Plant Responses to Changing Conditions

Investigating Native and Invasive Riparian Species Under Varying Environmental Stressors in the Arid Southwestern U.S.

Amber R. Archie
Northern Arizona University
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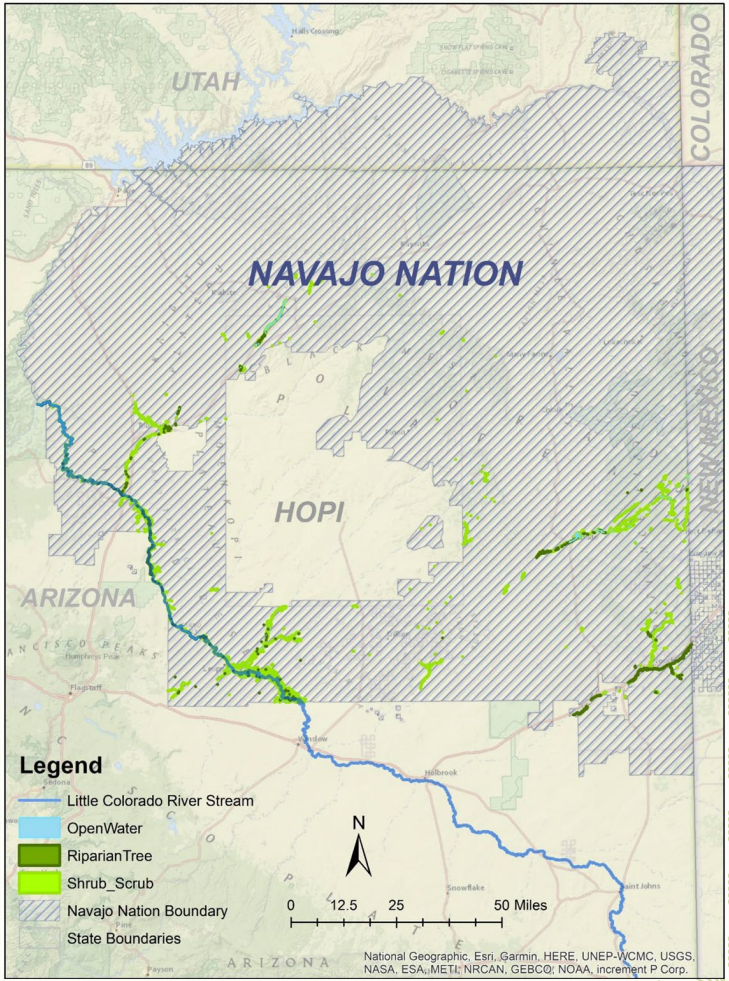
The Little Colorado River

- Northern Arizona, within the Colorado Plateau
- Major tributary of the Colorado River
- Characterized by:
  - Semi-arid climate
  - Variable flows/Ephemeral
  - Saline and alkaline floodplain soils
- Increasing surface salinization
- Widespread invasion by Tamarix (saltcedar)
- Ecologically and culturally significant to Indigenous communities



USGS

The Restoration Challenge

01 Increasing salinization in Southwestern riparian systems

02 Tamarix invasion alters soil & hydrology

03 Restoration success varies under stress

Drivers of Surface Soil Salinity in Riparian Systems

Hydrologic Alteration

- Reduced overbank flooding
- Shallow saline groundwater rise

Evapoconcentration

- High evaporation rates
- Salt accumulation at soil surface

Tamarix Influences

- High transpiration rates
- Salt excretion through leaf glands
- Leaf decomposition increases surface salt loads
- Incredibly dense stands of Tamarix throughout the LCR

