

Assessing Vegetation Response to Dam Operations using the Response Guild Approach



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Overview

- **Review general knowledge about riparian plant species downstream from Glen Canyon Dam**
 - Highlight known responses of vegetation to Glen Canyon Dam releases
- **Explain monitoring using Response Guild Approach**
 - Identified Guilds for the Colorado River
 - Linkages with National Parks in Upper Basin
 - Implementation of monitoring
 - Preliminary results from October 2012 sampling trip
- **Conceptual-frame based modeling**
- **Tamarisk Beetle Status**



Drivers of Vegetation Change

Operations

Location on the
Landscape/Landscape condition

Inter-annual and seasonal variability in hydrology

Flood timing



Seed dispersal/germination

Duration



Scour, cover, occupancy space

Magnitude



Area of disturbance

Frequency



Species selection/successional
processes

Surface water-ground water interactions –

Minimum discharge



Distance to water – upland, woody
riparian species

Daily range

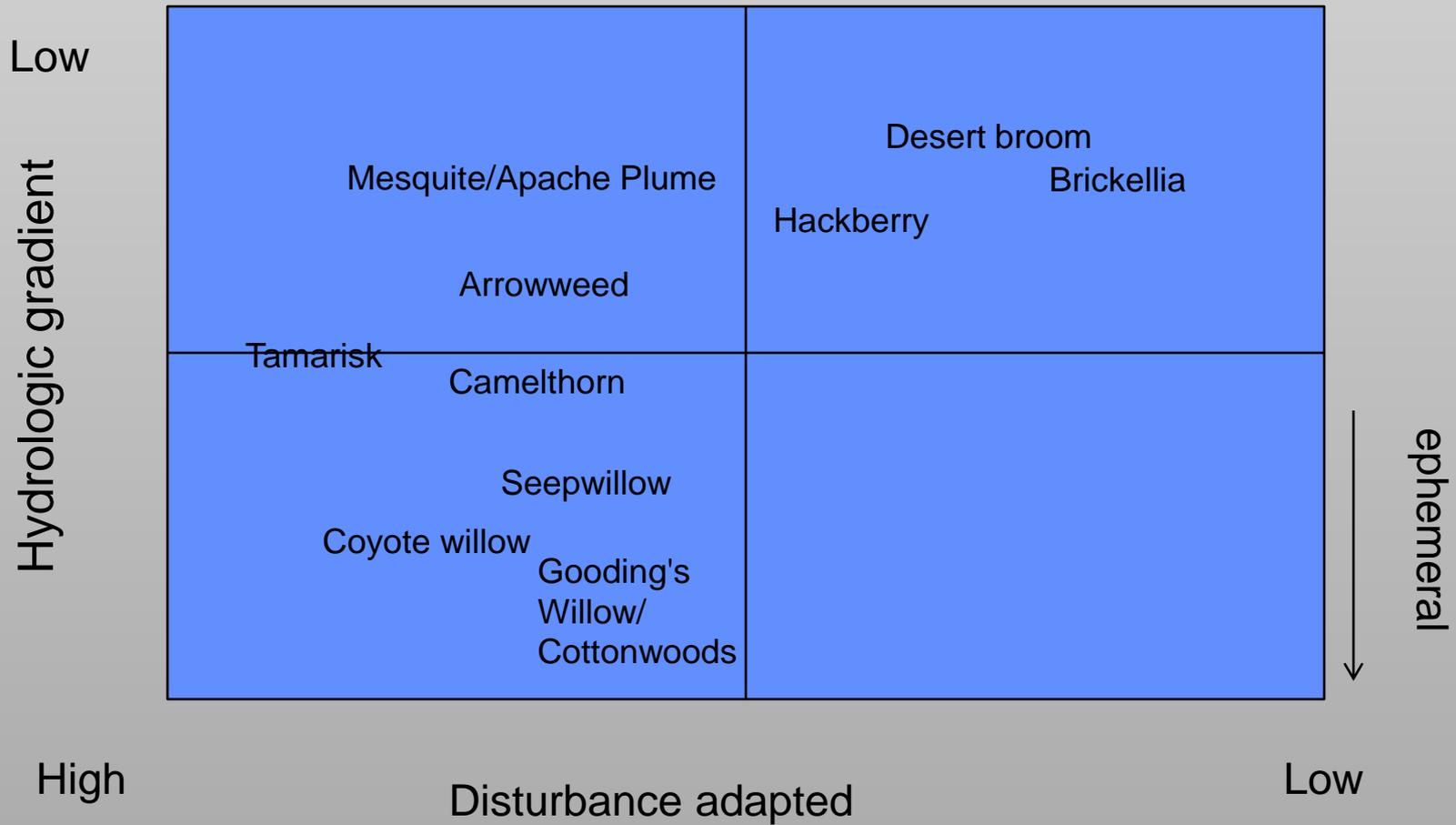


Inundation duration – marsh species,
woody riparian species

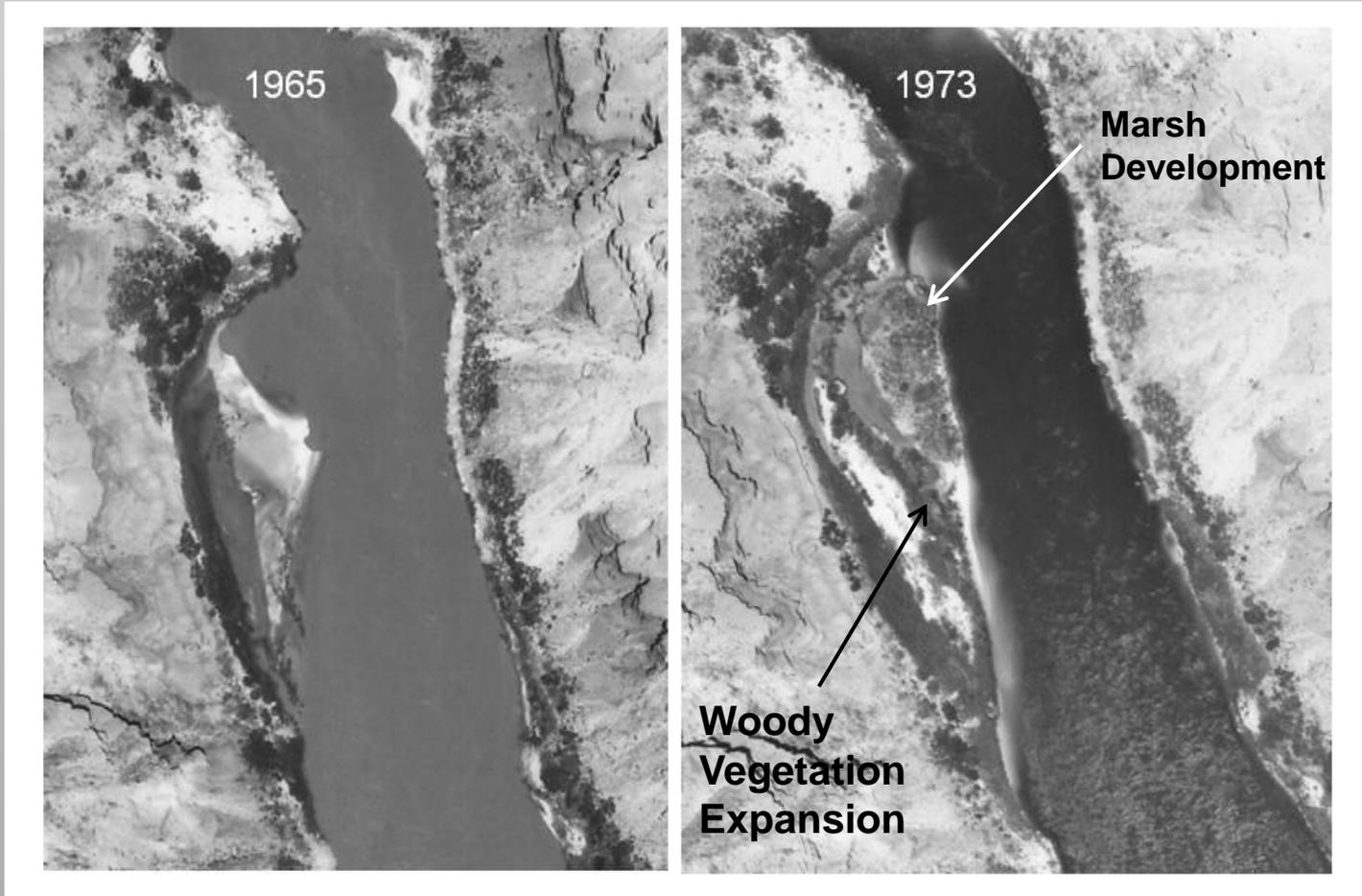
The Early Years



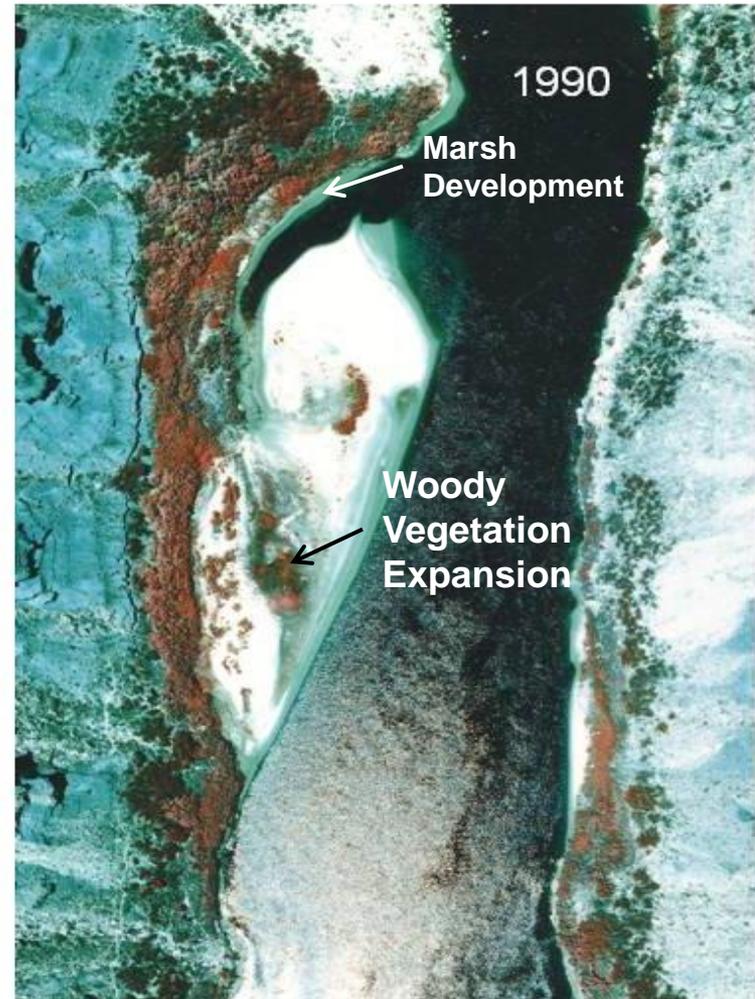
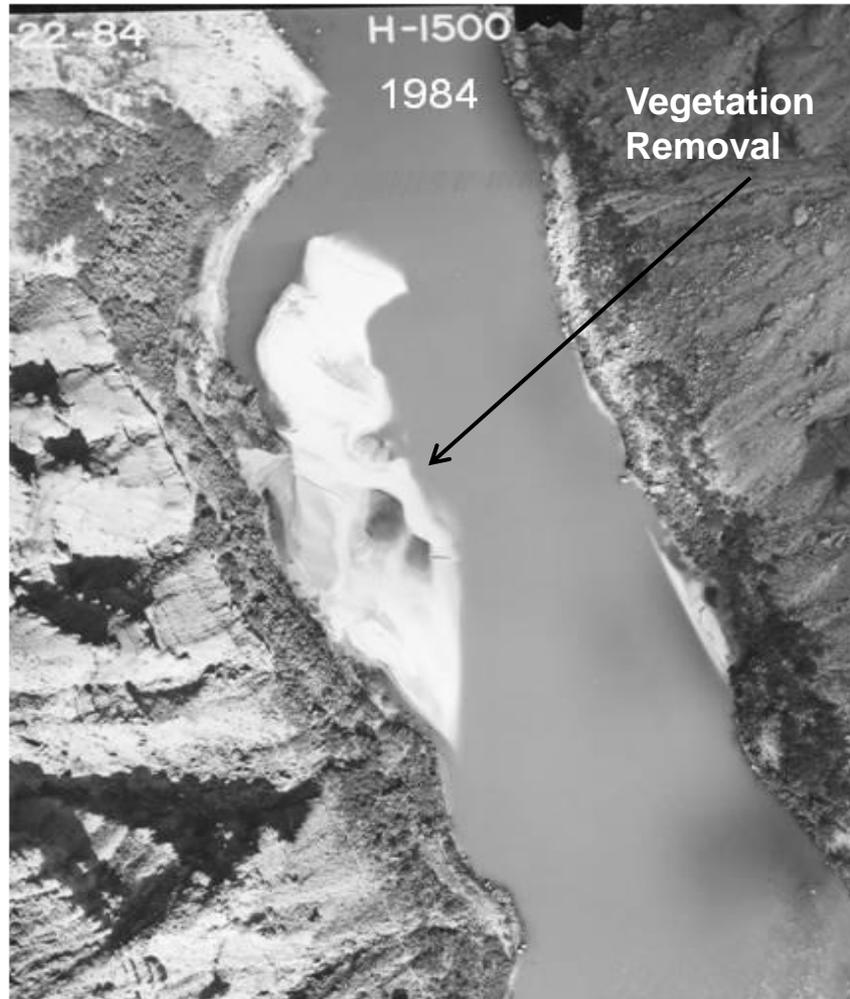
Plants along the Colorado River – historic assemblage



