Salinity Management for Floodplain Riparian Restoration

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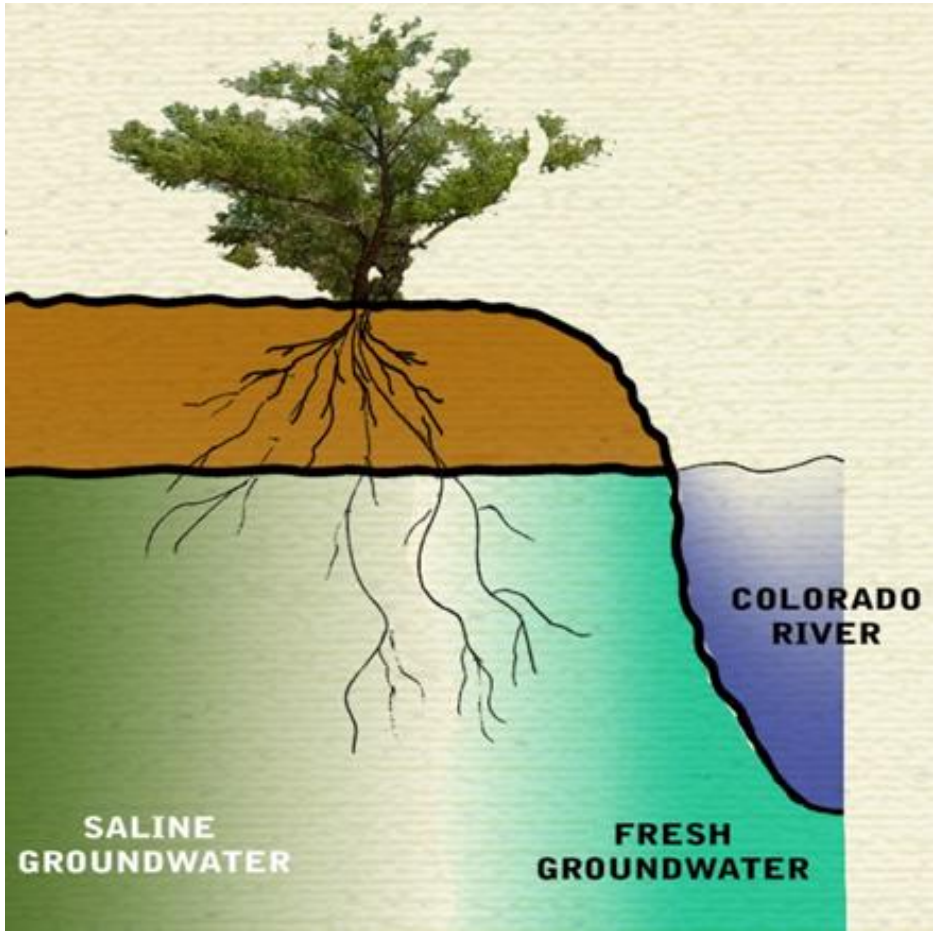
Soil and Groundwater Salinity along Regulated Rivers

- Most large rivers extensively regulated by dams, reservoirs, and levees.
- Hydraulically disconnected floodplain.



Salinity Gradient

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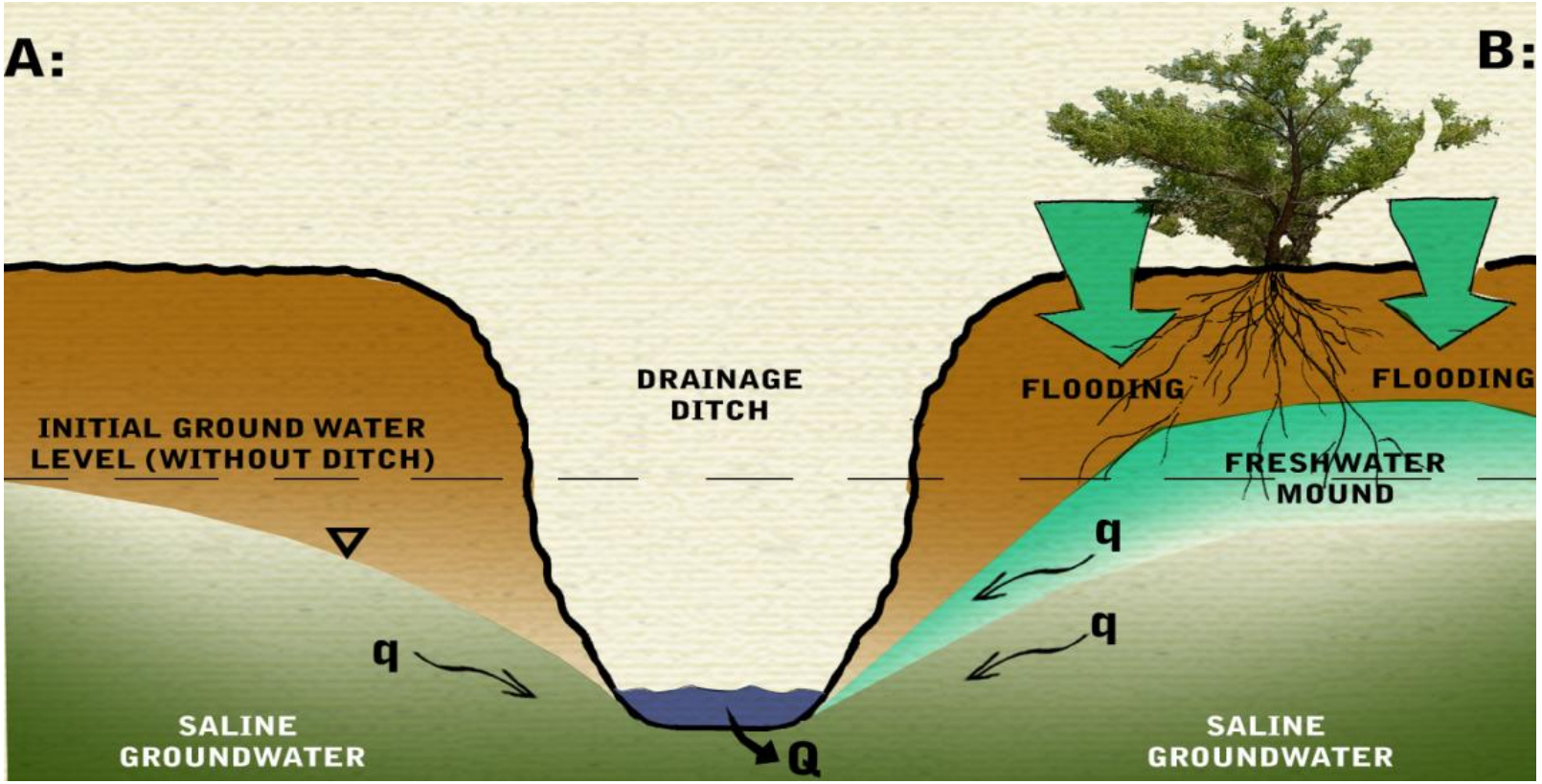
Traditional Salinity Management

