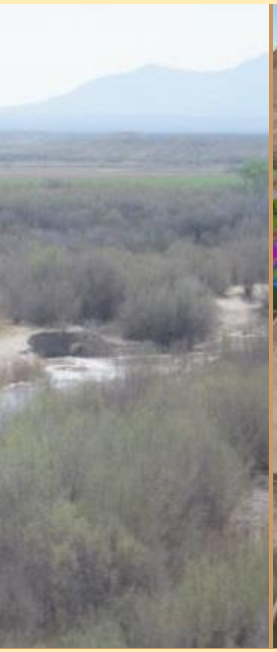


An Ecohydrological Framework for Riparian Restoration and Southwestern Willow Flycatch Recovery Planning & Prioritization

RiversEdgeWest

Riparian Restoration Conference

Phoenix, AZ

6 February 2019

Bruce Orr (Stillwater)

Glen Leverich (Stillwater)

Tom Dudley (UCSB)

Jim Hatten (USGS)

Matt Johnson (NAU)

Kevin Hultine (DBG)

Stillwater Sciences

Restoration Framework Process

- Restoration Goals and Objectives with Community Support
- Suitable Restoration Sites and Strategies
- Monitoring Objectives and Protocols
- Environmental Permits
- Implement Active Restoration

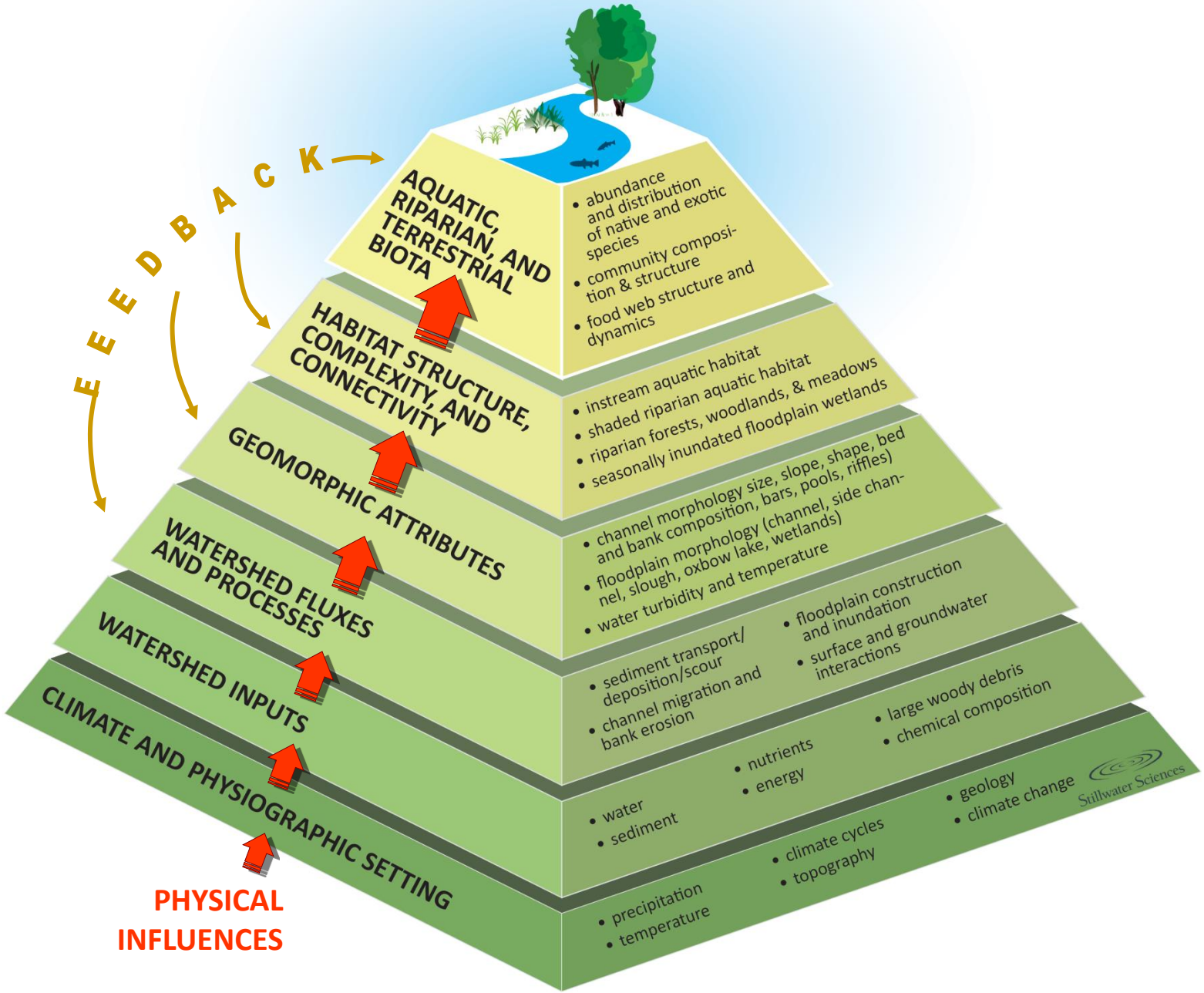
Desert Riparian Ecosystems

- **Ecologically and economically valuable**
  - **High diversity and productivity**
  - **Wildlife habitat**
  - **Water resources**
  - **Recreational use**
  - **Other ecosystem services**

Need for Riparian Restoration

- Tamarisk/Saltcedar infestation
  - Has replaced native vegetation
  - Increases fire risk
  - Changes river morphology
  - Uses deeper water resources
  - Can increase soil surface salinity
- Important habitat for Southwestern Willow Flycatcher (SWFL) and other wildlife species


Photo: USGS


FEEDBACK
AQUATIC, RIPARIAN, AND TERRESTRIAL BIOTA
• abundance and distribution of native and exotic species
• community composition & structure
• food web structure and dynamics
HABITAT STRUCTURE, COMPLEXITY, AND CONNECTIVITY
• instream aquatic habitat
• shaded riparian aquatic habitat
• riparian forests, woodlands, & meadows
• seasonally inundated floodplain wetlands
GEOMORPHIC ATTRIBUTES
• channel morphology size, slope, shape, bed and bank composition, bars, pools, riffles)
• floodplain morphology (channel, side channel, slough, oxbow lake, wetlands)
• water turbidity and temperature
WATERSHED FLUXES AND PROCESSES
• sediment transport/ deposition/scour
• channel migration and bank erosion
• floodplain construction and inundation
• surface and groundwater interactions
WATERSHED INPUTS
• water
• sediment
• nutrients
• energy
• large woody debris
• chemical composition
CLIMATE AND PHYSIOGRAPHIC SETTING
• precipitation
• temperature
• climate cycles
• topography
• geology
• climate change
PHYSICAL INFLUENCES
Stillwater Sciences

Key Elements of the Upper Gila River Riparian Restoration Framework Project

- Remote sensing data collection (USU RS/GIS)
- Ecohydrology Assessment (Stillwater)
- SWFL habitat modeling (USGS and NAU)
- Site surveys and pre-biocontrol baseline monitoring (Stillwater/UCSB/DBG/NAU)
- Technical input to GWP on restoration plan, monitoring protocols, plant propagation (Stillwater/UCSB/DBG/NAU)
- Community outreach, landowner coordination (GWP)
- Agency coordination and permitting application (GWP/Stillwater/NAU)

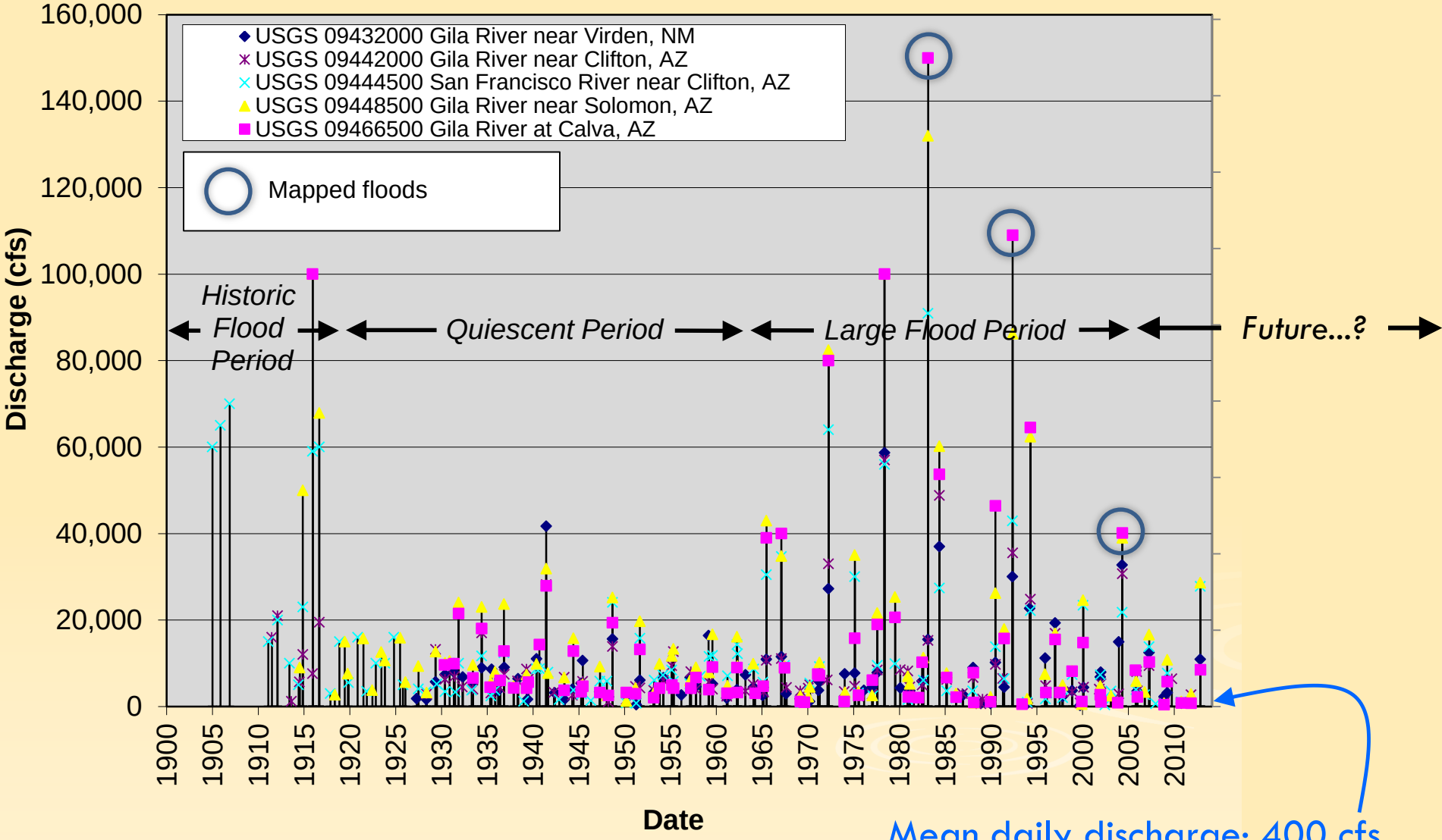
Ecohydrological Approach – Restoration Suitability