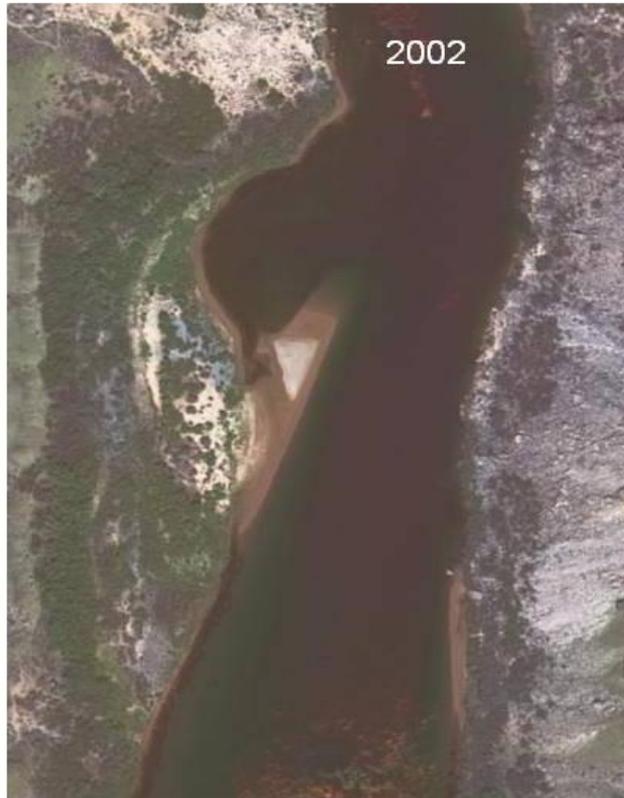
Period I – Flood reduction and flow stabilization



Period II – Prolonged flooding, sediment reworking & export, vegetation removal & re-establishment

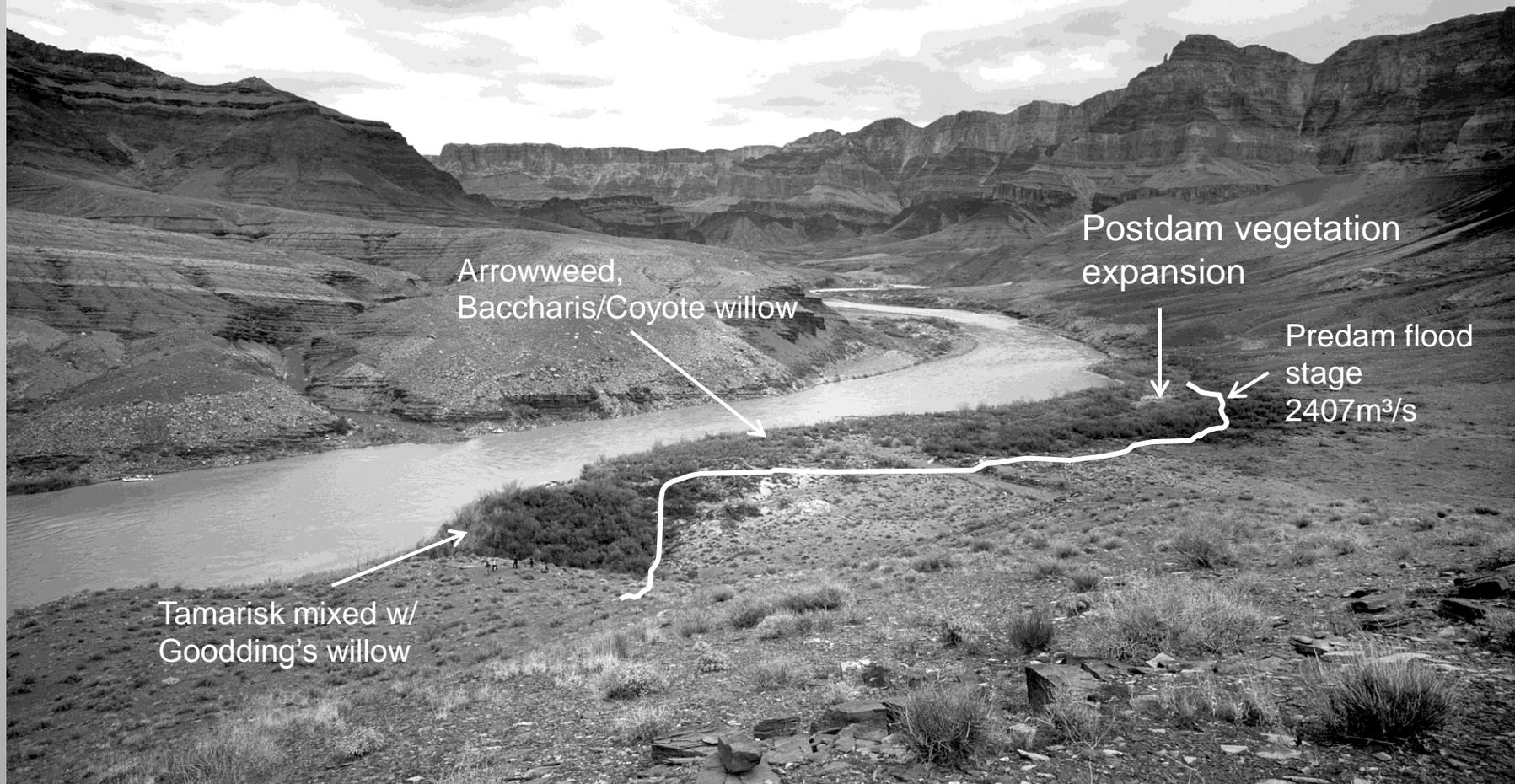


Period IV 2000-2012 – Reduced fluctuations, minimum annual delivery (drought) and equilization flows (MLFF, LSSF, HFE operations)