- A: Drain
- B: Add Water



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What About Riparian Vegetation?

- Riparian trees need low-salinity water, and lots of it.
- Shallow groundwater and/or high irrigation rates:
  - Shallow groundwater →
    - No salt "sink" available in soils.
    - Capillary rise, evapotranspiration.
  - Irrigation →
    - Salt addition.
    - Increased groundwater elevation.

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Project Objectives

1. Identify salinization causes and management options for riparian restoration areas.
2. Characterize three habitat creation sites on the lower Colorado River.
3. Develop a salinity model to assess irrigation and drainage management scenarios.

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Lower Colorado River (LCR) Multi-species Conservation Program (MSCP) Background

- MSCP tasked with creation and maintenance of riparian habitat on LCR (Lake Mead to Mexico).
- A regulated river system/disconnected floodplain prone to salinization.
- Irrigation and aquifer management to:
  - Provide water for transpiration.
  - Provide moist soils.
  - **Maintain acceptable salinity: ~8 dS/m soil salinity.**

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Project Locations

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Site Characterizations

- Soils (May 2010, Feb 2012):
  - Sampled to 6’.
  - Measured: Texture, salinity, nutrients.
- Groundwater (2010-July 2013):
  - Piezometer grid.
  - Measured: Groundwater depth, elevation/gradient, groundwater salinity.
- Aquifer:
  - Slug testing.
  - Measured: Hydraulic conductivity.

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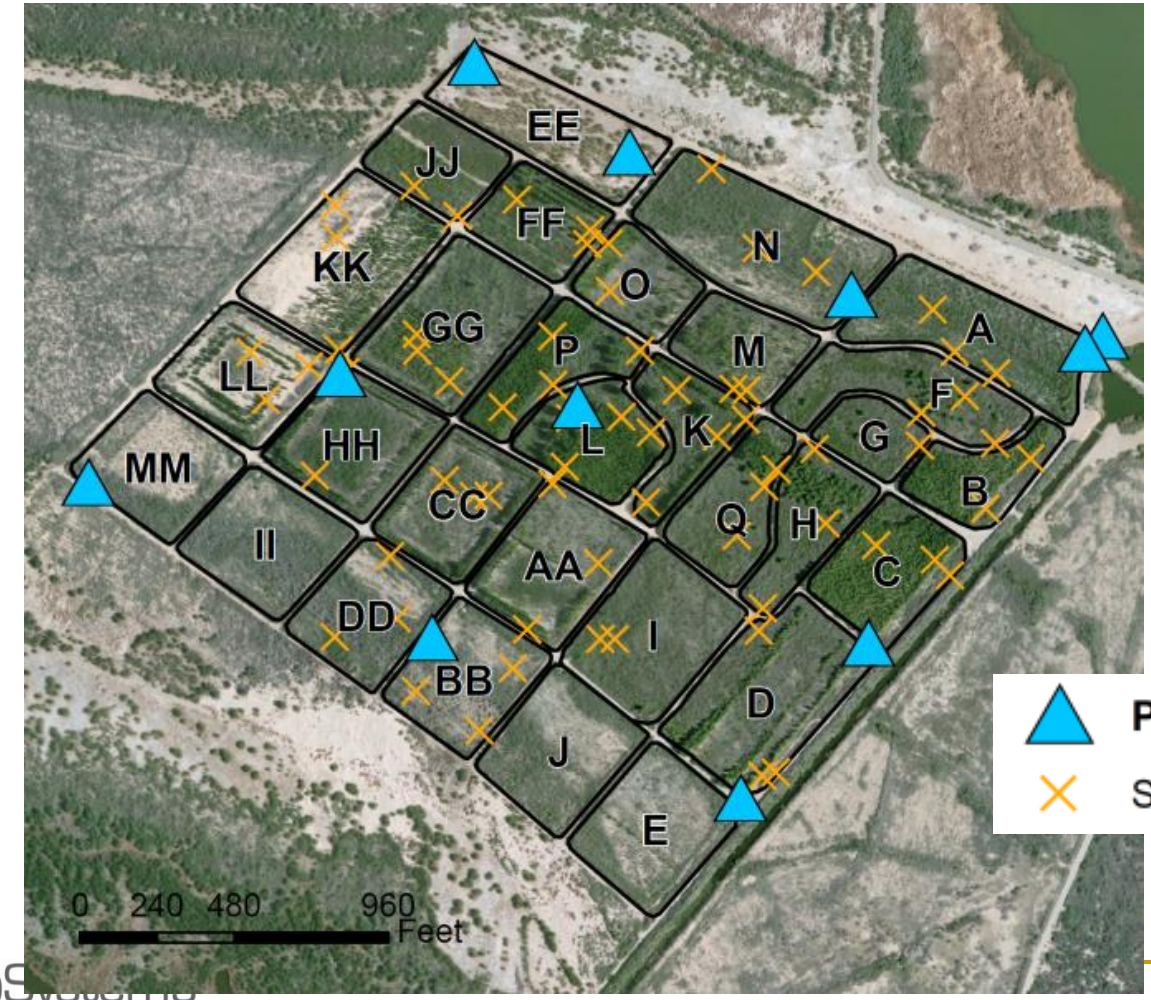
Multi-Species Conservation Program