Ecohydrology: Physical Setting

Ecohydrology: Topography

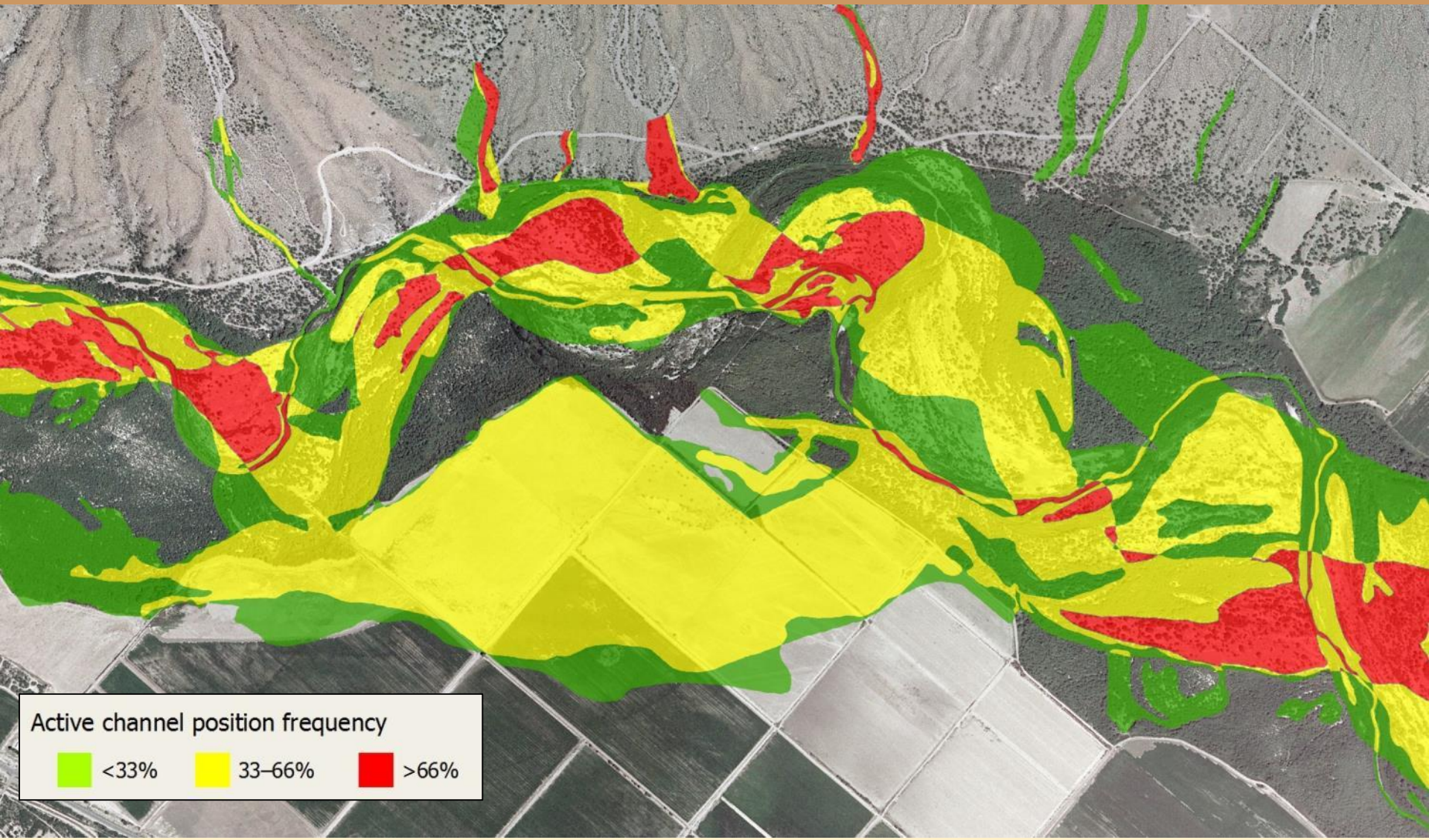
LiDAR Topography (USU RS/GIS)

