Environmental Flow Effects on Groundwater and Restoration Potential in Reach 4 of the Colorado River Delta

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Why Reach 4?

Laguna Grande Restoration Area
Reach 2
Reach 3
Reach 4: Laguna Grande Complex
Groundwater Concerns

- Shallow, low-salinity groundwater is essential for supporting desired habitat conditions.
  - Existing vegetation and hydrology
  - Completed restoration projects
  - Potential restoration sites

- Groundwater levels determined by a range of factors:
  - Agricultural return flows
  - Groundwater pumping
  - Phreatophyte evapotranspiration
  - Basin-wide precipitation
  - Environmental flows
2005-2007 Groundwater Trend at Laguna Grande
Current Groundwater Analysis for Reach 4

Groundwater Monitoring

- UABC/Minute 319 piezometer transects
- Additional ~20 piezometers at Laguna Grande
  - Sounding and automated monitoring
  - Groundwater salinity
- Water Budgets

Groundwater Modeling

- Determine depth to groundwater under different scenarios.
  - What are the reasonable expectations for groundwater changes in Reach 4 in the future?
- Use results to inform:
  - Restoration planning—site selection, long-term irrigation needs.
  - Future environmental flows—what are the effects of different volumes, where can they be applied to maximize ecological benefits in Reach 4?
Groundwater Modeling Methods

- Refine existing groundwater model to predict mean monthly groundwater depth under different input combinations (model scenarios).

- Use literature values, on-site observations, and remote sensing results to establish groundwater depth thresholds for riparian plants in the Delta.

- Determine the extent of groundwater support for existing and potential open water, marsh, and riparian areas.
Conceptual Water Balance Model

- Agricultural Return Flows
- Evaporation and Transpiration
- River Inflow/Outflow
- Environmental Flows and Rainfall
Existing Groundwater Model (UABC)

Conductivity: Diaz, 2001; Rodriguez-Burgueño, 2011

Pumping: CONAGUA 1994-2006

Recharge: 15-32 % Irrigation volume (Feirstein et al, 2008)

Drain: Irrigation District 014 (DR014) and USGS

River: Colorado River

Evapotranspiration: Feirstein, 2008
## Model Parameters

<table>
<thead>
<tr>
<th>Input Category</th>
<th>Input Level</th>
<th>Input Amount</th>
<th>Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agricultural Return Flows</strong></td>
<td>Baseline</td>
<td>Current Levels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increased</td>
<td>15-32% of water rights</td>
<td>Canal lining, fallowing, crop changes, groundwater pumping</td>
</tr>
<tr>
<td></td>
<td>Reduced</td>
<td>5-10% of water rights</td>
<td></td>
</tr>
<tr>
<td><strong>Riparian Corridor ET</strong></td>
<td>Baseline</td>
<td>Current</td>
<td>Saltcedar removal, saltcedar defoliation, vegetation composition, increased ET₀, increased WUE</td>
</tr>
<tr>
<td></td>
<td>Increased</td>
<td>Conversion of 10% of saltcedar/arrowweed to cottonwood-willow</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Decreased</td>
<td>15% saltcedar ET reduction</td>
<td></td>
</tr>
<tr>
<td><strong>Environmental Flow Deliveries</strong></td>
<td>None</td>
<td>TBD</td>
<td>Water lease/purchase availability, drought/water shortage conditions, infrastructure limitations</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>TBD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>TBD</td>
<td></td>
</tr>
<tr>
<td><strong>Upstream Subsurface Inflow</strong></td>
<td>Baseline</td>
<td>Pre 2014 upstream groundwater levels.</td>
<td>Groundwater pumping, reduced agricultural application, upstream environmental flows, extreme weather events.</td>
</tr>
<tr>
<td></td>
<td>Decreased</td>
<td>Lowest upstream groundwater levels in data record.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increased</td>
<td>2014-2015 upstream groundwater levels.</td>
<td></td>
</tr>
</tbody>
</table>

3 X 3 X 3 X 3 X 3 = 81 Scenarios
Analysis of Model Results

Model outputs:
- Mean monthly groundwater elevation in each model cell.

Overlay and subtract ground surface (LiDAR) elevation to obtain depth to groundwater for each month for each scenario.

Summarize groundwater depth conditions and habitat support for the reach.
Habitat Support Analysis
Cori Polygon: Groundwater Depth

- 2014-2015 Water Year
### Cori Polygon: Habitat Potential Categorization Matrix

<table>
<thead>
<tr>
<th>Mean Groundwater Depth</th>
<th>Habitat Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0 m</td>
<td>Open Water</td>
</tr>
<tr>
<td>0-0.5 m</td>
<td>Marsh</td>
</tr>
<tr>
<td>0.5-1.5 m</td>
<td>Wet Riparian</td>
</tr>
<tr>
<td>1.5-2.0 m</td>
<td>Dense Riparian</td>
</tr>
<tr>
<td>2.0-2.5 m</td>
<td>Low-Density Riparian</td>
</tr>
<tr>
<td>2.5-3.5 m</td>
<td>Mesquite</td>
</tr>
<tr>
<td>&gt;3.5 m</td>
<td>Upland</td>
</tr>
</tbody>
</table>
Cori Polygon: Herradura Habitat Potential
# Current Project Status and Next Steps

## Recently Completed

- Refinement of groundwater model for Reach 4.
- Compilation of historic groundwater data.
- Existing vegetation mapping for Reach 4.

## Ongoing

- Refinement of ET estimates.
- Development of environmental flow scenario volumes and delivery locations.
- Future:
  - Refinement of depth to groundwater thresholds.
  - Spatial analysis of model results.
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Questions?

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