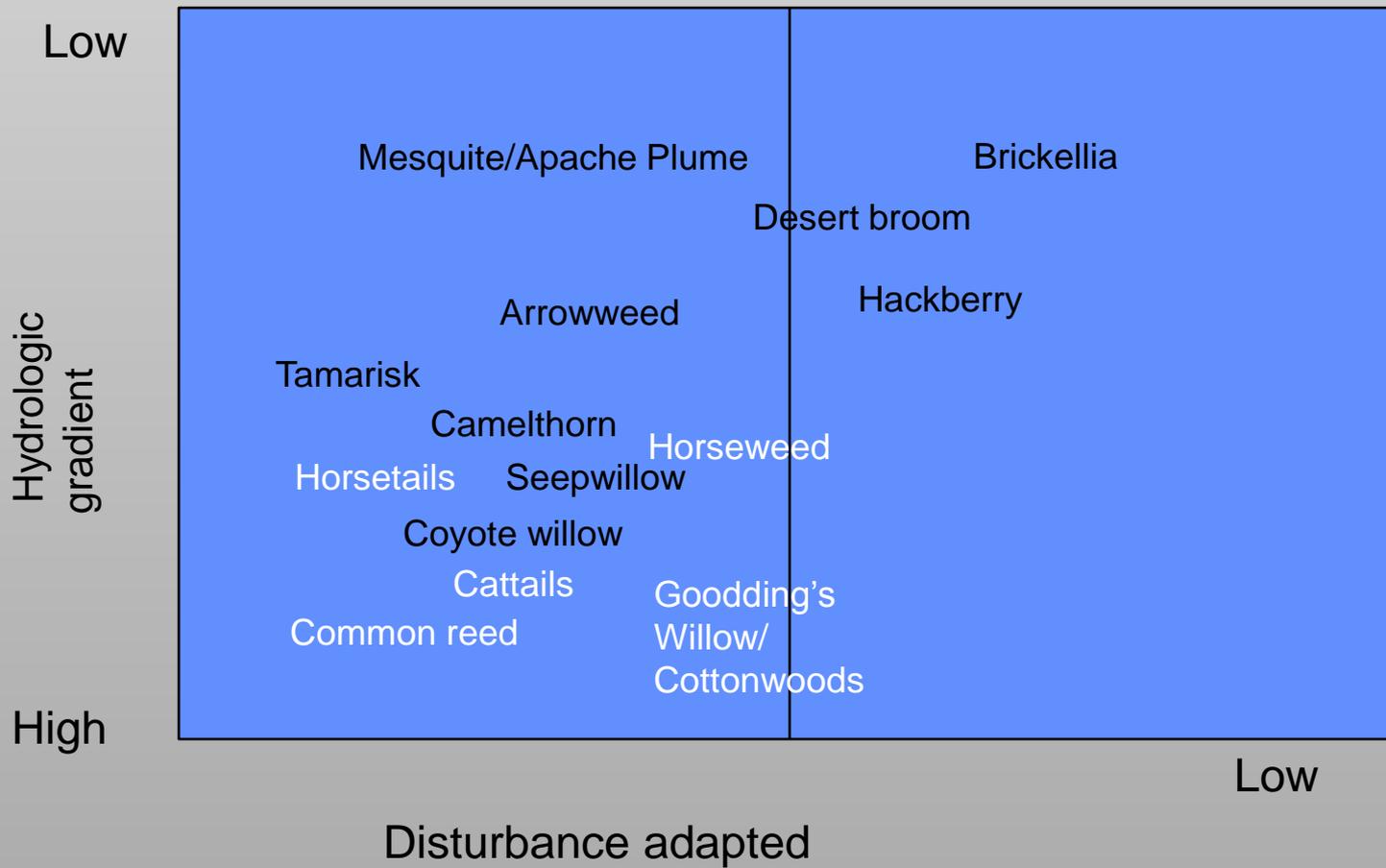
Continued vegetation expansion →

113 Years Later with 40 Years of Regulation



Repeat photograph 2003, Cardenas Creek
(USGS Desert Laboratory Repeat Photography Collection).

Plants along the Colorado River – post regulation



General vegetation response

- Riparian woody vegetation is expanding
- HFEs of present magnitude/duration do not remove woody vegetation
- Coarsening sandbars favor drought adapted vegetation → shoreward migration of woody species
- Basin hydrology, daily fluctuations and maximum daily discharge affects woody vegetation expansion.
- Operations that scour sandbars followed by reduced flows → tamarisk colonization
- At lower stage elevations, increased frequency of HFEs may favor clonal species that are burial adapted over seed production

Monitoring vegetation response to dam operations

Riparian Vegetation-Flow Response Guilds Framework

Groups of species that have shared life history traits and respond similarly to physical variables (e.g., hydrologic regime, geologic setting/substrate properties, ambient temperature)

Life history

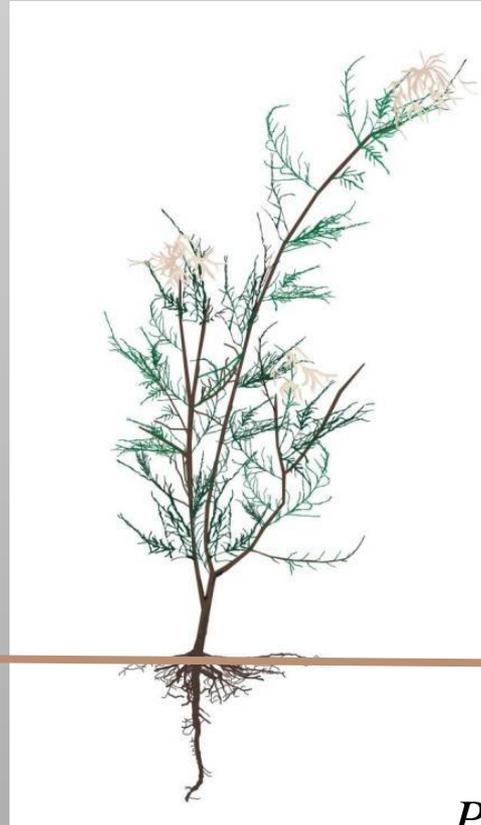
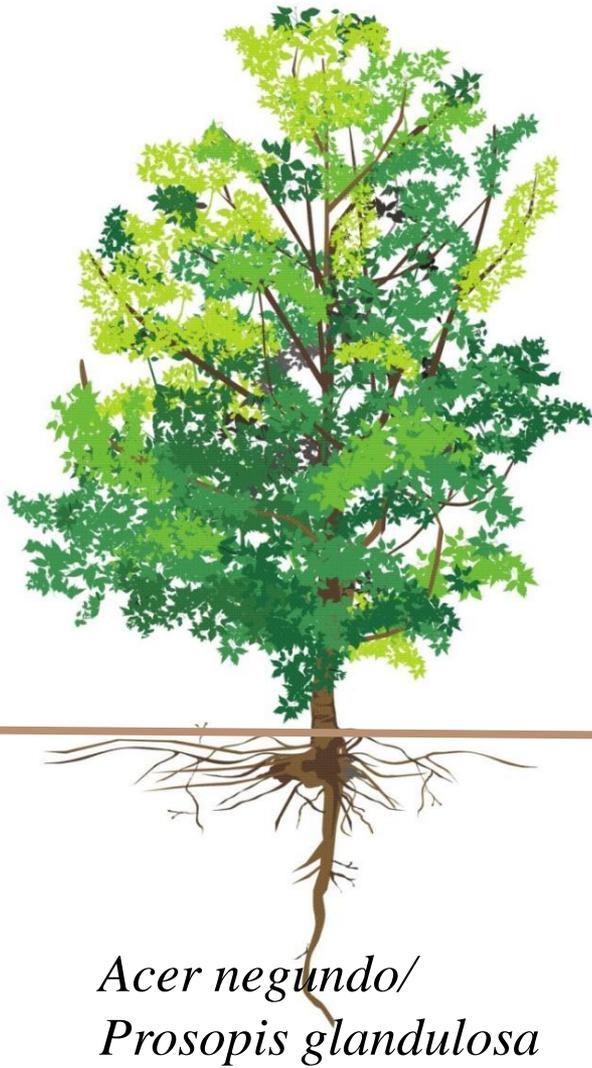
Reproductive strategy

