Groundwater Thresholds: Hydrologic Variables & Riparian Health

Incorporating Climate Information and Stakeholder Engagement in Groundwater Resources Planning and Management

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wrrc.arizona.edu/GCASE
Thresholds

- Based on scientific data

- Critical Thresholds
  - Limits where response is impossible without dramatic change to system (Lite & Stomberg, 2005)

- Thresholds of Probable Concern
  - Warnings to potentially undesirable environmental changes (Rogers and Biggs, 1999)

- Used to help define management goals
  - Not predictive values for desired conditions (Lite & Stomberg, 2005)
The mission of the Santa Cruz Active Management Area is to manage all water resources in the AMA conjunctively, to assure a reliable water supply for current and future uses, and to protect aquatic and riparian habitat while sustaining a healthy economy.

http://www.azwater.gov/AzDWR/WaterManagement/AMAs/SantaCruzAMA/default.htm
Third Management Plan (1.3.2.2)

- Management Goals
  - Unique hydrologic conditions
    1. safe-yield
    2. prevent local water tables declines long term

- Target Water levels
  - Younger Alluvium
    1. multiple use objectives
    2. sensitive to water levels changes
    3. majority of region’s water supply.
Upper Santa Cruz River

- Recent Die-offs
  - Late 1990s Nogales, AZ
  - Early 2000s Rio Rico
  - Possibly related to groundwater pumping

- Nogales International WWTP
  - Perennial effluent

- Shallow Unconfined Microbasins
Riparian Vegetation

- Cottonwood
- Willow
- Tamarisk

http://www.nasa.gov/

www.saguaro-juniper.com
Hydrologic Variables

Index = – (100 – Permanence %) * Maximum Depth * Fluctuation

(Lite & Stromberg, 2005)

- Max. Depth to Groundwater
- Surface Flow Permanence
- Groundwater Fluctuation

Hydrologic Index

- Maximum water level difference through year
- Dry Season: January → June
- Estimate of annual groundwater fluctuation
- Depth to saturated soil
- Greatest depth measured in year
- Spatially averaged across the floodplain
- Percentage of surface flow in year
- Surface flow is important for young trees (Smith et al., 1991)
- Strongest indicator of forest composition (Lite & Stomberg, 2005)
Riparian Health

Species Dominance
- Tamarisk
  - Co-Dominant
- Cottonwood & Willow

Mature Survival
- Cottonwood
- Willow

Sapling Survival

Seedling Establishment
- Specific & Narrow Conditions

“wet”

“dry”
<table>
<thead>
<tr>
<th></th>
<th>Max. Depth</th>
<th>Fluctuation</th>
<th>Permanence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mature Survival</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cottonwood¹</td>
<td>16 ft</td>
<td>~ 3.3 ft/yr</td>
<td></td>
</tr>
<tr>
<td>Willow¹</td>
<td>10 ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dominant</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tamarisk²</td>
<td>&gt; 9.8 ft</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Co-Dominant³</td>
<td>&gt; 8.5 ft</td>
<td>&gt; 1.5 ft/yr</td>
<td>42 %</td>
</tr>
<tr>
<td>Cottonwood/ Willow³</td>
<td>&lt; 8.5 ft</td>
<td>&lt; 1.5 ft/yr</td>
<td>76 %</td>
</tr>
<tr>
<td><strong>Sapling Survival</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cottonwood/ Willow¹</td>
<td>6 ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Seedling</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Establishment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cottonwood</td>
<td>~ 5 ft (4)</td>
<td>~1 in/day (5)</td>
<td></td>
</tr>
</tbody>
</table>

¹ San Pedro River, AZ (Stromberg et al., 1996)
² San Pedro River, AZ (Leenhouts et al., 2005)
³ San Pedro River, AZ (Lite & Stromberg, 2005)
⁴ Scott et al. (1999), plus others
⁵ Mahoney and Rood (1992), plus others
Threshold Recommendations

Hydrologic Variables
- Maximum Depth
- Depth Fluctuation
- Flow Permanence

Riparian Health
- Cottonwood & Willow Species Dominance

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