Beal Lake Conservation Area (BLCA)

107 acres, 30 independently-irrigated fields.



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Palo Verde Ecological Reserve(PVER)

1,352 acres, 8 phases. Phase 2 and 3—150 acres.

Piezometer Locations

Soil sample locations

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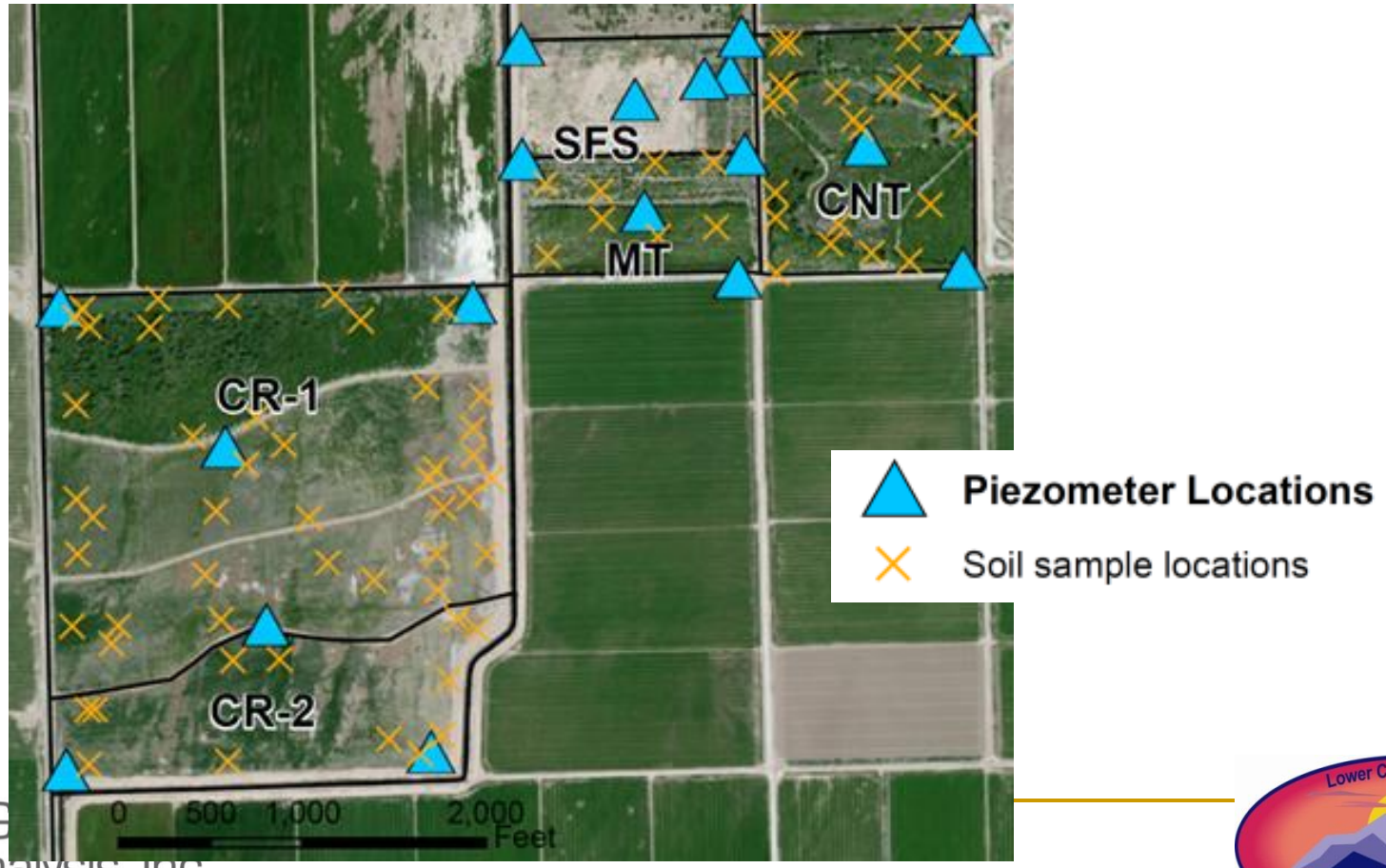
Cibola NWR Unit 1 Conservation Area (CNU1) 900 acres, 5 Areas. 200 acres for this study.