Ecohydrology: Flood Regime



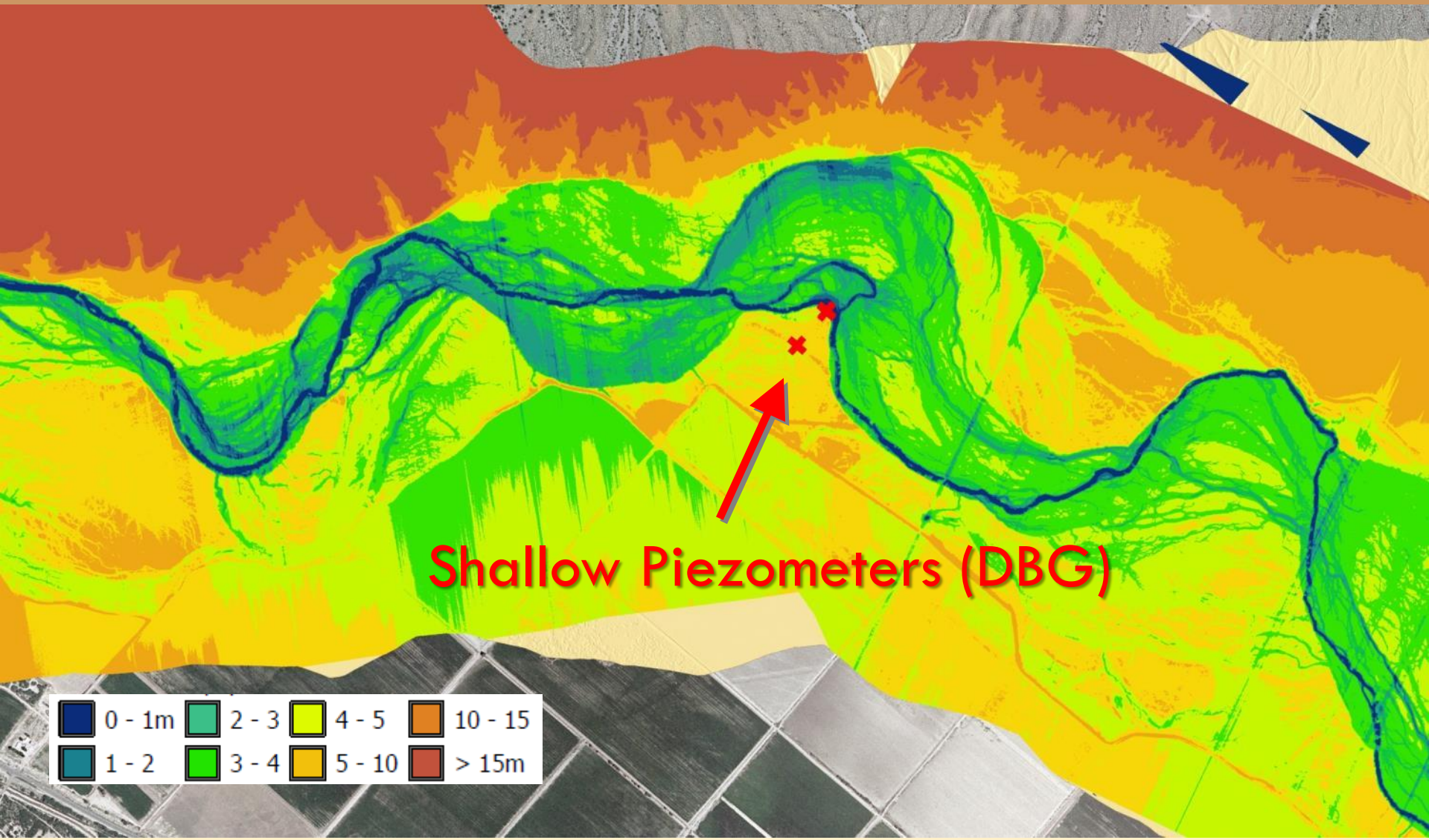
Mean daily discharge: 400 cfs

Ecohydrology: Flood-Scour Frequency



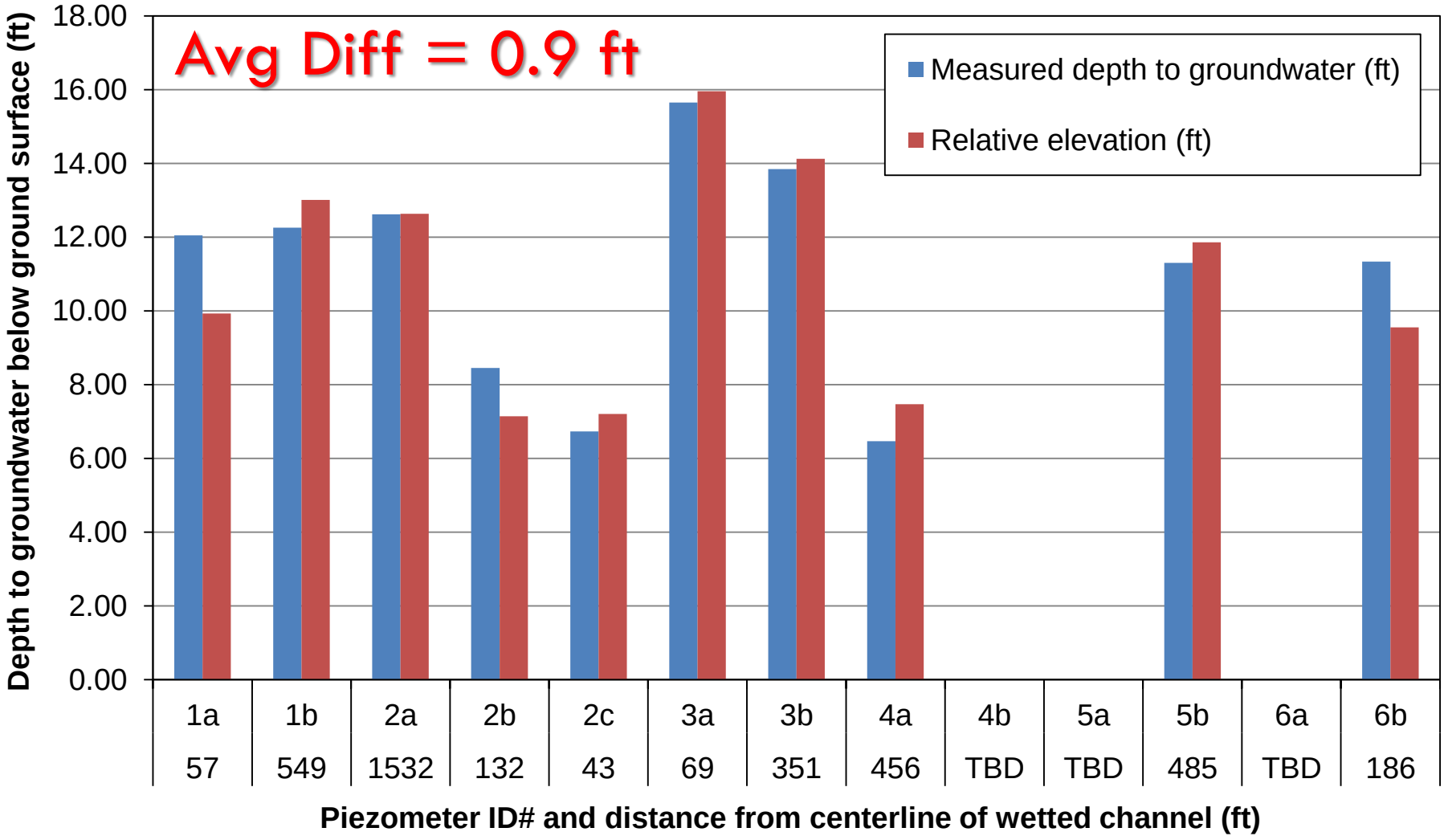
Flood-scour Frequency and "Flood Reset Zone" (Stillwater)

Ecohydrology: Water Availability (Relative Elevation)



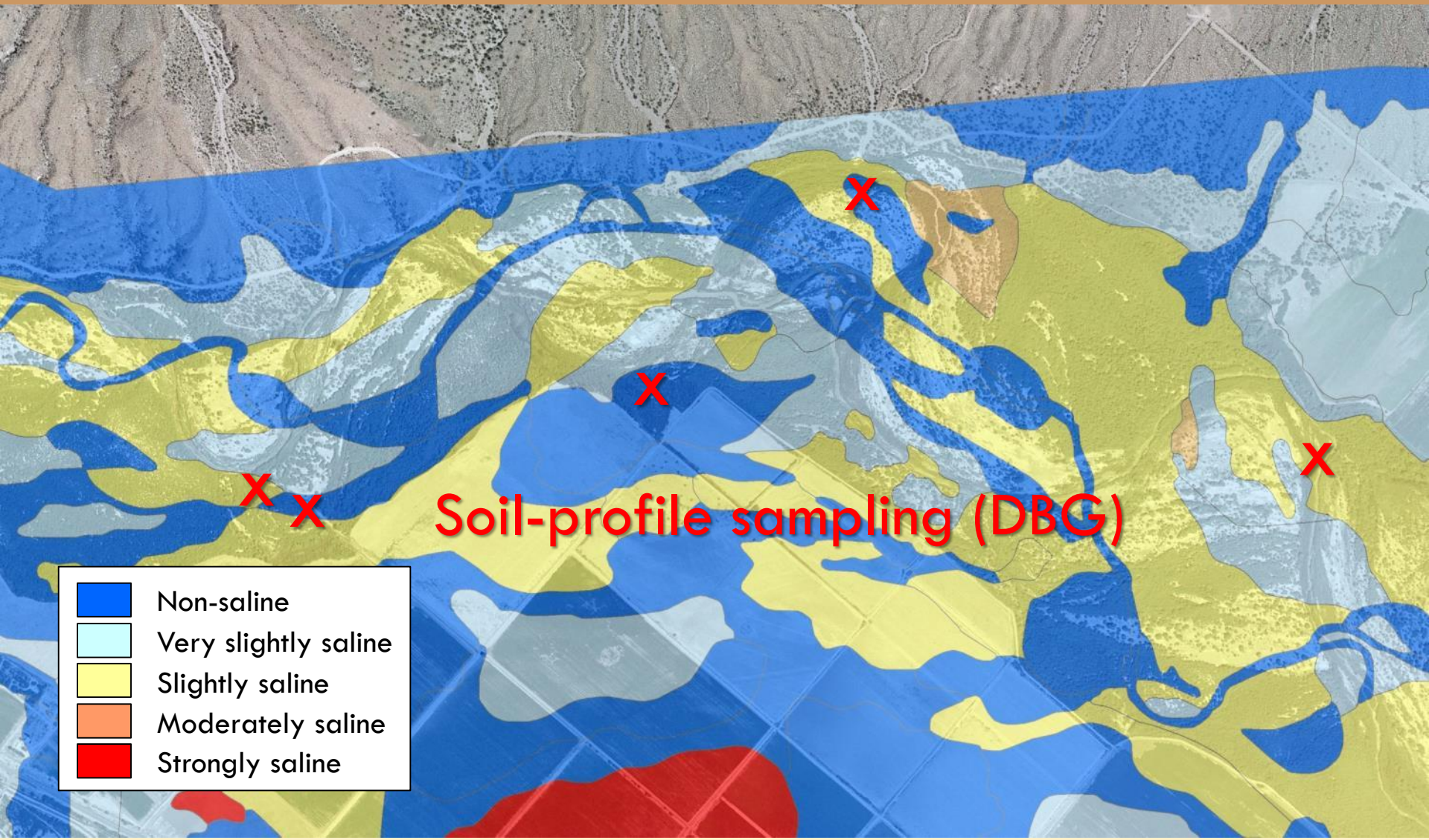
Relative Elevation above low-flow channel from LiDAR (USU/Stillwater)

Ecohydrology: Groundwater (Direct Measurement)