Morphology

Fluvial disturbance

Water balance

Selection and Adaptation



Life History Guilds

Traits

- Longevity (life span)
- Annual, short- and long-lived perennial, biennial



Relevant Flow Component

- Frequency of extreme floods
- Anoxia
- Timing of floods
- Flow duration



Reproductive Strategy Guilds

Traits

- Vegetative-Sexual-Combined
- Timing in synchrony with flow component (dispersal, flower, fruit)

Relevant Flow Component

- Magnitude of extreme flow
- Timing of high & low flow
- Rate of drawdown
- Duration of inundation



Traits

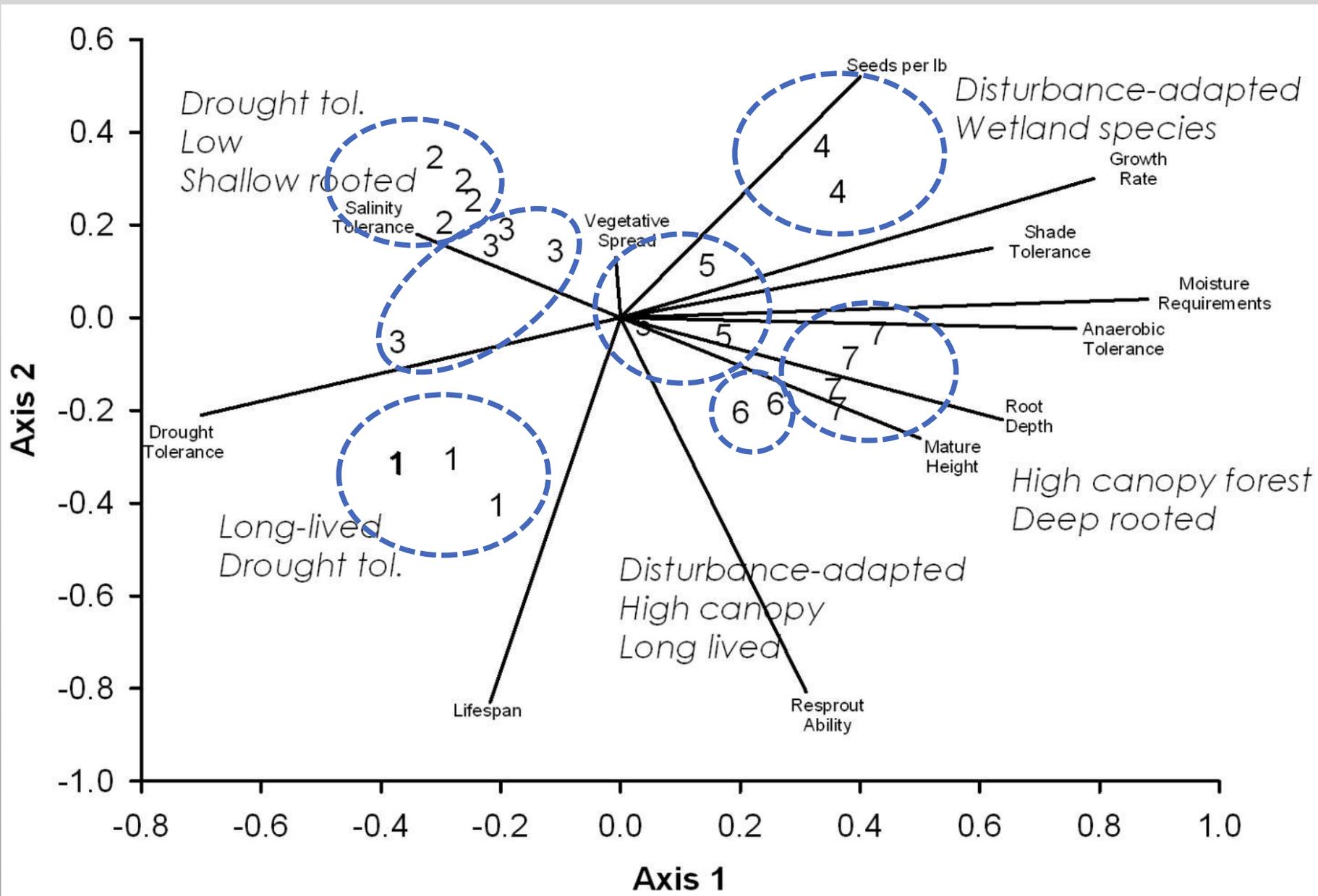
- Growth form (e.g., herbaceous-woody, graminoid-shrub-tree)
- Rooting depth (phreatophytic)
- Root morphology (lateral-taproot, shallow-deep)
- Size at maturity (canopy height, vegetation volume)



Relevant Flow Component

- Flow duration
- Magnitude and duration of low and high flow
- Water table depth and inter- and intra-annual variability
- Flow permanence, groundwater depth, flow variability