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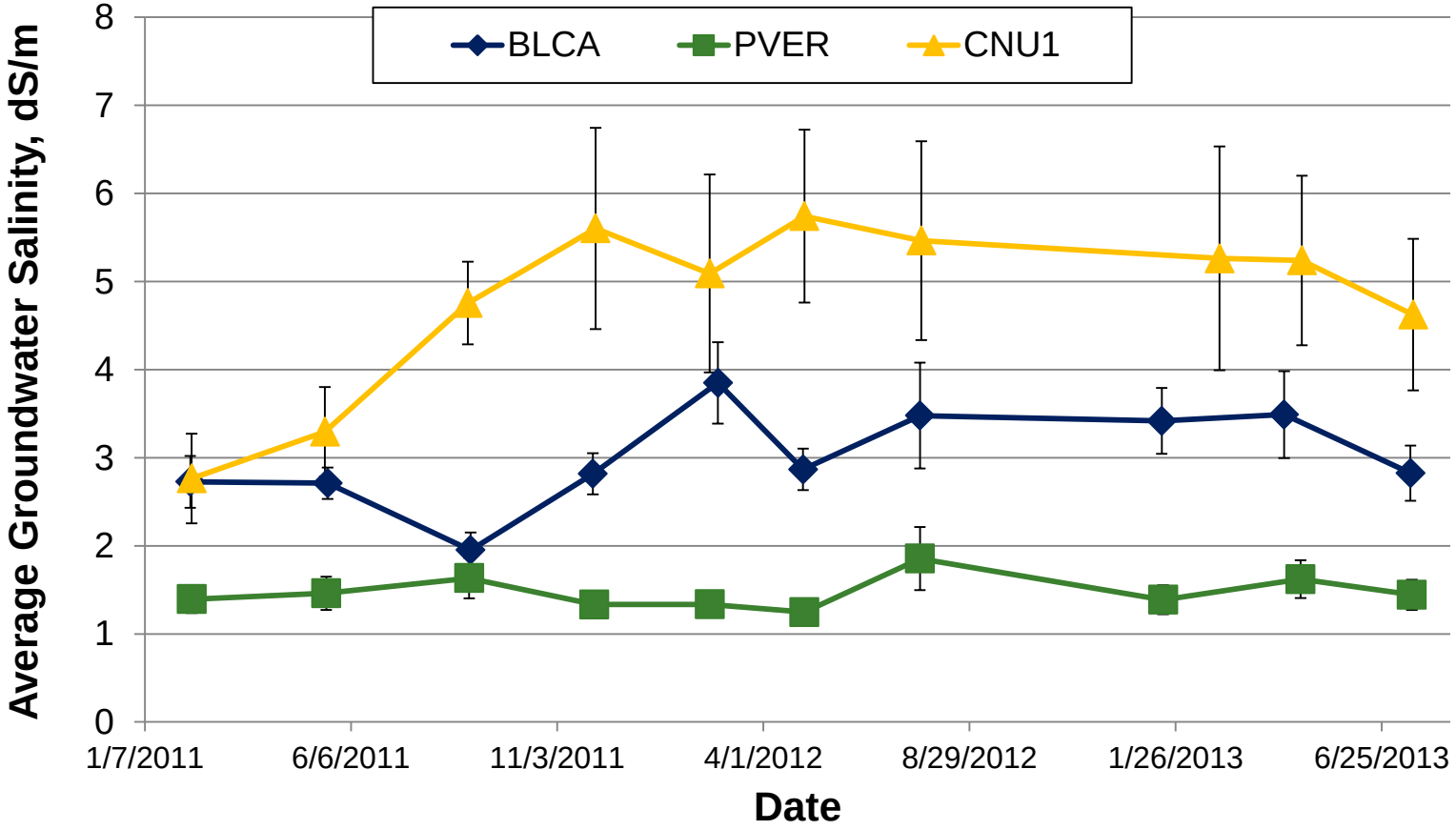
Groundwater Salinity: January 2011-July 2013



•Note:
1 dS/m =
1 mS/cm =
1,000 µS/cm

- Higher groundwater EC at Cibola, lowest at PVER, BLCA intermediate.