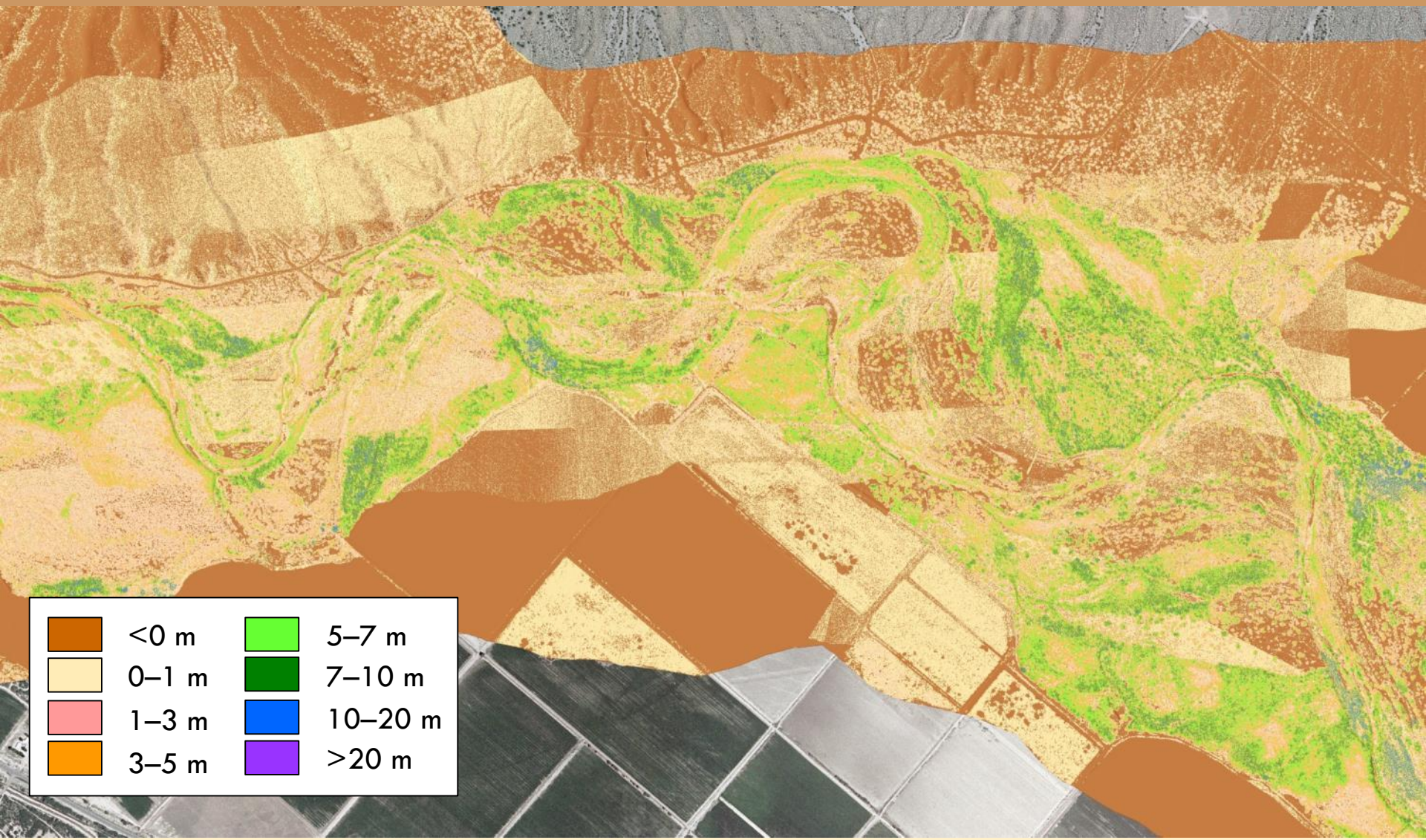
10 of 13 GW Monitoring Stations [3 forthcoming] (DBG/Stillwater)

Ecohydrology: Soil Characterization (Salinity)



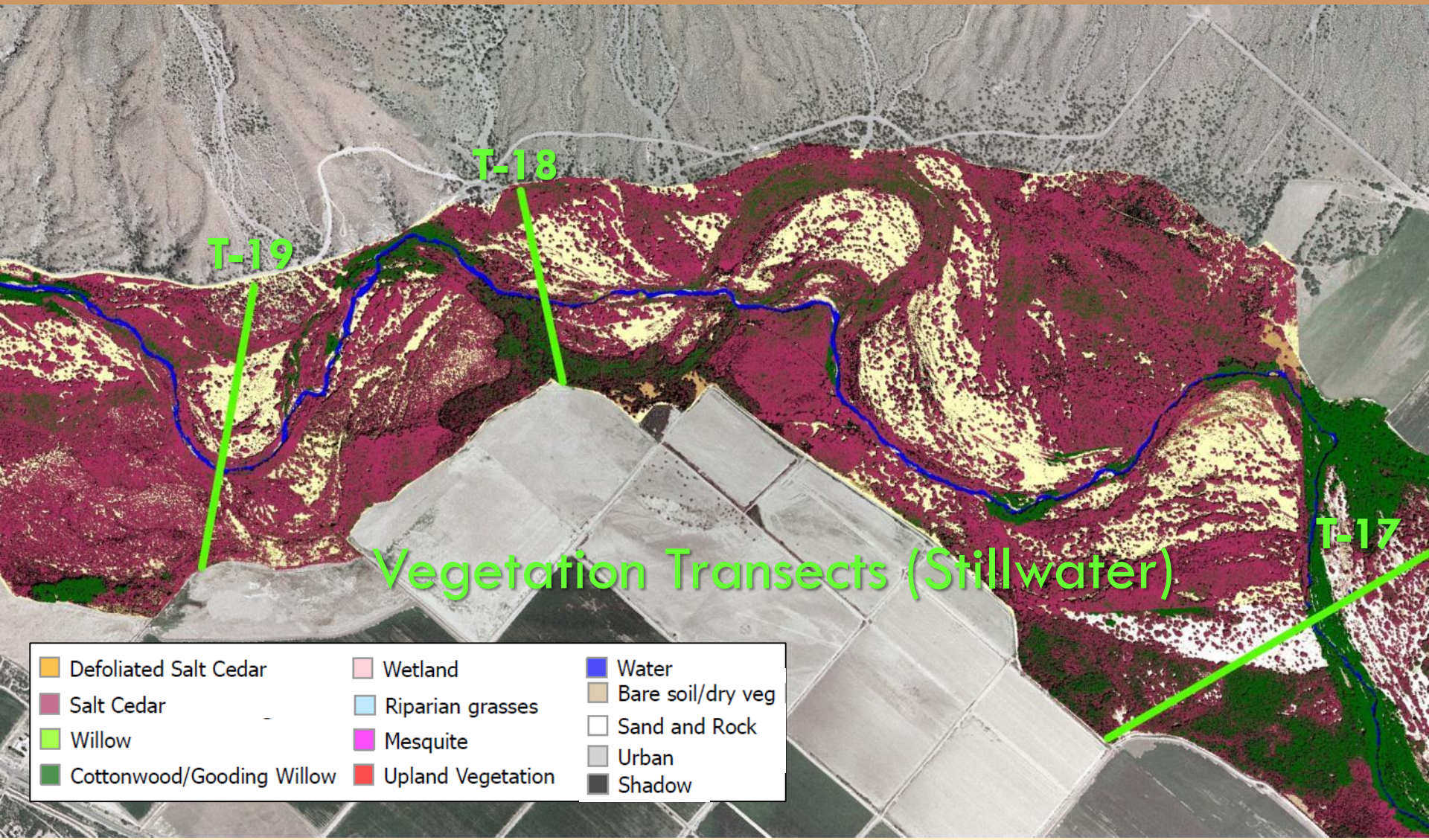
Soil Salinity from SSURGO Database (NRCS/Stillwater)

Ecohydrology: Vegetation Characterization



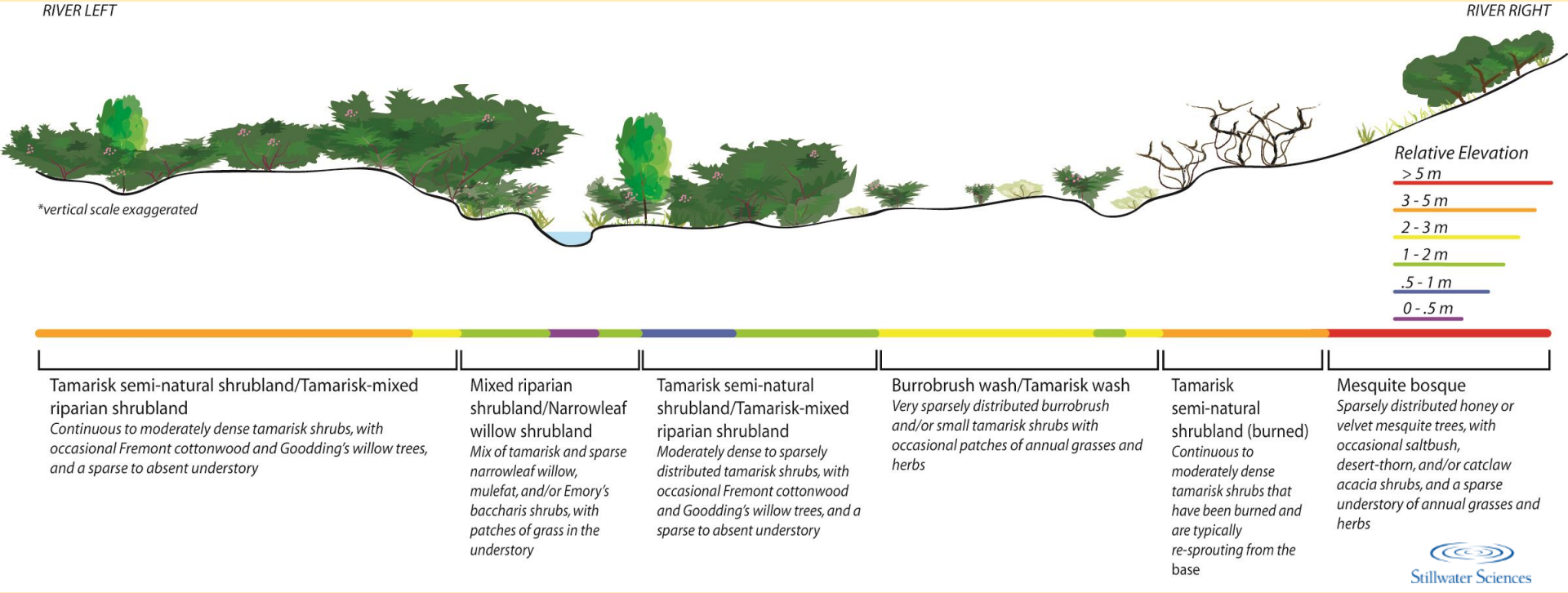
Canopy Heights derived from LiDAR 1st returns (USU/Stillwater)