Knowledge Gaps

Most studies test salinity in isolation

Few integrate salinity x competition

Limited data on source population tolerance

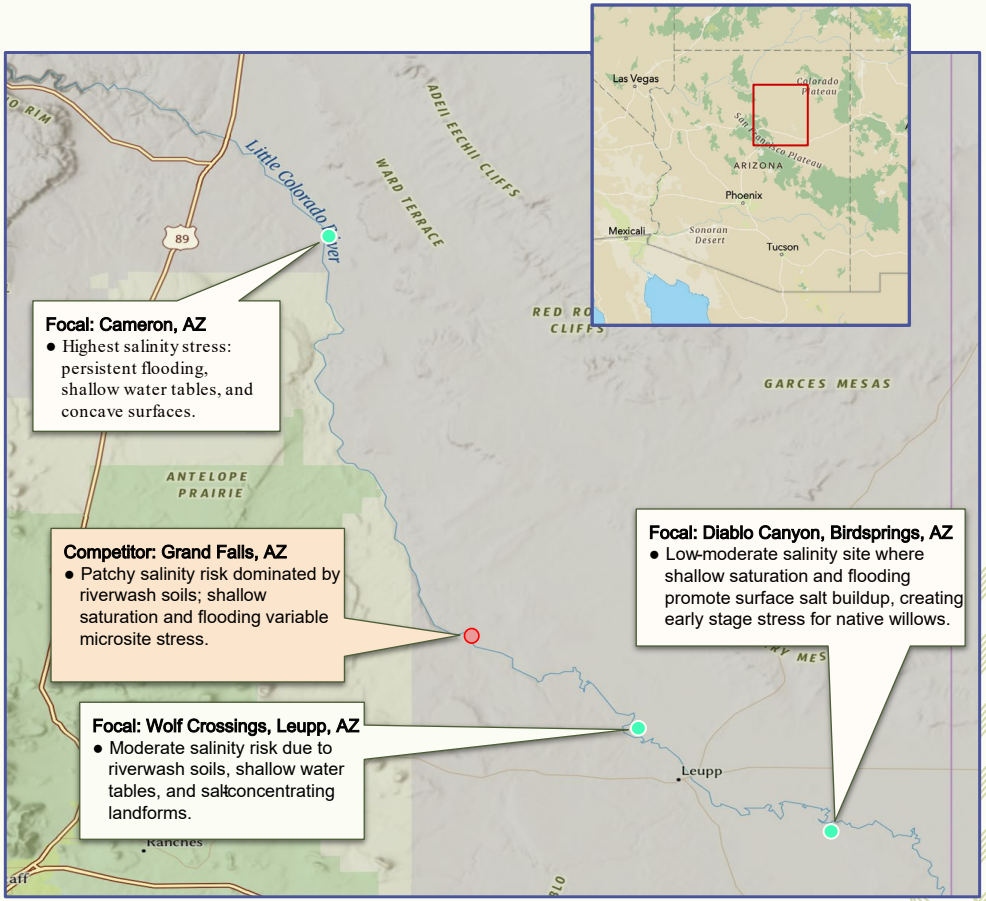
Bottom line: **How does willow respond to compounding effects of competition with Tamarix and increased salinity stress?**

Research Questions

- Does increasing salinity reduce willow growth?
- Does Tamarix competition intensify these effects?
- Do high-salinity sourced willows perform better under stress?

Field Site Context

- 3 willow source populations
- Floodbank habitats along the Little Colorado River
- Selected using surface salinity risk assessments
- Research conducted with Tribal permitting
- Salinity Gradient:
  - Low: LDCA
  - Moderate: LWCA
  - High: MFCAM



*Measurements focused on focal willows only.

Experimental Design

Focal Willow Collections - Early 2025 → Pairings - June 2025 → Greenhouse Growth (~13 weeks) → Finals Phenotypic Traits Measured (October 2025)

Salinity Treatment	Phase One (0-6 weeks)	Phase Two (6-13 weeks)
Control	0 ppt NaCl	0 ppt NaCl
Low	1 ppt NaCl	5 ppt NaCl
High	5 ppt NaCl	10 ppt NaCl

