Riparian Restoration Planning for Long-term Success: an Example from the Upper Gila River, Arizona

Bruce Orr (Stillwater)
Glen Leverich (Stillwater)
Zooey Diggory (Stillwater)
Tom Dudley (UCSB)
Jim Hatten (USGS)
Kevin Hultine (DBG)
Matt Johnson (NAU)
Shawn Stone (Gila Watershed Partnership)
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)
Need for Riparian Restoration

> Expected arrival of tamarisk beetle within a few years

Virgin River, June 2010

Photo: Dan Bean, CO Dept. of Agriculture

> Anticipated impacts to SWFL habitat

Virgin River, July 2010

Photo: Tom Dudley, U.C. Santa Barbara
Ecological Linkages Conceptual Model

**Landscape & Ecoregion Context**
- Climate
- Topography
- Geology

**Watershed Inputs**
- Water
- Sediment
- Nutrients
- Energy
- Large woody debris
- Chemical pollutants

**Fluvial Geomorphic Processes**
- Sediment transport, deposition, and scour
- Channel migration and bank erosion
- Floodplain construction and inundation
- Surface and groundwater interactions

**Geomorphic Attributes**
- Channel morphology (channel cross section, slope, bed and bank composition)
- Floodplain morphology
- Water turbidity
- Water temperature

**Habitat Structure, Complexity, and Connectivity**
- Instream aquatic habitat
- Shaded riparian aquatic habitat
- Riparian woodlands
- Seasonally inundated floodplain wetlands

**Human Land Use Flow Regulation Natural Disturbance**

**Biotic Response**
- Abundance and distribution of native and exotic species
- Community composition and structure
- Food web structure
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

Restoration Site Suitability

Within Low Lying & High Productivity Areas

High and Medium Priority Restoration Areas

Vegetation Character

Flood Scour

Riparian Corridor

Water Availability

Soil Salinity

SWFL Habitat
Ecohydrology: Physical Setting
Ecohydrology: Flood Regime

- USGS 09432000 Gila River near Virden, NM
- USGS 09442000 Gila River near Clifton, AZ
- USGS 09444500 San Francisco River near Clifton, AZ
- USGS 09448500 Gila River near Solomon, AZ
- USGS 09466500 Gila River at Calva, AZ

Mapped floods

- Quiescent Period
- Large Flood Period
- Historic Flood Period

Future...?

Mean daily discharge: 400 cfs
Ecohydrology: Flood-Scour Frequency

Flood-scour Frequency and “Flood Reset Zone” (Stillwater)
Ecohydrology: Topography

LiDAR Topography (USU RS/GIS)
Ecohydrology: Water Availability (Relative Elevation)

Shallow Piezometers (DBG)

Relative Elevation above low-flow channel from LiDAR (USU/Stillwater)
Ecohydrology: Groundwater (Direct Measurement)

**Avg Diff = 0.9 ft**

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</table>

 Avg Diff = 0.9 ft
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

Transect-Plot Surveys

Estimated time since last flooded: <1, 1–2, 3–5, 6–10, or >10 years
Soil texture: gravel, silt, loam, clay, sand
Topography: convex, flat, concave, undulating
Percent ground cover of: water, vegetation, organic debris, cobble/boulder, gravel, and fine sediments
Evidence of: flooding, fire, soil moisture, and agricultural return flows
Types and intensities of unnatural disturbances: competition from nonnative invasive species, off-road vehicle use, and bulldozing/earth moving
Vegetation-type dominance: trees, shrubs, or forbs
Tree, shrub, and herb phenology: early, peak, or late
Species: name, age (e.g., seedling, mature, decadent), and percent cover of all prevalent plants
Vegetation type: name and vegetation type name of any adjacent, un-sampled vegetation
Ecohydrology: Vegetation Characterization

**Fremont cottonwood- Goodding’s willow woodland**

**Mixed riparian shrubland**

*Group or alliance level of the U.S. National Vegetation Classification (NVC) system*
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
Ecohydrology: Soil Characterization (Salinity)

Soil Salinity from SSURGO Database (NRCS/Stillwater)

- Non-saline
- Very slightly saline
- Slightly saline
- Moderately saline
- Strongly saline

Soil-profile sampling (DBG)
Ecohydrology: Potentially Suitable Restoration Areas

All Potentially Suitable Restoration Areas (Stillwater)
“High” and “Medium” Priority Restoration Areas (Stillwater)

- 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)
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.
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
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
Implementation
> 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)
The Reality of Climate Change and the Need for Genetics Approaches in Riparian, River and Watershed Restoration to Maintain Biodiversity in Changing Environments

Tom Whitham, Northern Arizona University
Extensive genetic variation in natural populations, especially for foundation, keystone, dominant, and other species of large effect can define communities.
Genetics-Based Community and Ecosystem Structure


**Community Stability 32%** Keith et al. 2010 Ecology


**Rapid Evolution in Plants Redefines Communities** Stultz et al. 2009 Global Change Biology, Gehring et al. 2014 Molecular Ecology, Smith et al. 2015 Oecologia

Genetic solutions from reciprocal common gardens that identify genotypes and populations that can survive future environments
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
CONCLUDING COMMENTS

- 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**: surface flow and groundwater management, grazing, floodplain development
Acknowledgements

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Science Team:

GIS Staff: Karley Rodriguez, Rafael Real de Asua

Field Support: Devyn Orr and Dan Koepke

Additional Support:
Goal: Develop a restoration plan to enhance and expand existing habitat for the SWFL and other riparian birds

80 acre parcel

- Existing Vegetation: Dense Tamarisk, scattered Goodding’s willow and a few other natives

Restoration Implementation Concepts:
- Clark County Virgin River Reserve Unit 1
- Clark County Desert Conservation Program
- Great Basin Institute
- Partners in Conservation
- Stillwater Sciences
- UC Santa Barbara
- Walton Family Foundation
Initial Planting Areas
Focused monitoring and adaptive management will be critical in designing and implementing effective riparian management to conserve habitat for listed wildlife species, reduce risk of secondary invasion by non-native plants, maintain native biodiversity, and maximize the long-term benefits associated with tamarisk biocontrol provided by the tamarisk beetle.

Assessing ecological restoration potential is essential for identifying areas most likely to benefit from active restoration, and greatly reduce the risk of failure. Restoration feasibility is also strongly driven by practical considerations such as funding, landowner cooperation, site logistics, and need to limit grazing impacts by livestock in many areas.
Lessons Learned

In designing adaptive management and monitoring programs, we typically focus on measures to increase resiliency to natural disturbances. However, unexpected human actions in or near the restoration area can also create substantial challenges and surprises.

Careful oversight during implementation is critical — the best laid plans can go astray if the plan is not properly implemented.
Concerns about genetic pollution are minor relative to the impacts of global change.

1. Restoration often occurs at sites like the Little Colorado River, where few natives still exist and there is nothing left to pollute.

2. Local maladaptation to a changing environment renders genetic pollution a moot issue as the local stock looses its homesite advantage.

3. Reliance on local evolution only works if the genetic variance in local population is greater than the predicted environmental changes and if plants can migrate faster than the predicted climate changes.