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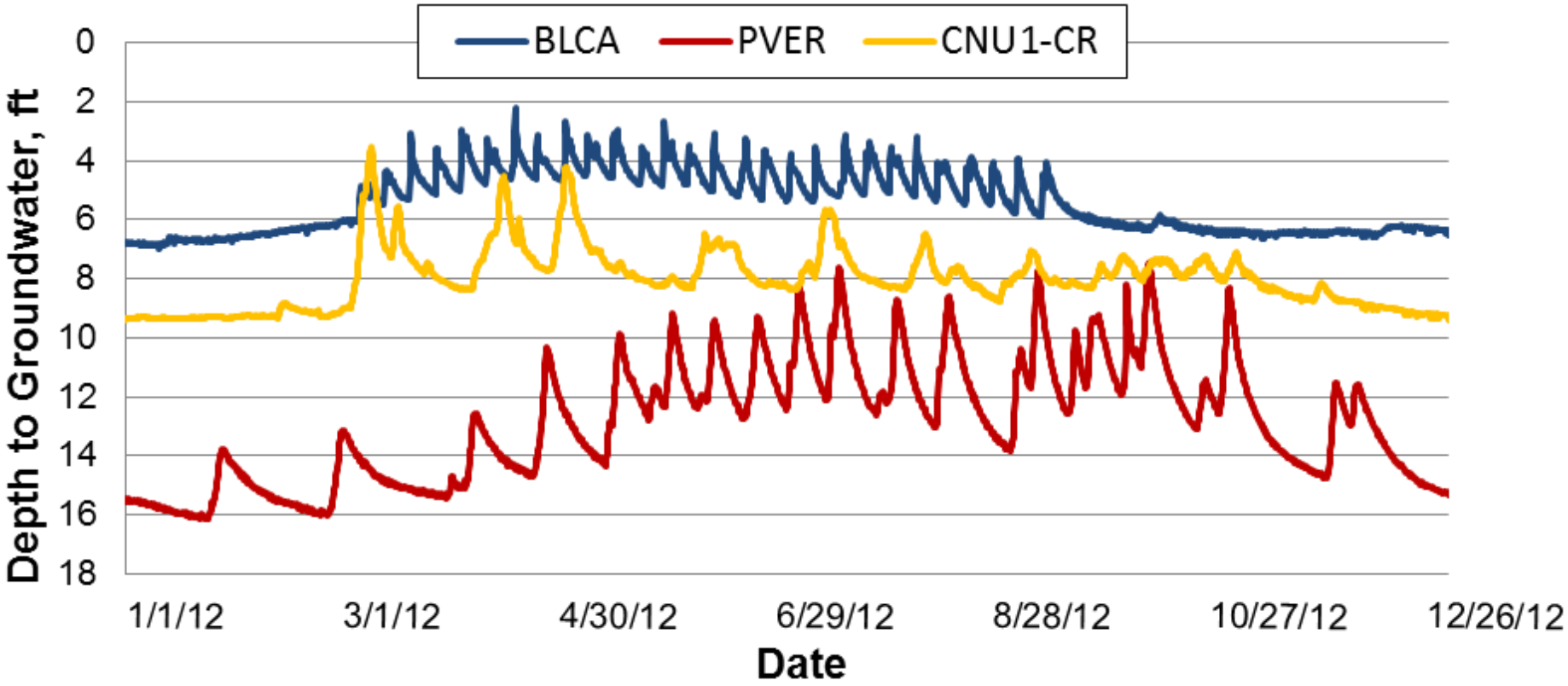
Representative Groundwater Depth: 2012



- Shallowest at BLCA, deepest at PVER, CNU1 intermediate.
- Frequent, extensive mounding at BLCA and PVER.

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Relative Site Condition Summary

- Good, Neutral, Bad in terms of salinity management.

Site	Soil texture	Groundwater depth	Groundwater salinity	Irrigation Frequency	Percolation
BLCA	Coarse	Shallow	Intermediate	High	High
PVER	Intermediate	Deep	Low	Intermediate	High
CNU1	Fine	Intermediate	High	Low	Low