Ecohydrology: Vegetation Characterization



Vegetation Classification from Remote Sensing (USU RS/GIS)

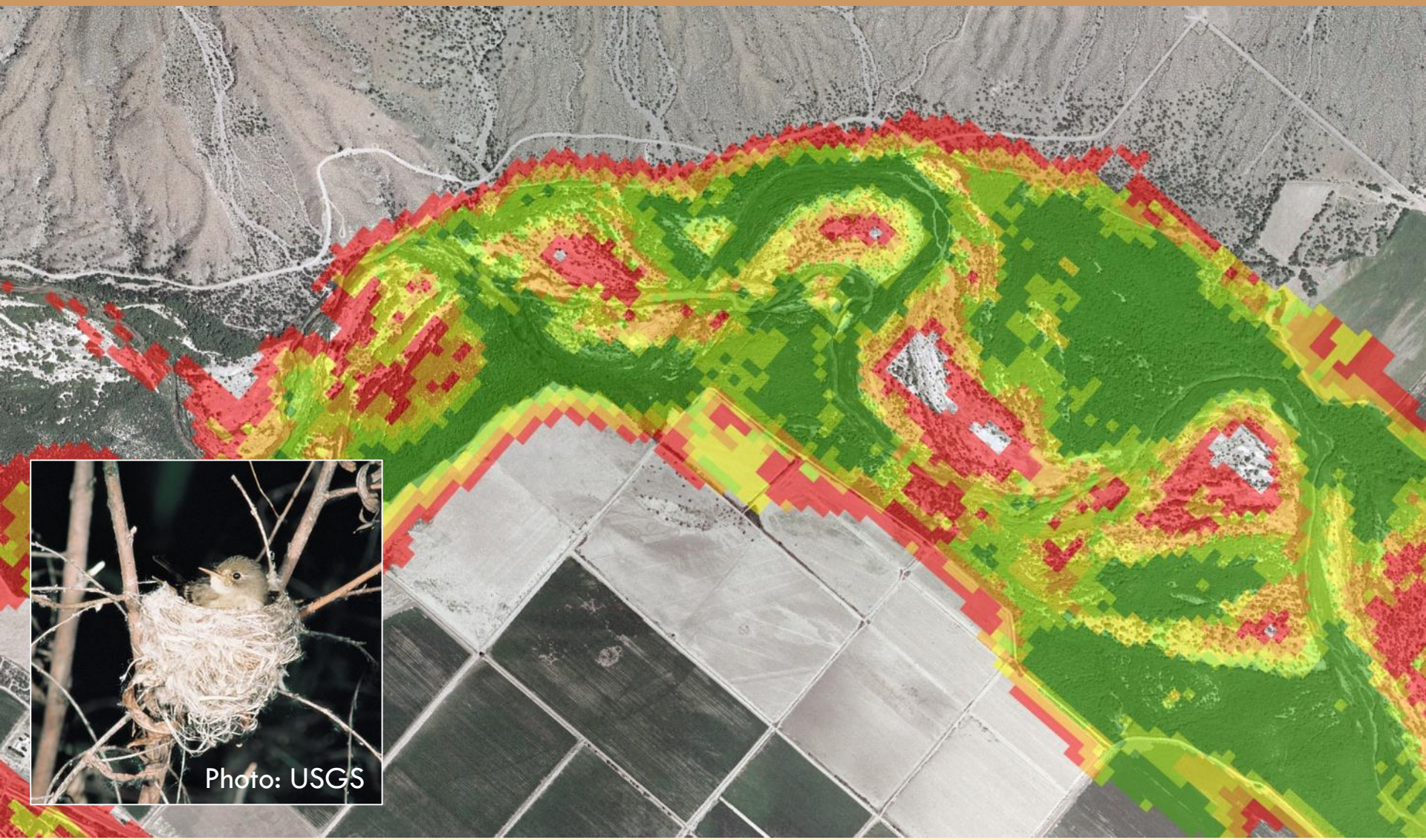
Ecohydrology: Vegetation Characterization



Findings

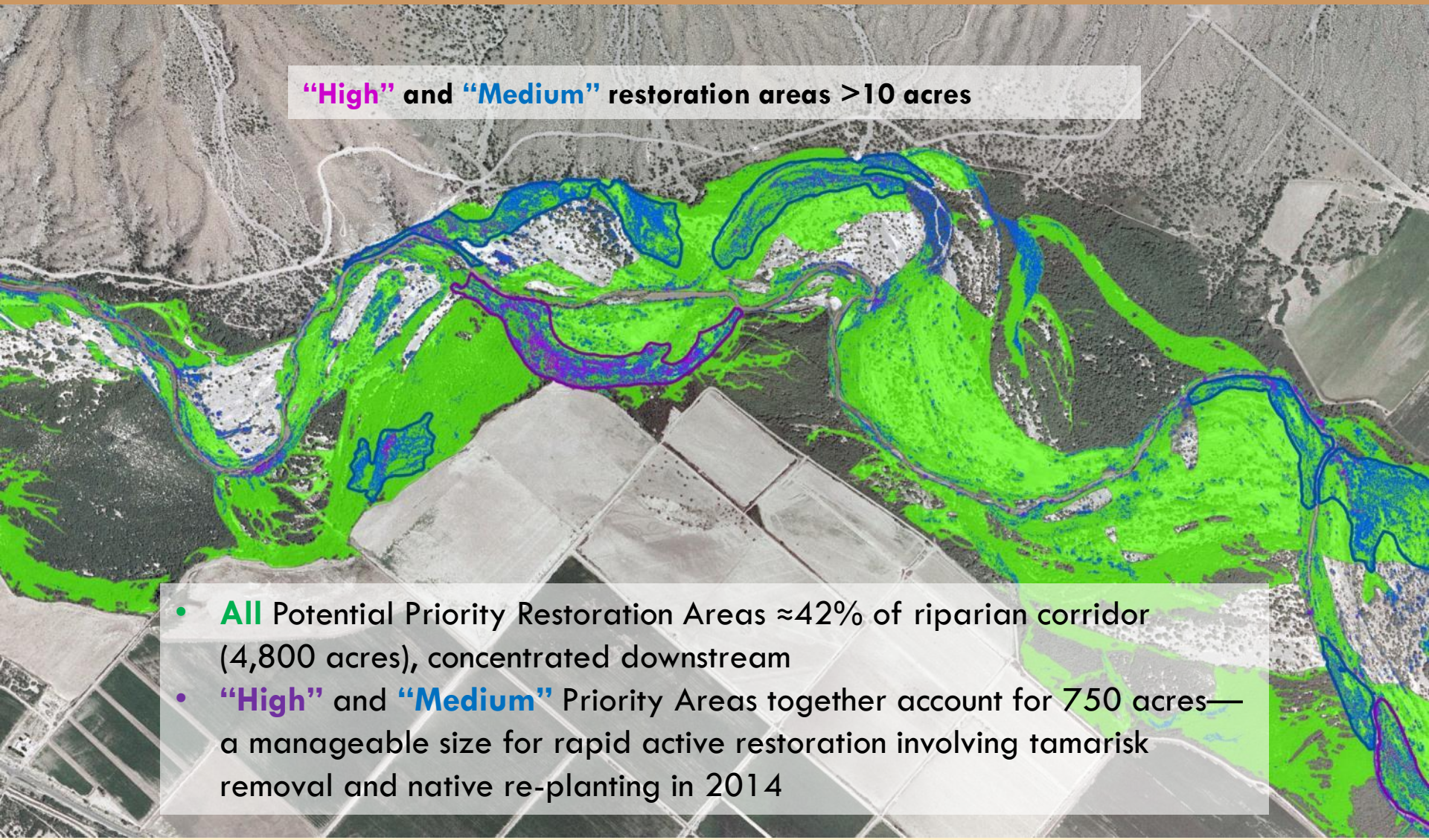
- **Variation along river length and across width; density (growth potential) greatest downstream (ag return flows) and closest to river (surface water/shallow groundwater)**
- **Limited natural recruitment of native woody vegetation; most stands aged to 1993 flood**
- **Natural recruitment potential greatest in and near the Flood Reset Zone (active scour in Sept 2013: 28600 cfs=6 yr RI, 8500 cfs=3 yr RI)**
- **Propagule islands at existing native stands; new islands implemented almost anywhere else**
- **Take advantage of recent burned areas**

SWFL Breeding Habitat Suitability



SWFL Breeding Habitat Suitability (LANDSAT) from J. Hatten (USGS)

Ecohydrology: Potentially Suitable Restoration Areas



- **All** Potential Priority Restoration Areas ≈42% of riparian corridor (4,800 acres), concentrated downstream
- **"High"** and **"Medium"** Priority Areas together account for 750 acres—a manageable size for rapid active restoration involving tamarisk removal and native re-planting in 2014

"High" and "Medium" Priority Restoration Areas (Stillwater)

Restoration Approach

1. Restore native riparian vegetation suitable for SWFL nesting habitat
    - Remove and treat tamarisk to create space for natives
    - Facilitate natural recruitment of natives
    - Plant natives
    - Use a phased, patchwork approach to minimize short-term impacts
    - Risk management and the flood reset zone
2. Strategic active restoration of native habitat patches or “propagule islands” in occupied habitat
3. Passive restoration in areas disturbed by fires or floods

Road to Implementation

- Stakeholder and Landowner Outreach
- Refine Priority Sites
- Planting Design and Nursery
- Agency Coordination
- Permit Applications
- Refine and Implement Monitoring Plan
- Implement restoration in phases

Implementation

Monitoring

- Monitor vegetation recruitment, planting success, size and density
- Wildlife monitoring: SWFL and WYBC
- Experimental plots to test planting methods
- Monitoring of beetle colonization and habitat changes vs pre-beetle conditions (have restoration and the beetle put the ecosystem on a desired trajectory?)
- Common garden plots to compare response of different ecotypes (with Tom Whitham and colleagues at NAU)

SUMMARY

- Riparian ecosystems are **naturally dynamic**
- Human alterations, including ***Tamarix*** introduction, have created **novel riparian ecosystems**
- Introduction of the **Tamarisk Beetle** is **shifting trajectory** of these novel ecosystems
- **Management interventions** will often be required to shift systems to a **more desirable trajectory**
  - ***Active Restoration***: Removal of *Tamarix* and active planting of native riparian species to promote more rapid recovery
  - ***Reduce other stressors (passive restoration)***: surface flow and groundwater management, grazing, floodplain development

SWFL (Photo by USGS)

Recovery Express: A Recovery Planning Prioritization Tool

Faced with declining salmon and steelhead populations and a great range of possible mitigation actions, Recovery Express can objectively prioritize every option for maximum recovery impact.