Measured Variables

Aboveground

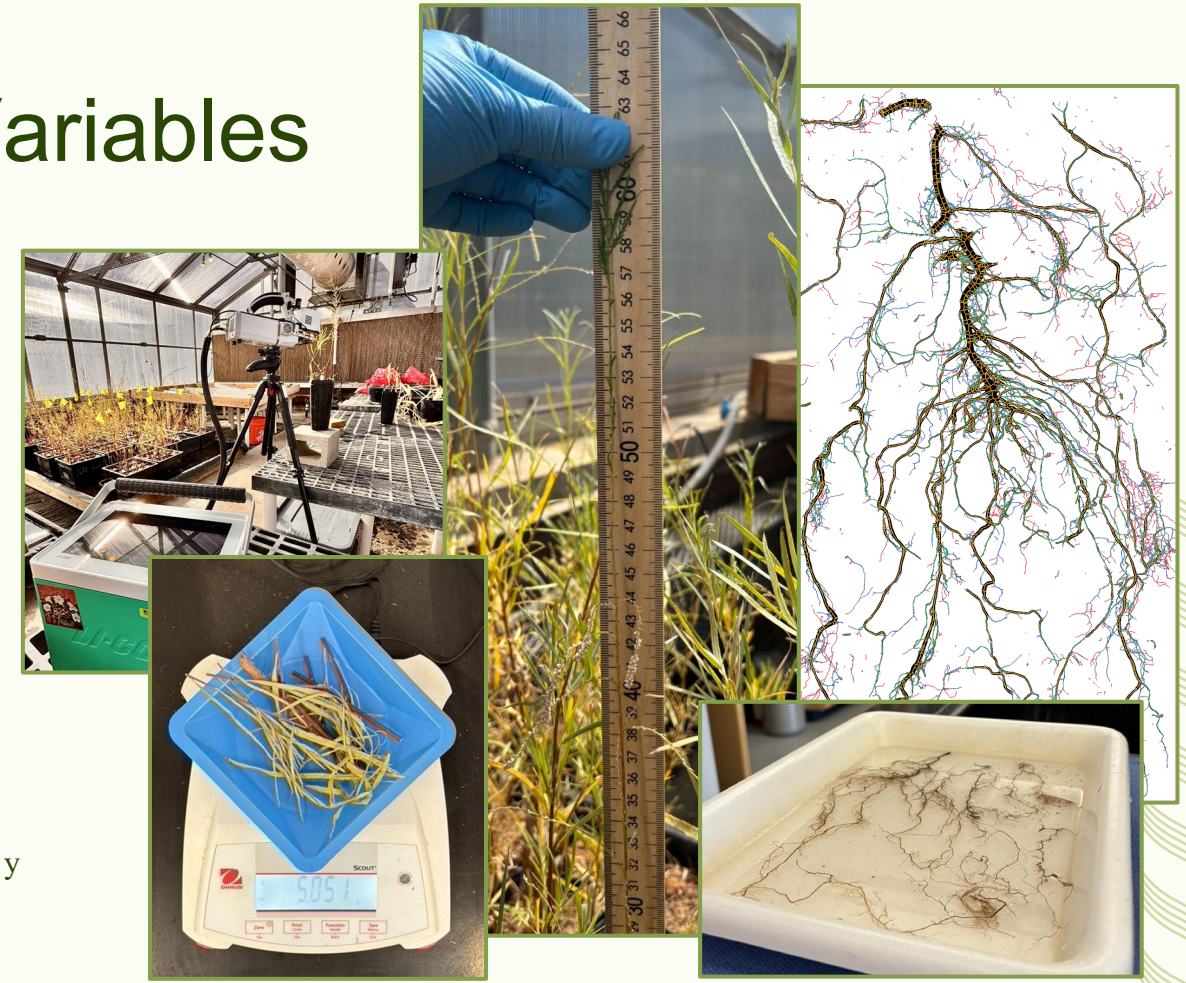
- Height
- Basal Diameter