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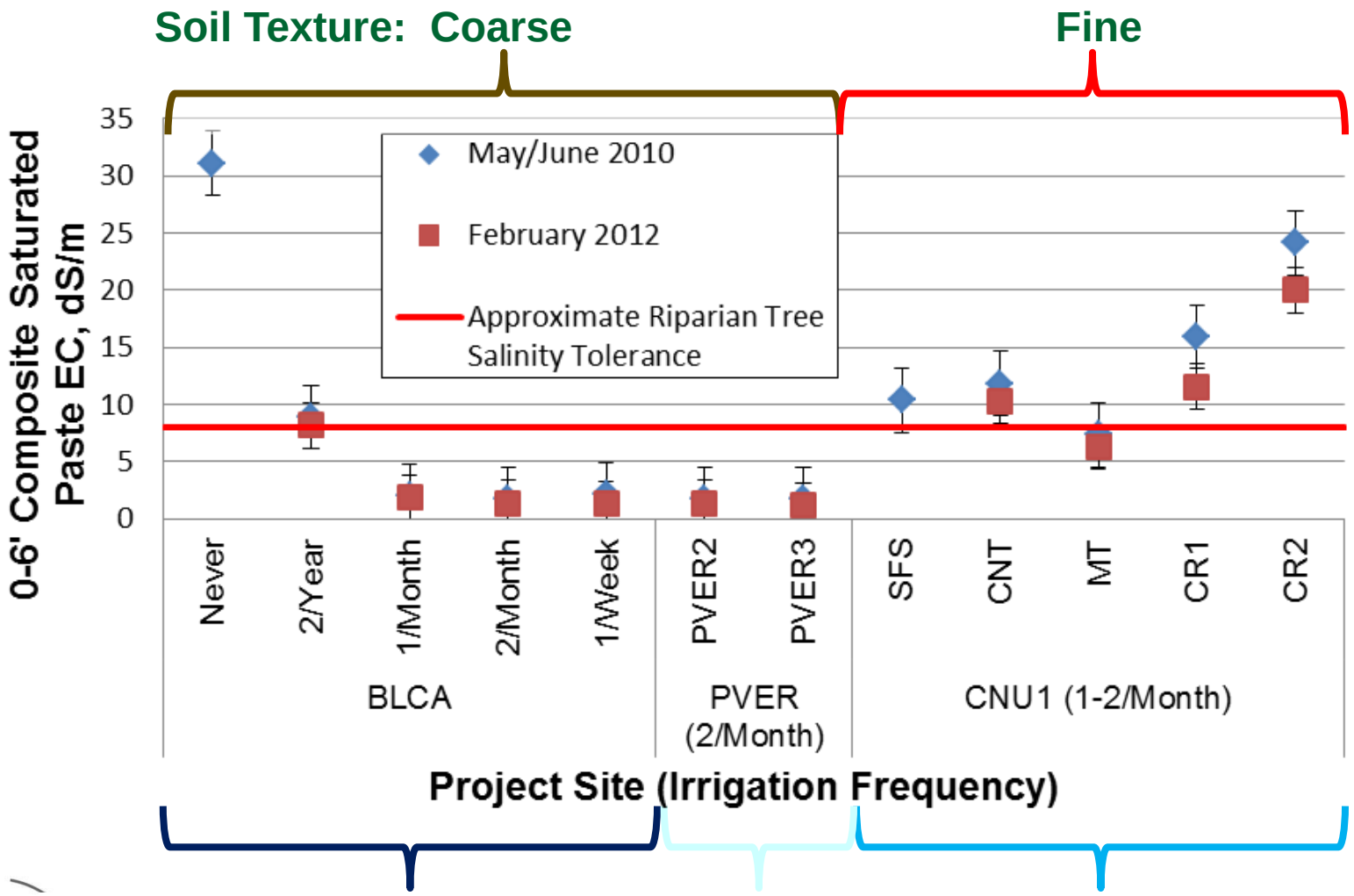
Soil Salinity Conditions



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Dense Goodding's willow growth at PVER—intermediate soil texture, low salinity, deep groundwater.

Salt crusts and marginal cottonwood success at CNU1 Crane Roost—fine soils, high salinity, intermediate groundwater depth.

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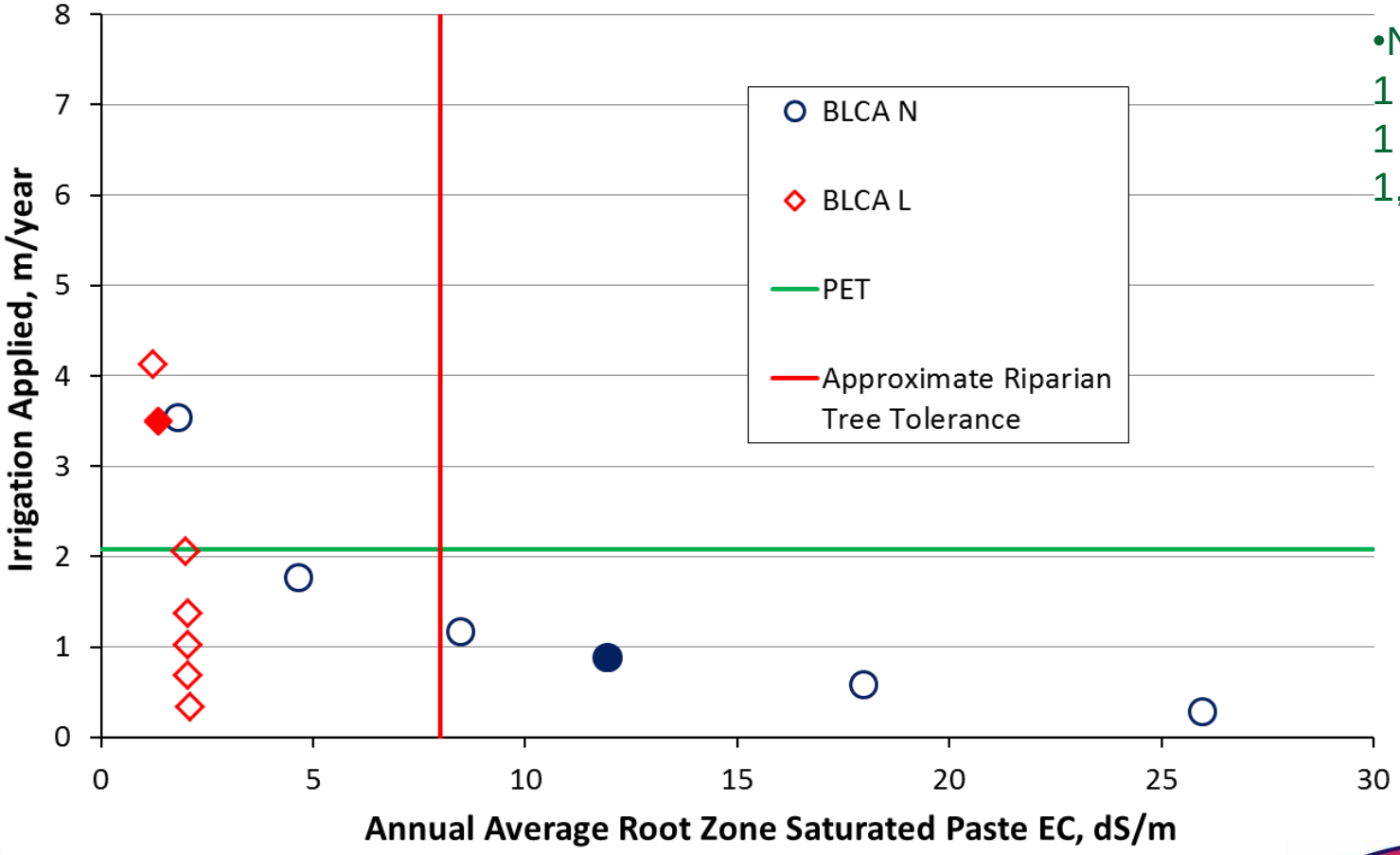
Model Development and Calibration