Five key attributes of Recovery Express

1. Considers biological, social, and economic criteria – in combination – to prioritize actions.
2. Employs an instant ranking function for easy updates.
3. Facilitates swifter agreement on collaborative recovery actions to be taken.
4. Coordinates regional projects for maximum impact.
5. Identifies the strategy with the best benefit-cost ratio for full recovery of an ESU.

Built by stakeholders with divergent points of view

CalTrout, PG&E, and Stillwater Sciences led a collaborative effort to identify and prioritize recovery actions for threatened and endangered salmon and steelhead in the Sacramento River Basin. Diverse stakeholders brought their recovery actions to the table and worked toward prioritizing them as a group - according to biological, social, and economic criteria. Stillwater Sciences created a technical framework to support this process – Recovery Express - applicable to any watershed.

Vetted by water users, agencies, and non-profits

The tool provides objective data to recommend the most promising recovery actions, reducing conflict between agencies and water users.

The tool uses NMFS' Viable Salmonid Population (VSP) concept to ensure that recovery priorities relate to agency-mandated recovery plans.

NMFS: "We believe the *Recovery Express* tool will help further the objectives of the NMFS Central Valley Recovery Plan and look forward to exploring its potential applications".

How it works

VSP deficits are established for the "recovery" of target populations and ranked on a scale of 0-5, with 0 being no deficit (target is met) and 5 being maximum deficit (20% or less of target is met). For example, the abundance of Winter-run Chinook salmon might be given a deficit rank of 4, meaning it is only 20-40% of the abundance needed for a viable population. Every potential mitigation action is then evaluated by impartial experts and quantified by the amount of VSP deficit relief it provides for each species and its cost.

DEFICIT[1]

Winter-Run Chinook				Spring-Run Chinook				Steelhead			
Abundance*	Population Growth Rate*	Spatial Structure*	Diversity*	Abundance*	Population Growth Rate*	Spatial Structure*	Diversity*	Abundance*	Population Growth Rate*	Spatial Structure*	Diversity*
4	**2**	**3**	**2**	**3**	**3**	**4**	**3**	**4**	**1**	**4**	**3**

*Population parameters from McElhany et al. (2000)

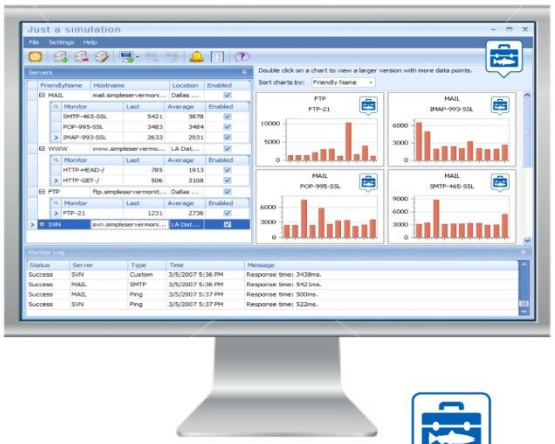
[1] Deficit or potential effect: **0** = none; **1** = 0-20%; **2** = 20-40%; **3** = 40-60%; **4** = 60-80%; **5** = 80-100%

Ranking

Proposed actions are ranked by an iterative algorithm. VSP quantified actions are examined for cost and related advantages – Sparkle Points – and potentially insurmountable impediments - Deal Killers. The action yielding the largest Benefit-Cost ratio, *after deducting benefits for any VSP criteria whose targets have already been met by previously ranked actions*, is assigned the next available rank. The ranking calculations are "live", that is, the rank values are updated whenever the data change.

Predicted Benefit of Action to Salmonids

Estimated Cost of Action



Deal Killers

- Technical infeasibility
- Stakeholder opposition
- Impacts on public safety
- Regulatory infeasibility

Sparkle Points

- Short timeline
- Funding identified
- Stakeholder support
- Opportunity driven
- Visible
- Replicable
- Minimal disturbance
- Benefits to other species
- Conjuctive use of water

Ranked List of Recovery Actions

Recovery Express has been applied to the Sacramento River Basin.

The tool has evaluated over 200 recovery actions developed and contributed by resource agencies, Central Valley water users, and non-profits. The technical team has produced detailed analysis of the top 20.

From flows to fish passage to floodplains on the Sacramento River, Battle Creek, Mill Creek, Deer Creek, Feather River, Yuba River, and more, our research and design efforts are available on request.

REFERENCES

- Orr, B., M. Johnson, G. Leverich, , T. Dudley, J. Hatten, Z. Diggory, K. Hultine, D. Orr, and S. Stone. 2017. **Multi-scale riparian restoration planning and implementation on the Virgin and Gila Rivers**. In: B.E. Ralston and D.A. Sarr (eds.), *Case Studies of Riparian and Watershed Restoration Areas in the Southwestern United States—Principles, Challenges, and Successes.* U.S. Geological Open File Report 2017-1091, 116 p., https://doi.org/10.3133/ofr20171091.
- Orr, B.K., A.M. Merrill, Z.E. Diggory, and J.C. Stella. 2017. **Use of the biophysical template concept for riparian restoration and revegetation in the Southwest**. In: B.E. Ralston and D.A. Sarr (eds.), *Case Studies of Riparian and Watershed Restoration Areas in the Southwestern United States—Principles, Challenges, and Successes.* U.S. Geological Open File Report 2017-1091, 116 p., https://doi.org/10.3133/ofr20171091.
- Rasmussen, C.G. and B.K Orr. 2017. **Restoration principles for riparian ecosystem resilience.** 2017. In: B.E. Ralston and D.A. Sarr (eds.), *Case Studies of Riparian and Watershed Restoration Areas in the Southwestern United States—Principles, Challenges, and Successes.* U.S. Geological Open File Report 2017-1091, 116 p., https://doi.org/10.3133/ofr20171091.
- Johnson, R. Roy; Carothers, Steven W.; Finch, Deborah M.; Kingsley, Kenneth J.; Stanley, John T., tech. eds. 2018. **Riparian research and management: Past, present, future: Volume 1**. Gen. Tech. Rep. RMRS-GTR-377. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 226 p., https://www.fs.usda.gov/treesearch/pubs/57341 [Has chapters addressing tamarisk, tamarisk beetle, and SWFL and other wildlife in addition to broader coverage of riparian ecology and restoration – including a chapter by Mary AnneMcLeod]

Acknowledgements

Stillwater Sciences

Funding:

GILA WATERSHED PARTNERSHIP OF ARIZONA

The WALTON FAMILY FOUNDATION

Science Team:

1939 2014 DESERT BOTANICAL garden

NORTHERN ARIZONA UNIVERSITY

UNIVERSITY OF CALIFORNIA SANTA BARBARA

USGS science for a changing world

LABORATORY RS/GIS Laboratory

GIS Staff: Karley Rodriguez, Rafael Real de Asua

Field Support: Devyn Orr and Dan Koepke

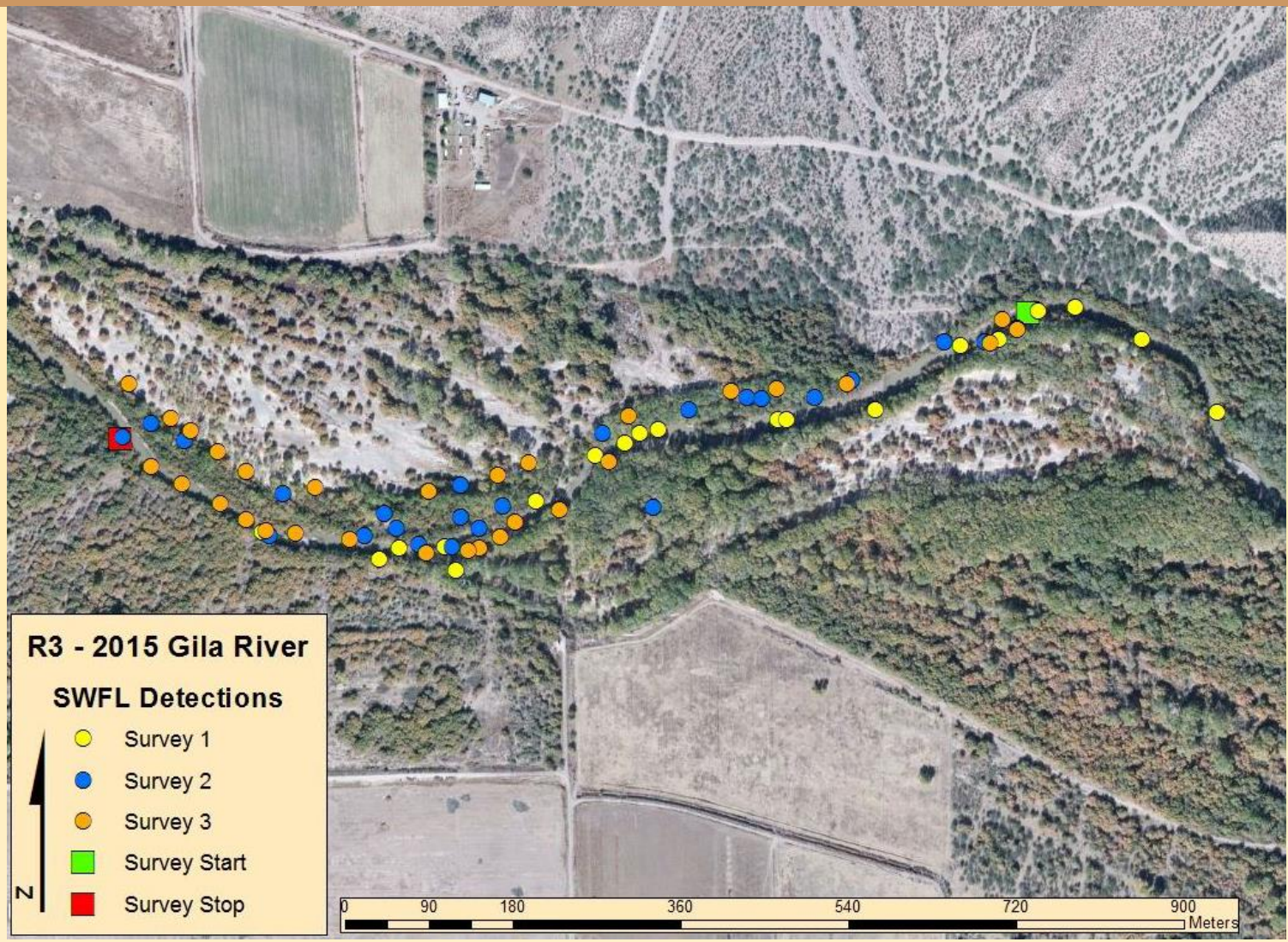
Additional Support:

Tamarisk Coalition Restore. Connect. Innovate.

Cross-Watershed Network —XWN—

Southwest Decision Resources

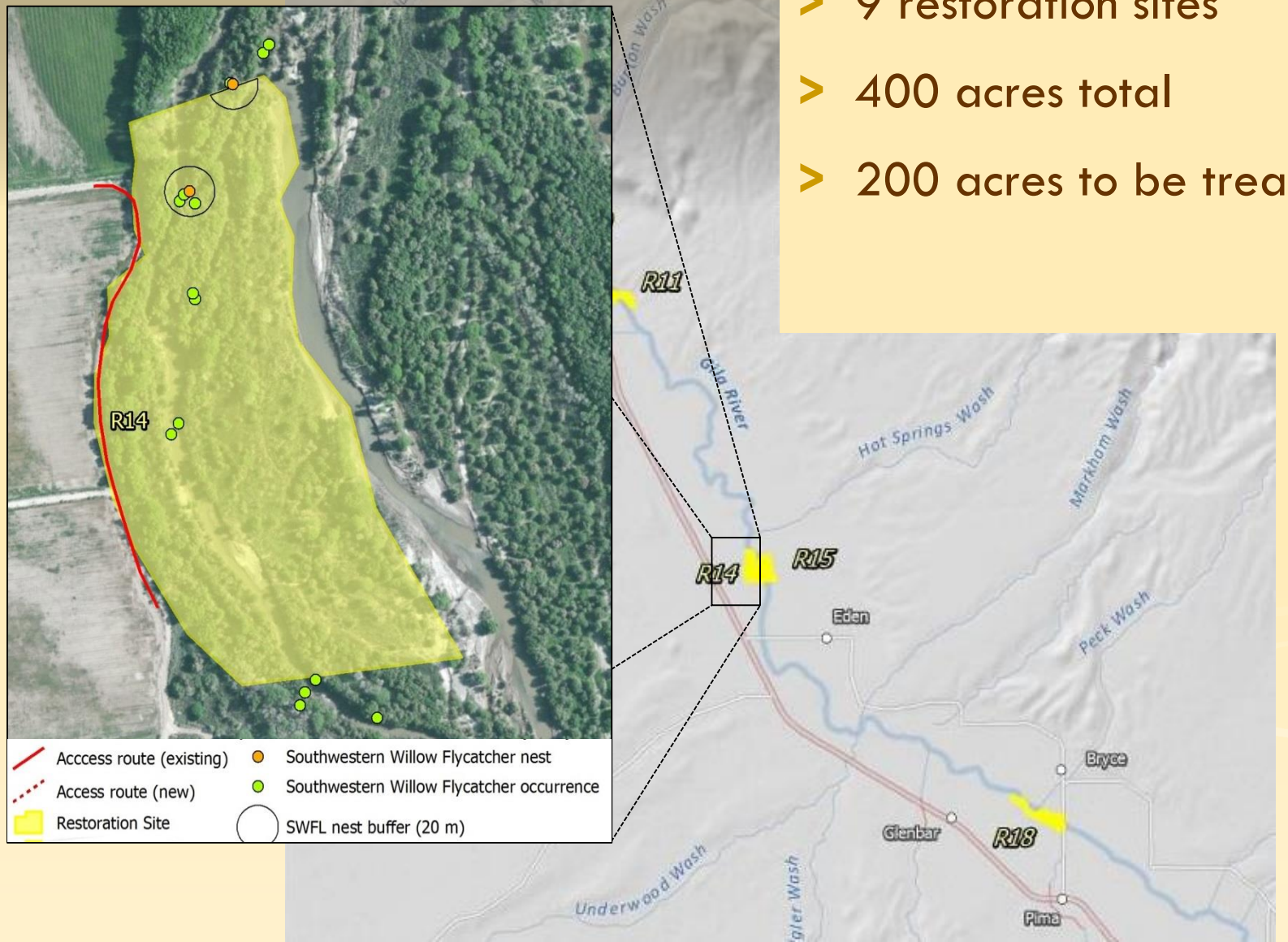
SWFL and WYBC Presence



SWFL and WYBC Protocol-Level Surveys

Restoration Sites

- 9 restoration sites
- 400 acres total
- 200 acres to be treated

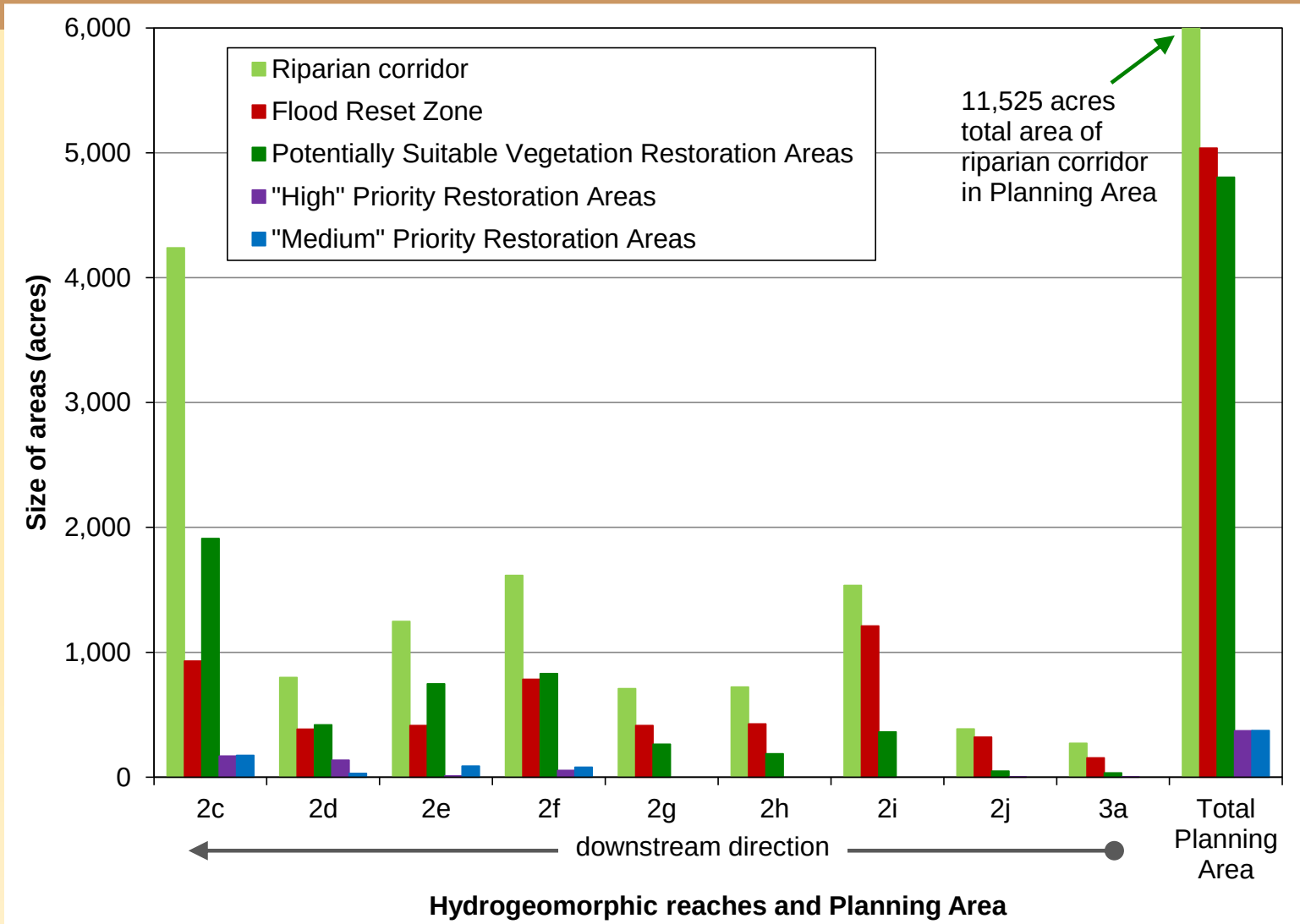


Agency Coordination & Permitting Process

- Pre-application discussions with USFWS to introduce project and consider permitting alternatives
- CWA Section 404 Nationwide Permit 27 for Aquatic Habitat Restoration, Establishment, and Enhancement Activities from USACE
- Federal nexus for USFWS consultation under Section 7 of the ESA
- CWA Section 401 Certification with ADEQ
- NHPA Section 106 Review with SHPO

