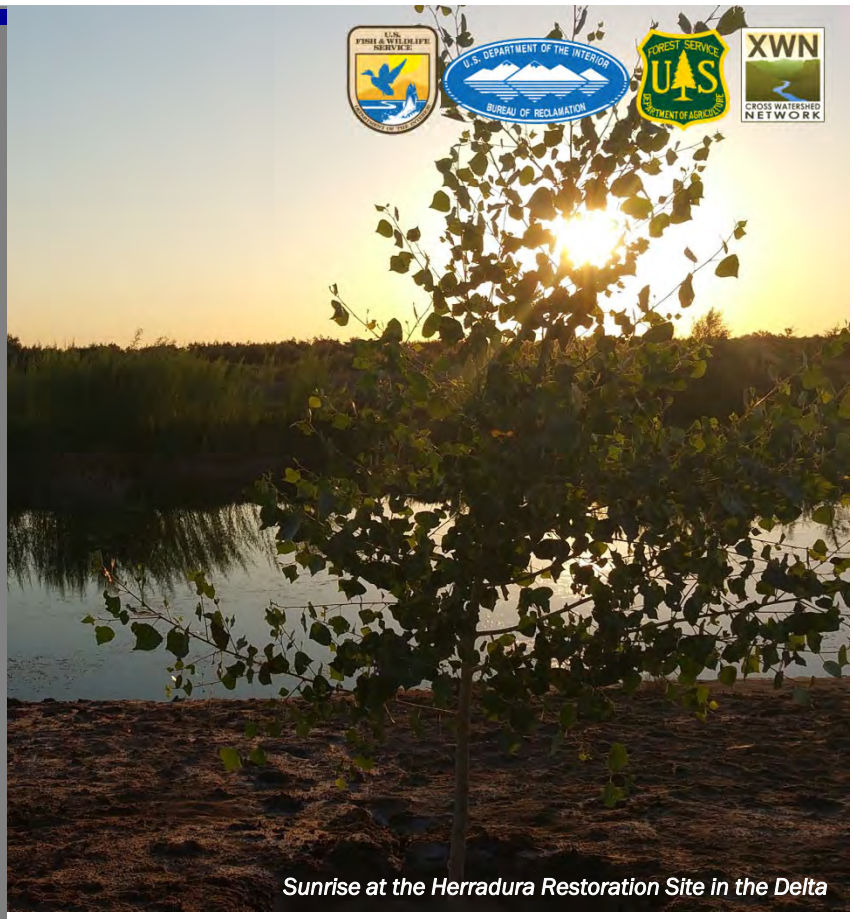
ACTIONABLE SCIENCE

Shallow Groundwater in the Colorado River Delta: Modeling Susceptibility and Management Options

SONORAN INSTITUTE

The Colorado River Delta historically provided tremendous environmental and cultural benefits, but agricultural land conversion, river regulation, consumptive water use, and non-native species have decreased and degraded riparian areas. While many organizations are conserving and restoring cottonwood-willow and mesquite forests along the river in the United States and Mexico, overuse and changing climates indicate increasing vulnerability of habitat. Determining the extent of groundwater-supported riparian ecosystems under different scenarios enables conservation organizations to prioritize restoration areas and identify strategies for mitigating groundwater limitations.





Sunrise at the Herradura Restoration Site in the Delta

KEY ISSUES ADDRESSED

Riparian vegetation is dependent on shallow groundwater, especially in the arid Colorado River Delta, where summer temperatures are frequently above 115°F. Areas that currently have shallow groundwater are being targeted for restoration. Philanthropic foundations and government agencies are investing significant funding to re-plant native vegetation and deliver water to restoration sites and remaining native ecosystems.

Groundwater levels in the Delta are affected by agricultural practices, groundwater pumping, water use by plants, and environmental flows. An existing groundwater model was used to predict groundwater depth in the central Delta that would support different riparian ecosystem types under plausible future scenarios and explore if environmental flows could mitigate the effects of regional groundwater changes.

PROJECT GOALS

- Establish groundwater depth thresholds for native vegetation and wetlands in the Delta
- Refine a groundwater model to predict average monthly groundwater depth under different scenarios
- Estimate the area of aquatic, cottonwood-willow, and mesquite cover types that could be supported under each scenario

CRITICAL ENVIRONMENTAL FLOWS

Model results indicate that environmental flows have the potential to mitigate declining groundwater levels resulting from possible future changes in agricultural practices.

A Backwater Laguna at the Herradura Restoration Site

PROJECT HIGHLIGHTS

Groundwater Threshold Analysis: Depth to groundwater thresholds and sensitivity to groundwater fluctuations for cottonwood and willow species were estimated specifically for the Delta by correlating local groundwater elevations with locations of remnant riparian vegetation.

Groundwater Model Refinement: An existing regional MODFLOW groundwater model was refined to analyze potential groundwater levels at high spatial resolution. The regional (parent) groundwater model was integrated with the central Delta riparian corridor (child) model.

Integrated Scenario Development: Upstream subsurface inputs were based on upstream piezometer groundwater data ranges. Agricultural return flow scenarios were based on changes in groundwater recharge due to fallowing, crop changes, and/or irrigation efficiency improvements. Plant water use and evaporation scenarios were developed from regional models, and took into account potential regional water use impacts of active restoration and the arrival of the tamarisk leaf beetle. Modeled environmental flows reflect current delivery plans being used by conservation organizations in the Delta.

Collaborators

- Sonoran Institute
- Universidad Autónoma de Baja California
- GeoSystems Analysis, Inc.
- Jeff Milliken, US Bureau of Reclamation (retired)

Funding Partners

- Desert Landscape Conservation Cooperative
- Lincoln Institute of Land Policy

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Photos courtesy of Sonoran Institute

LESSONS LEARNED

Agricultural return flows are the most significant factor influencing groundwater levels in the area. If agricultural return flows were reduced by 25%, over 50% of the potential cottonwood-willow and mesquite forest area may no longer be supported.

Modeled changes in evaporation and water use by plants did not significantly impact groundwater levels. Revegetation with native plants (higher water use) or arrival of the tamarisk leaf beetle (lower water use) is not expected to impact local groundwater levels.

Model results suggest that environmental flow deliveries are the second most important factor for sustaining groundwater levels. Under baseline agricultural return flow levels, environmental flows would greatly increase the spatial extent of the region that would support cottonwood-willow habitat; environmental flows would mitigate nearly all impacts of groundwater reductions resulting from modeled decreases in agricultural return flows.

NEXT STEPS

- Incorporate potential impacts of groundwater decline and long-term water needs into restoration planning
- Use environmental flows to mitigate potential negative impacts of climate change and reduced agricultural water
- Advise binational water policy through data and modeling analyses

PROJECT RESOURCES

For more information on this project, contact Karen Schlatter: kschlatter@sonoraninstitute.org

For additional project resources and case studies, visit the Collaborative Conservation and Adaptation Strategy Toolbox: WWW.DESERTLCC.ORG/RESOURCE/CCAST

An Aerial View of the CILA Restoration Site