- SaltMod: http://www.waterlog.info/saltmod.htm
  - 1-D salt balance model.
- Model Development:
  - Use available data to specify model parameters.
  - Calibrate to observed soil and groundwater salinity.
- Model Projections:
  - How much water is needed to achieve desired soil salinity?

Example Modeling Predictions: BLCA

Sandy soils, shallow, moderate-salinity groundwater.



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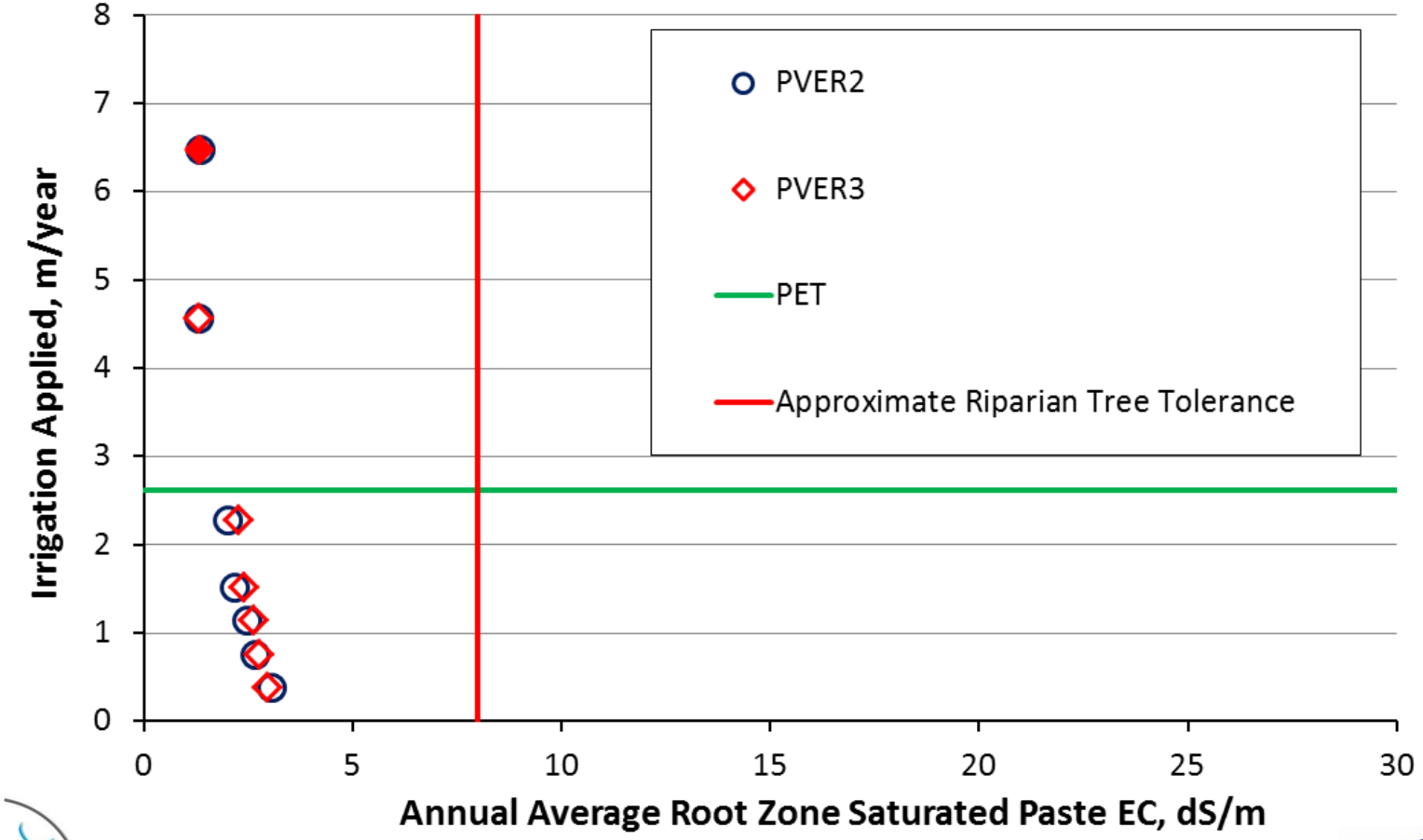
Modeling Predictions: PVER

Sandy and loamy soils, deep, low-salinity groundwater.