Belowground

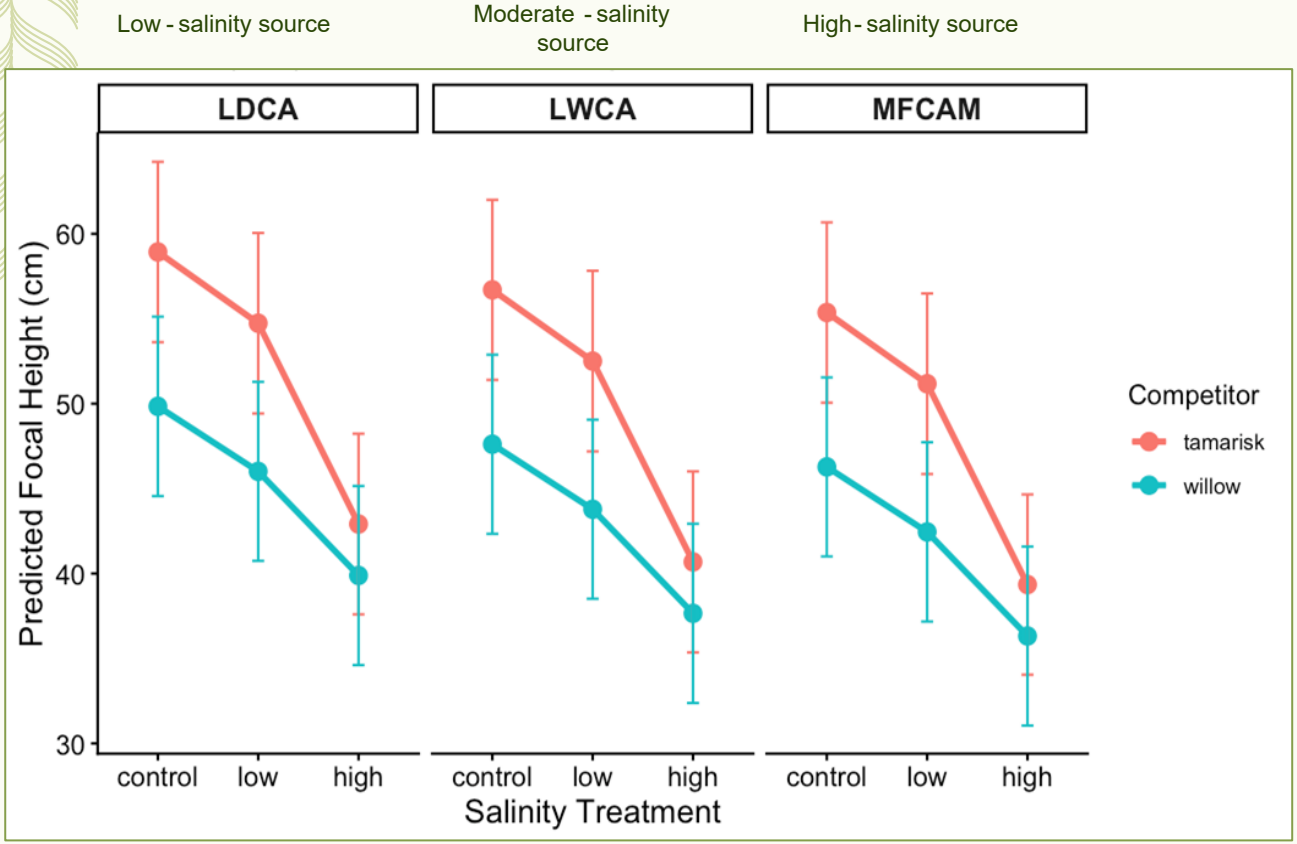
- Biomass Allocation
- Root Architecture