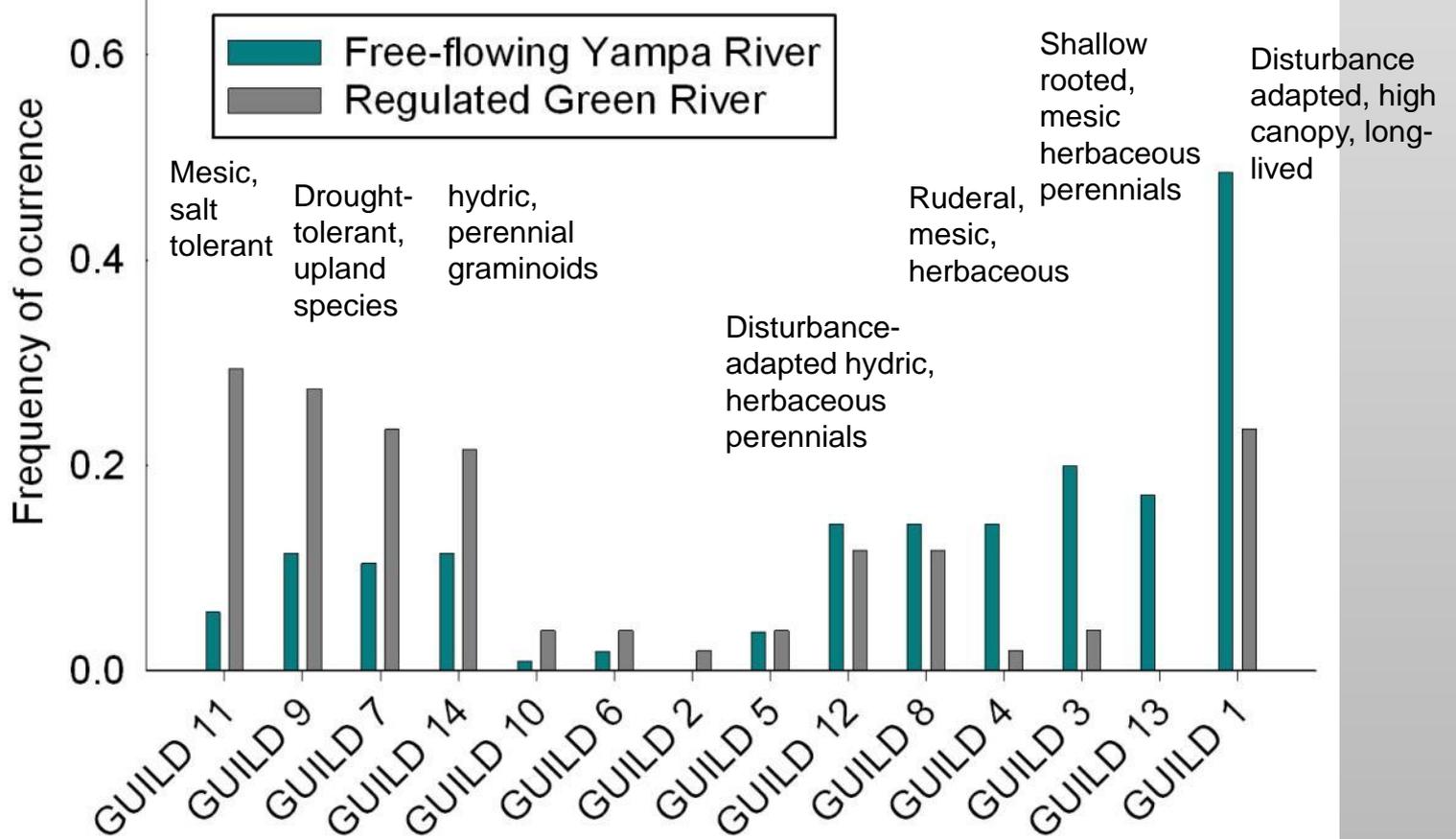




Green and Yampa rivers, Colorado-Utah



Merritt, unpublished

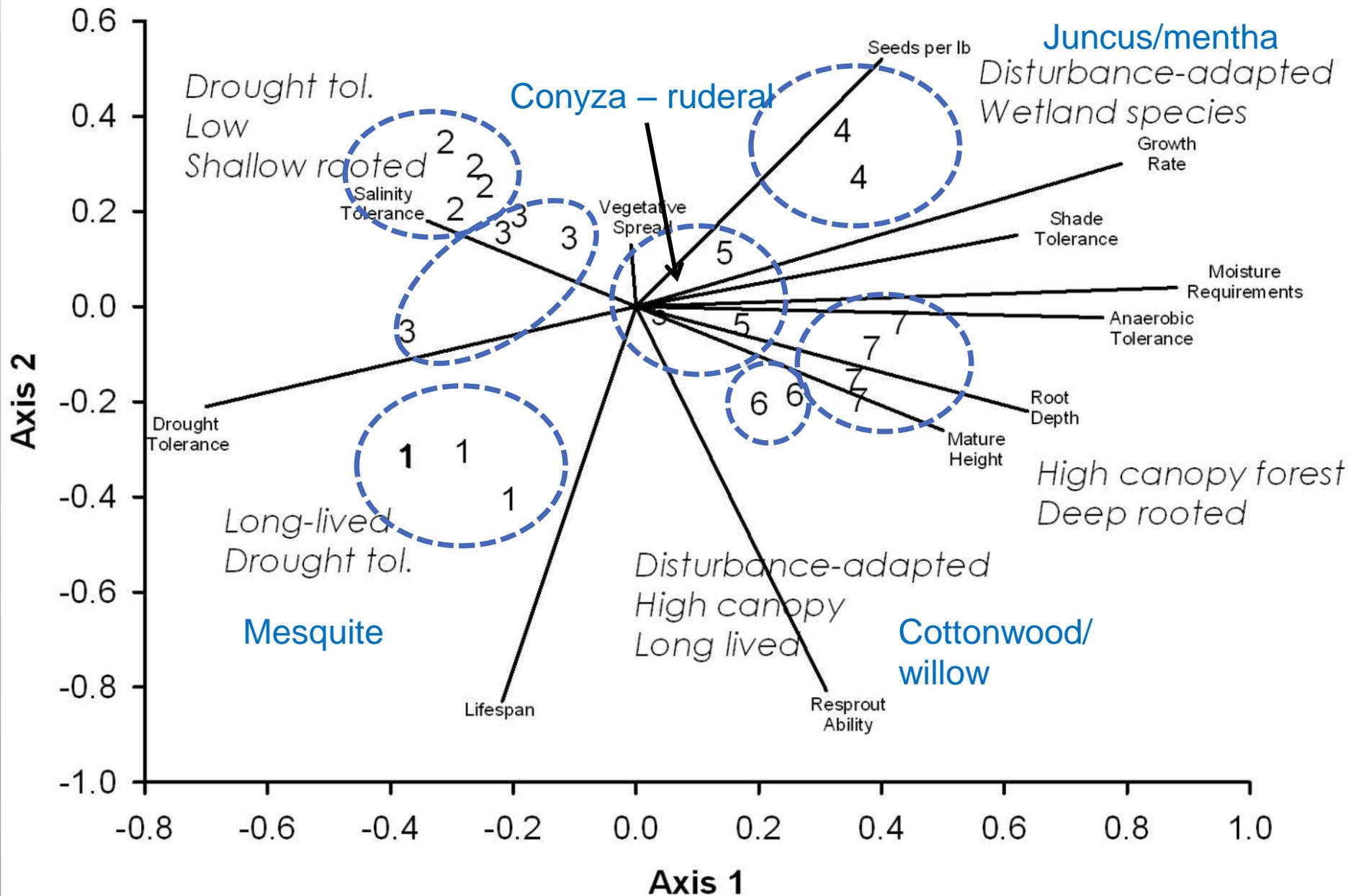


Merritt, unpublished do not cite

Guilds Identified for Colorado River in Grand Canyon

14 biological attributes

- Growth rate
- Height at maturity
- Life span
- Resprout ability
- Anaerobic tolerance
- Drought tolerance
- Fire tolerance
- Salinity tolerance
- Vegetative reproduction
- Spread rate
- Root-depth
- Shade tolerance
- Moisture usage (inundation/duration)
- Fire tolerance
- Sexual reproduction