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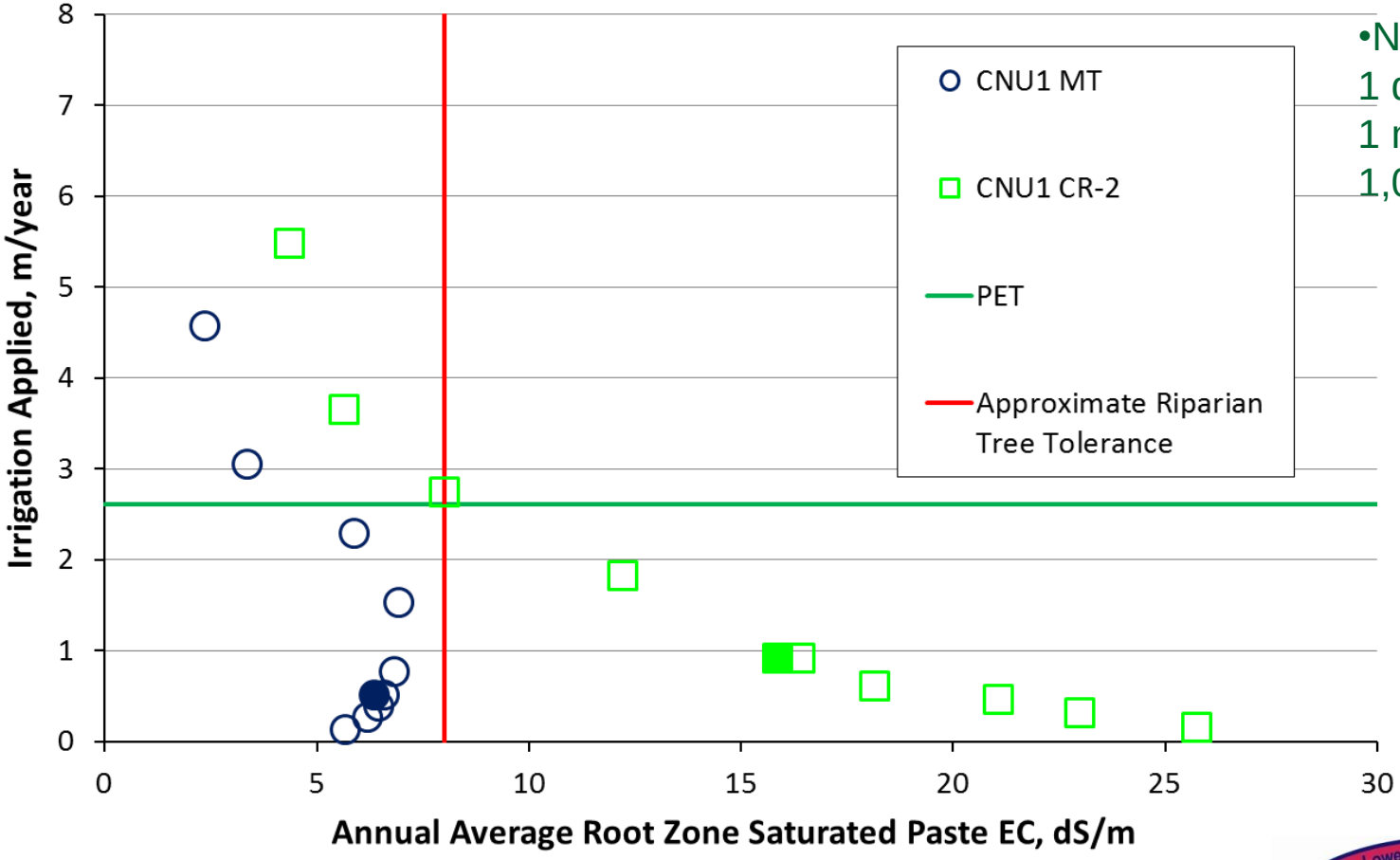
Example Modeling Predictions: CNU1

Silty loam soils, intermediate depth groundwater. High-salinity groundwater (CR-2) versus moderate-salinity groundwater (MT)



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Conclusions

- Soil and groundwater salinity determined by:

1. Soil texture: More sand → more efficient drainage and leaching.
2. Groundwater depth: Shallower water=more capillary rise and evapoconcentration in root zone.
3. Incoming groundwater salinity: up-gradient groundwater EC dictates groundwater EC at each site.
4. Irrigation application: Greater irrigation depth → more leaching.

Recommendations

1. Soil texture: Select sites with intermediate soil textures.
2. Irrigation: Optimize irrigation depth.
3. Groundwater depth: Drainage.
4. Groundwater salinity: Avoid leaching high salt loads up-gradient.

Monitoring and Adaptive Management Framework

- Sites with acceptable salinity:

1. Monitor for changes.

- Sites with unacceptable salinity:

1. Identify site-specific remediation tools.
2. Implement demonstration project.
3. Monitor for favorable results, and revise remediation tools as needed.

❖ **Additional considerations: vegetation maintenance, habitat quality.**

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