Update on the Vegetation Response to Environmental Flows and Restoration in the Colorado River Delta

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Historic Delta

Photo source: IBWC
Colorado River Flow at U.S. - Mexico Border 1878-2009

- Hoover Dam Completion
- Colorado River Compact Signed
- Treaty With Mexico Signed
- Glen Canyon Dam Completion
- Treaty obligation
- Pulse flow
Minute 319

- 5-year agreement signed in November 2012 by US and Mexico
- Establishes new guidelines for the management of Colorado River water during times of drought and promotes investments in water conservation projects
- Water dedicated for ecological flows to the Colorado River in Mexico for the 1st time in history
- Total water to be dedicated to Delta: 158,088 acre-feet (af)
- Delta Water Trust to provide 52,700 af for river base flow; 105,400 af provided by US and MX for flood pulse flow
- NGO goal is to restore 2300 acres of habitat by end of 5-year term
- At end of 5-year term, US and MX will determine if/how to expand commitments
Monitoring impacts of Minute 319 environmental flows
The Minute 319 Science Team

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Dale Turner, The Nature Conservancy
Jorge Ramirez, Universidad Autónoma de Baja California
Eliana Rodriguez, Universidad Autónoma de Baja California
Francisco Zamora, Sonoran Institute
Seedling transects

• Located in Reaches 1-5

• 21 transects co-located with piezometers

• The following was measured:
  o Seed dispersal timing and abundance
  o Pre- and post-pulse vegetation
  o Seedling locations and densities
  o Pre- and post-pulse topography
  o Pre- and post-pulse sediment texture and salinity
Vegetation Monitoring in Laguna Grande

Objective: Assess native seedling establishment and growth in Laguna Grande for different restoration treatments:

- Control (no inundation, no nonnative species removal)
- Removal of tamarisk and arrowweed
- Grading and reconnection of meanders to river channel
- Inundation with pulse and base flows
Seedling mortality

Seed available? (Yes) → Seed augmentation

No → Bare, moist surface available? (Yes) → large pulse flow, vegetation removal, land contouring, irrigation

No → Moisture available in rooting zone? (Yes) → base flows, irrigation

No → Protected from future flooding/scour? (Yes) → Managed recession, site selection, flow sequencing

No → Low competition? Low salinity? Low herbivory/grazing? (Yes) → weed control, overbank flooding, exclosures

No → survival, growth (Yes) → SEEDLING ESTABLISHMENT

No → No
Seed Availability

- SAGO = Goodding's willow (Salix gooddingii)
- POFR = Fremont cottonwood (Populus fremontii)
- TASP = Tamarix species
- BASP = Baccharis species

Graphs showing availability of seeds for REACH 1, REACH 2, REACH 3, REACH 4, and REACH 5 from March to June.
Bare Soil Requirement:
Soil Salinity:

By Reach: March and May

In (All) Seedling Establishment Plots (October)
Depth to Groundwater

![Depth to Groundwater Graph](image.png)
## Conditions Assessment for Native Riparian Recruitment:

<table>
<thead>
<tr>
<th>Component</th>
<th>Reach 1</th>
<th>Reach 2</th>
<th>Reach 3</th>
<th>Reach 4 (unprepared)</th>
<th>Reach 4 (prepared)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed Availability</td>
<td>good</td>
<td>fair</td>
<td>poor</td>
<td>good</td>
<td>excellent</td>
</tr>
<tr>
<td>Bare Substrate</td>
<td>fair</td>
<td>good</td>
<td>good</td>
<td>fair</td>
<td>good</td>
</tr>
<tr>
<td>Continued Moisture</td>
<td>good</td>
<td>poor</td>
<td>poor</td>
<td>good</td>
<td>good</td>
</tr>
<tr>
<td>Protected from future flooding</td>
<td>fair</td>
<td>poor</td>
<td>poor</td>
<td>fair</td>
<td>fair</td>
</tr>
<tr>
<td>Low competition</td>
<td>poor</td>
<td>good</td>
<td>good</td>
<td>poor</td>
<td>good</td>
</tr>
<tr>
<td>Low soil salinity</td>
<td>good</td>
<td>good</td>
<td>fair</td>
<td>fair</td>
<td>poor - fair</td>
</tr>
<tr>
<td>Lack of herbivory/grazing</td>
<td>good</td>
<td>good</td>
<td>good</td>
<td>good</td>
<td>good</td>
</tr>
</tbody>
</table>
2014 and 2015 Frequencies

A  Frequency of Seedling Presence Oct. 2014

<table>
<thead>
<tr>
<th>Site</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>100%</td>
</tr>
<tr>
<td>R2</td>
<td>80%</td>
</tr>
<tr>
<td>R3</td>
<td>60%</td>
</tr>
<tr>
<td>R4</td>
<td>40%</td>
</tr>
<tr>
<td>R5</td>
<td>20%</td>
</tr>
<tr>
<td>LG1</td>
<td>100%</td>
</tr>
<tr>
<td>LG2</td>
<td>80%</td>
</tr>
<tr>
<td>LG3</td>
<td>60%</td>
</tr>
</tbody>
</table>

B  Frequency of Seedling Presence Oct. 2015

<table>
<thead>
<tr>
<th>Site</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>100%</td>
</tr>
<tr>
<td>R2</td>
<td>80%</td>
</tr>
<tr>
<td>R3</td>
<td>60%</td>
</tr>
<tr>
<td>R4</td>
<td>40%</td>
</tr>
<tr>
<td>R5</td>
<td>20%</td>
</tr>
<tr>
<td>LG1</td>
<td>100%</td>
</tr>
<tr>
<td>LG2</td>
<td>80%</td>
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SAGO = Goodding’s willow (*Salix gooddingii*)
POFR = Fremont cottonwood (*Populus fremontii*)
TASP = *Tamarix* species
BASP = *Baccharis* species
2014 and 2015 Densities

SAGO = Goodding's willow (*Salix gooddingii*)
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Numbers signify:
1st #: Transect id
2nd #: Aug 2014 C-W count
3rd #: Oct 2014 C-W count

Source: ESRI, DigitalGlobe
AEZ: California, USA
Change in NDVI (greenness) in the inundated area:
Conclusions:

• Most requirements for woody, native riparian species recruitment were met in Reaches 1 and 4 unprepared areas.

• In unprepared sites, establishment was limited by either low water availability or lack of bare soils.

• Seedling establishment requirements were met at the majority of prepared restoration areas in Reach 4 due to management actions.

• Native, woody riparian species established with highest frequencies and densities in Reach 4 prepared areas and Reach 1 unprepared areas.

• More extensive native riparian vegetation recruitment from environmental flows will likely require additional active management.
Thank you!

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Acknowledgements:
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Martha Gomez, University of Arizona
Matt Grabau & Francisco Zamora, Sonoran Institute