Sampling Approach

NAU Sandbar Sites - (Sampled in October 2012)

Random Sites - TBD

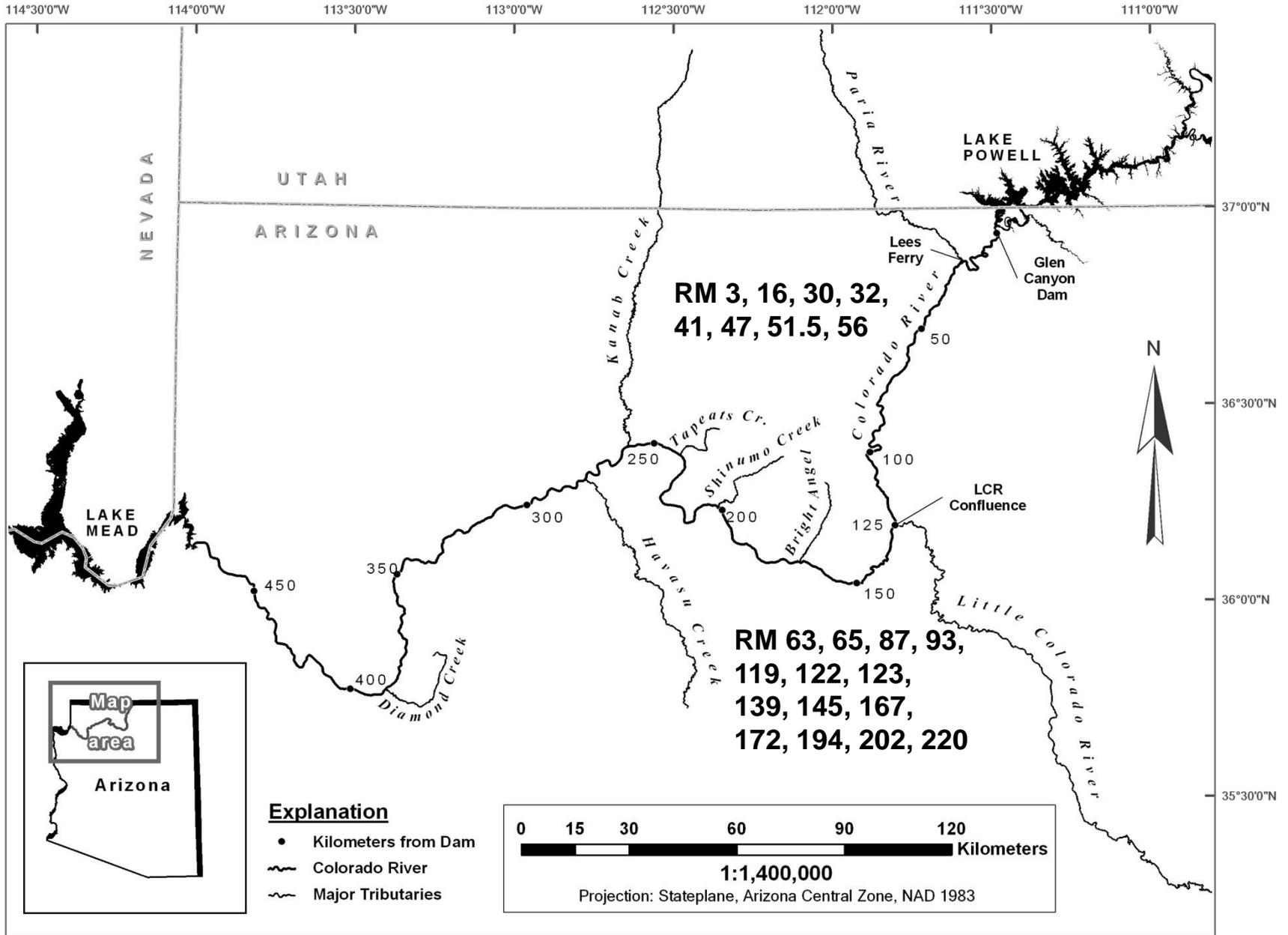
Inactive Flood Plain (IF)

Active Flood Plain (AF)

Active Channel (AC)

3- 1m² plots per zone – location surveyed

3 transects per geomorphic feature

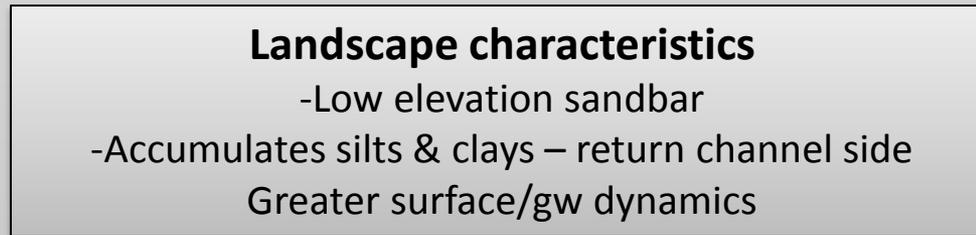


Preliminary Results

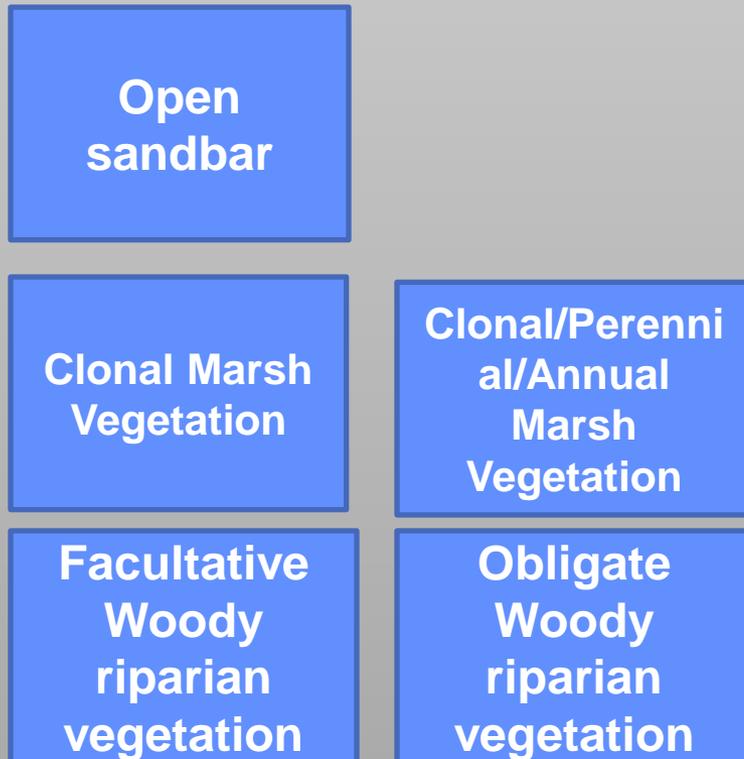
- **22 sites, 847 plots sampled**
- **73 species identified in Marble Canyon**
 - 10 (AF), 0 AC
- **50 species Eastern Grand Canyon**
 - 8 (AF), 0 AC
- **44 in Western Grand Canyon**
 - 7 (IF), 0 AC