Physiology

- Gas Exchange
- Photochemical Efficiency



Willow Height Declines with Increasing Salinity and Competition



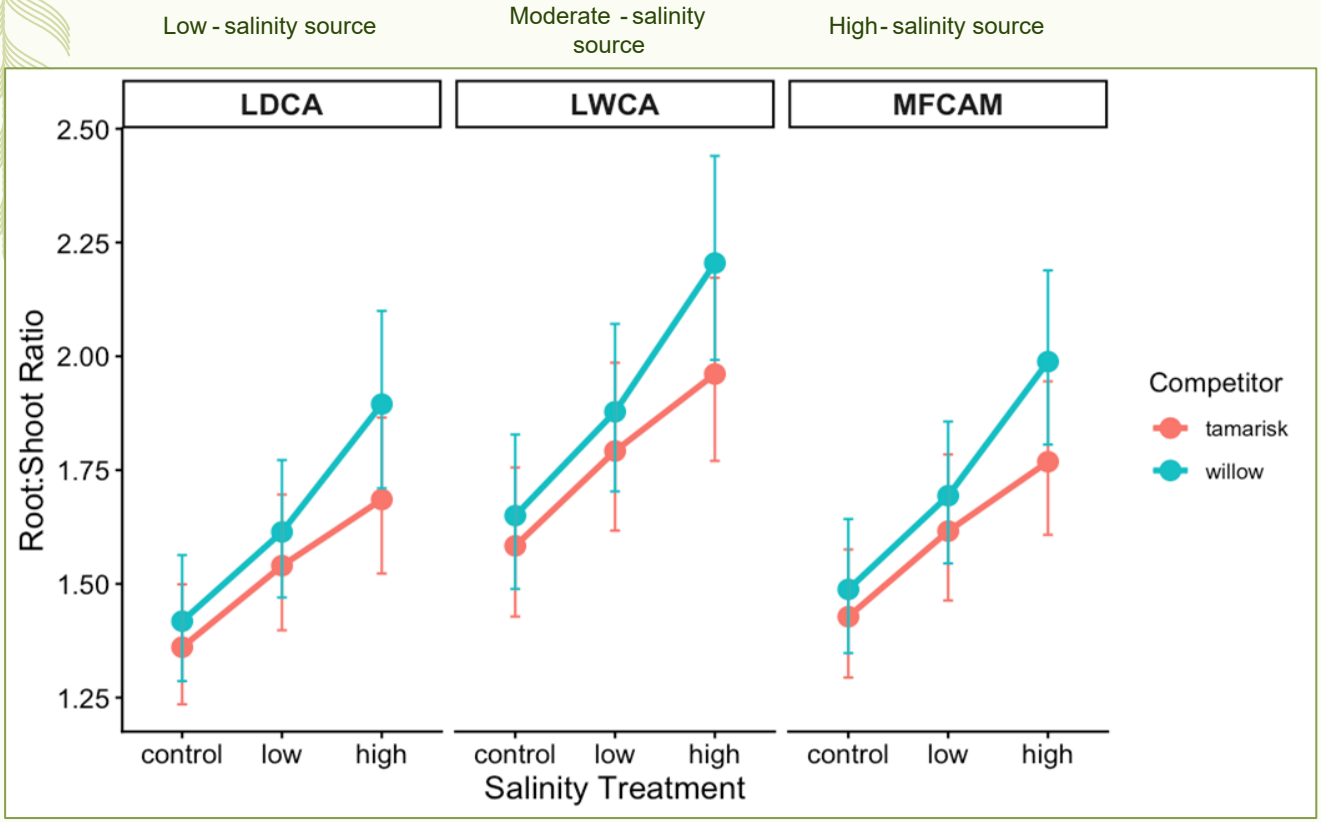
Salinity $p < 0.001$

Competitor $p < 0.001$

Salinity:Competitor $p < 1$

*Error bars indicate ± 95% CI

Increasing Salinity Drives Greater Root Allocation



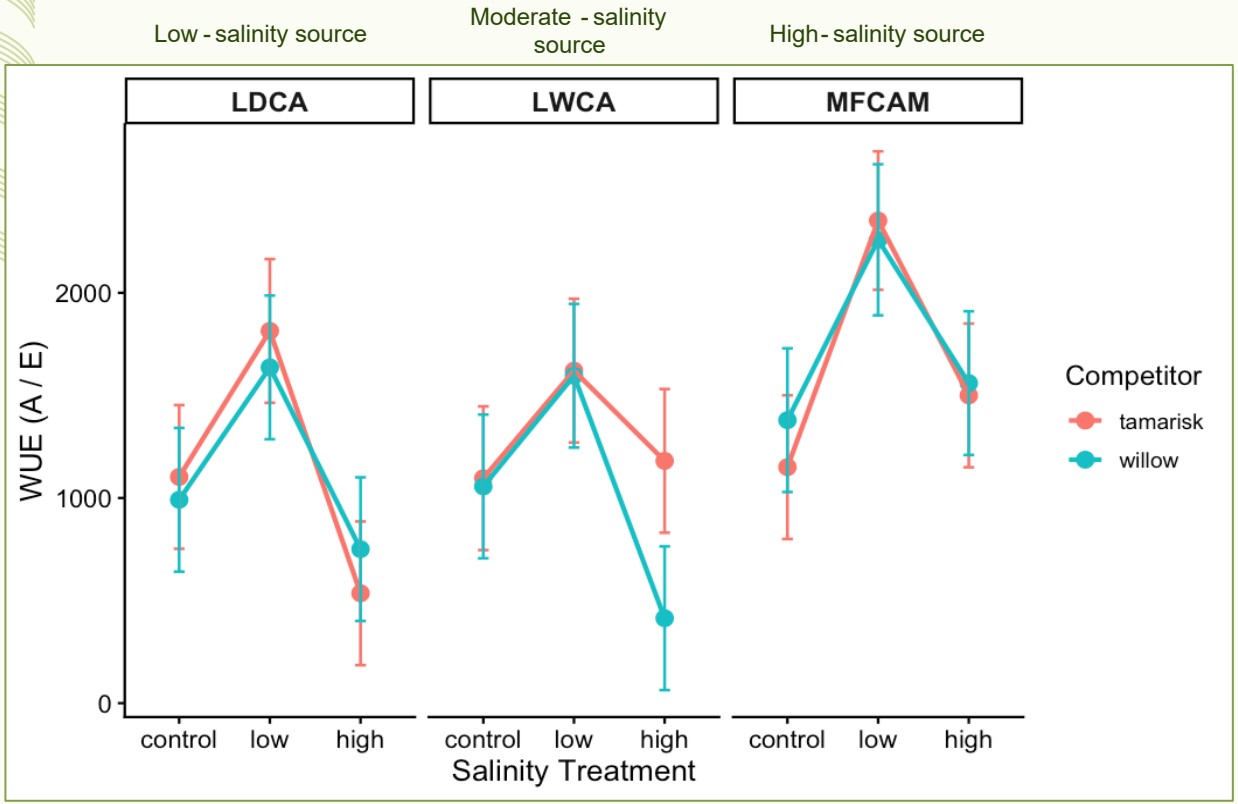
Salinity $p < 0.001$

Competitor $p < 0.05$

Population $p < 0.05$

*Error bars indicate ± 95% CI

Low Salinity Treatments Enhance Water Use Efficiency



Salinity $p < 0.001$

Fieldsite $p < 0.001$

Salinity:Fieldsite $p < 0.05$

*Error bars indicate ± 95% CI

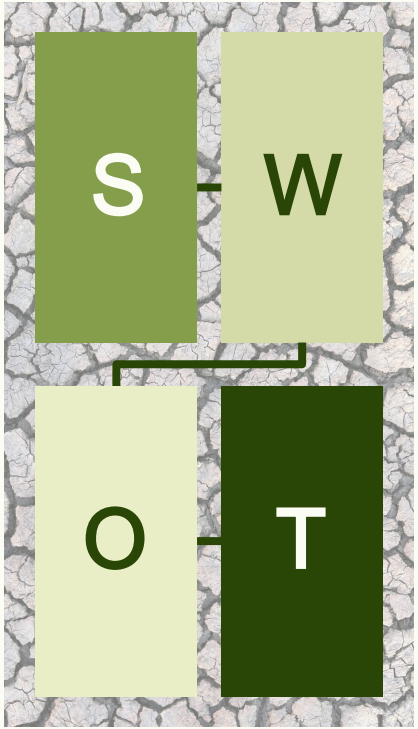
Integrating the Stressors

Strengths

- Willow plasticity
- Some source populations show tolerance

Weaknesses

- Growth suppression under high salinity



Opportunities

- Strategic source selection
- Tamarix removal timed with low salinity windows

Threats

- Increasing climate-driven salinization
- Continued hydrologic alteration
- Invasive dominance in stressed microsites

Research Implications

- Source population selection may influence restoration success under salinity stress
- Interactions between salinity and invasives — they should not be managed independently
- Physiological metrics can provide early stress indicators
- Restoration planning should incorporate site-specific salinity risk assessments
- Integrating hydrology, soil chemistry, and invasion dynamics improves outcome prediction

Thank you!

Questions?

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