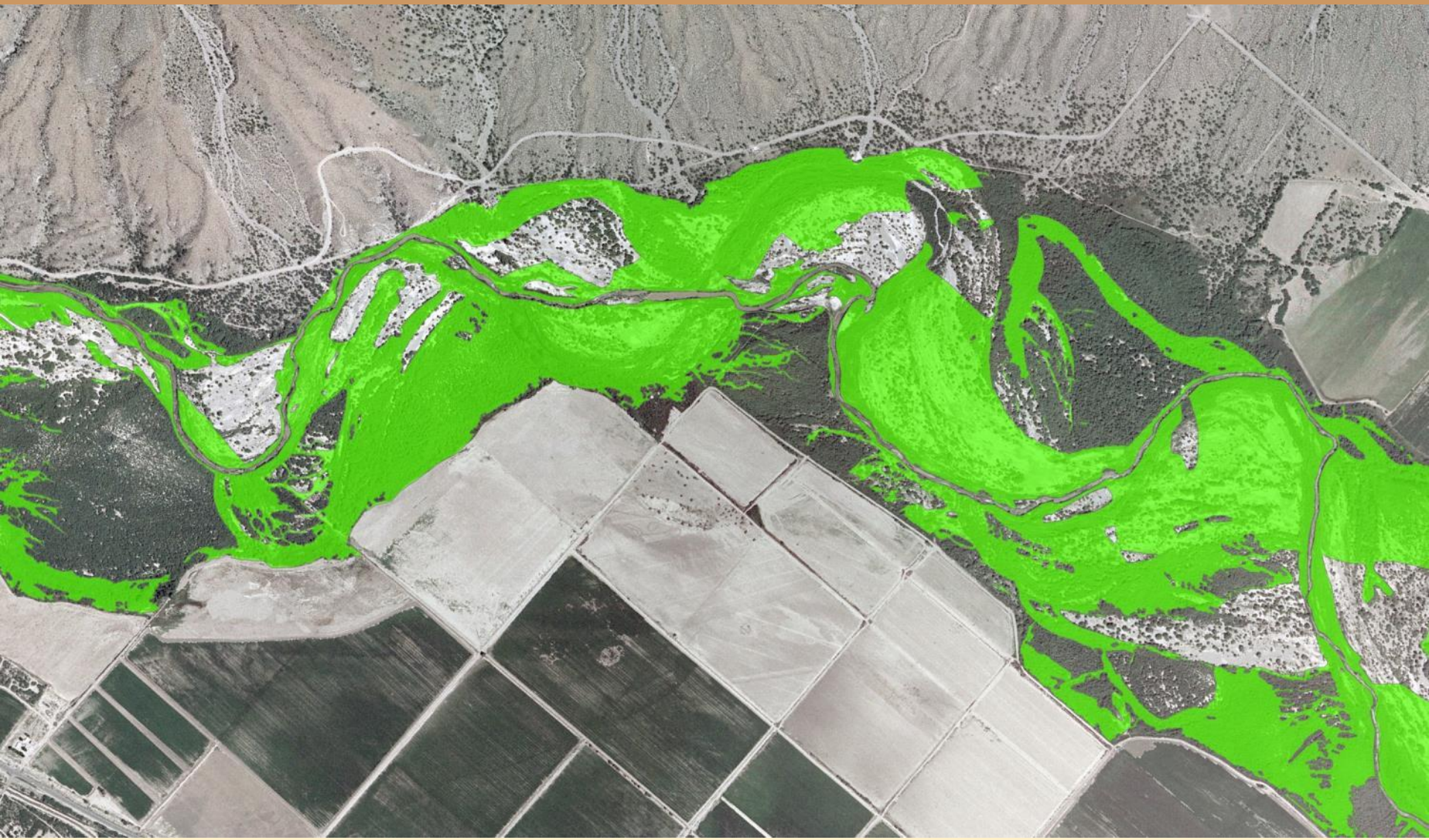

Photo: USFWS

Ecohydrology: Potentially Suitable Restoration Areas



Histogram of sizes of the riparian corridor, Flood Reset Zone, and Potentially Suitable Vegetation Restoration Areas within the Planning Area and each of the hydrogeomorphic reaches.

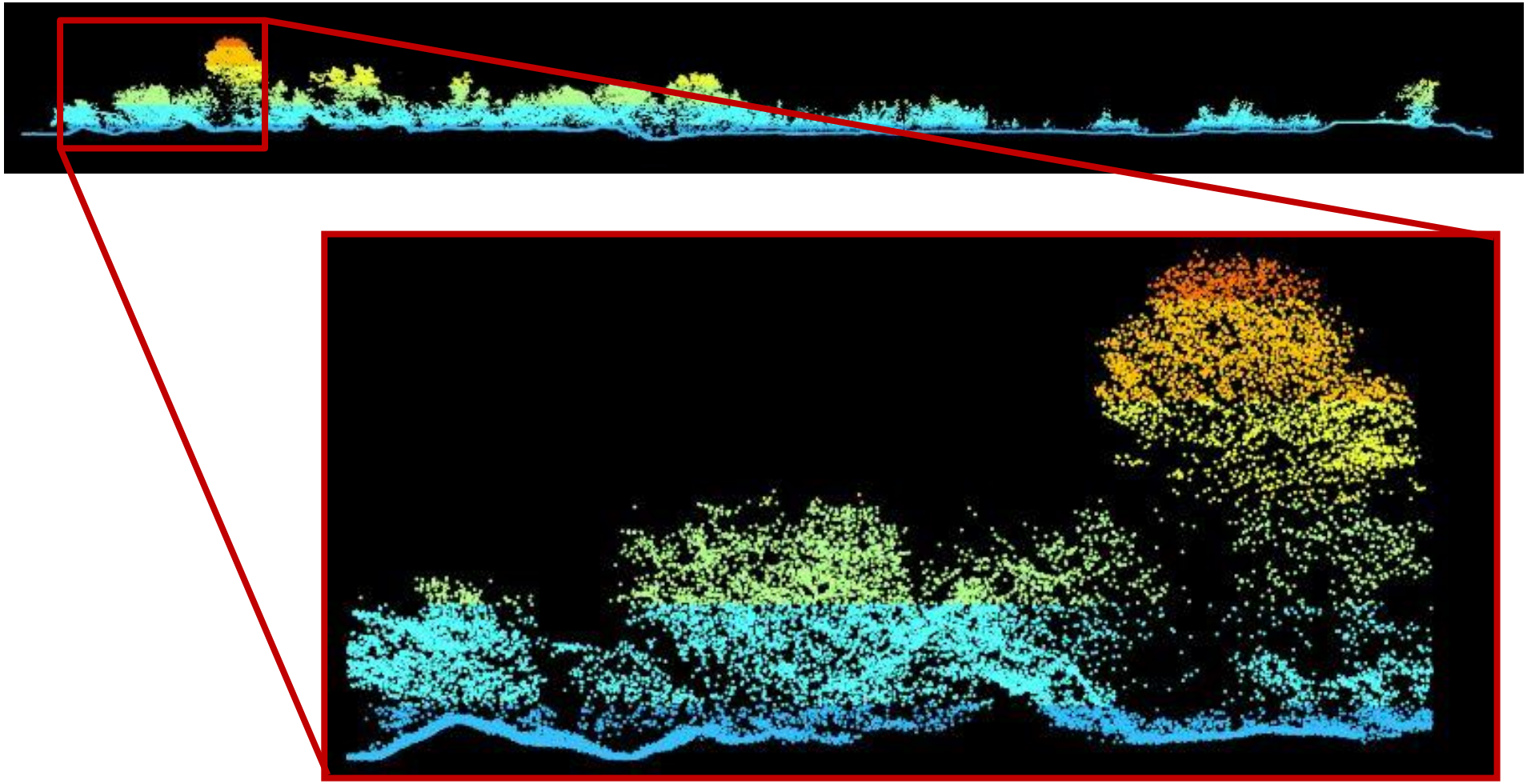
Ecohydrology: Potentially Suitable Restoration Areas



All Potentially Suitable Restoration Areas (Stillwater)

VEGETATION & HABITAT STRUCTURE

- High density LiDAR to assess vegetation structure
- Habitat Suitability Modeling for Southwestern Willow Flycatcher, Western Yellow-billed Cuckoo, and Least Bell's Vireo



Ecological Linkages Conceptual Model