**Richness, diversity, frequency of guilds,
Cover, native/nonnative ratio**

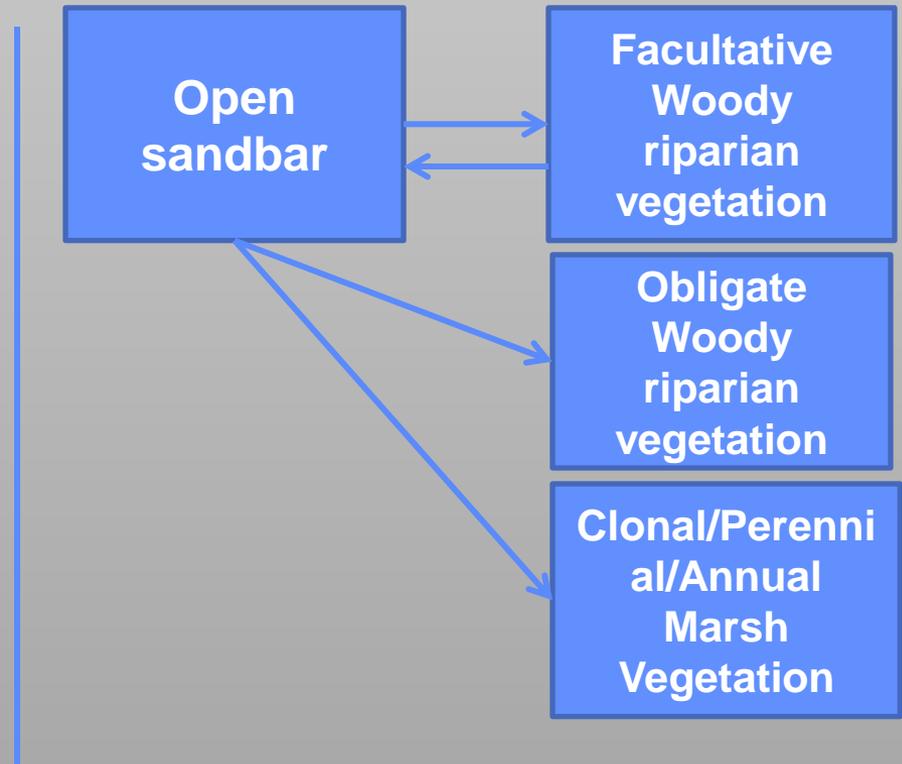
Developing a Conceptual Model for Vegetation Response



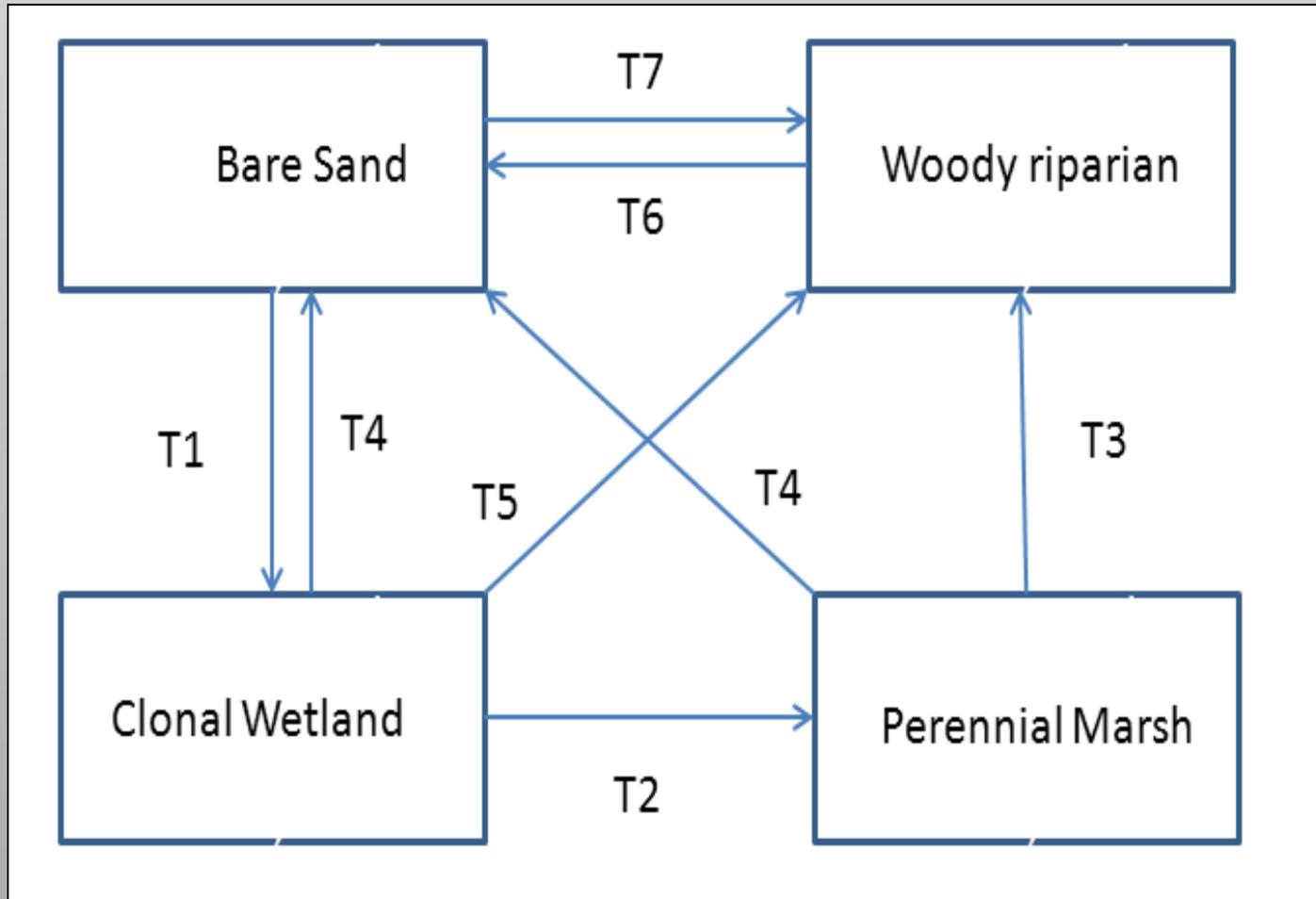
Ecological States



Operations that cause switches between states & rules of response



Reattachment bar



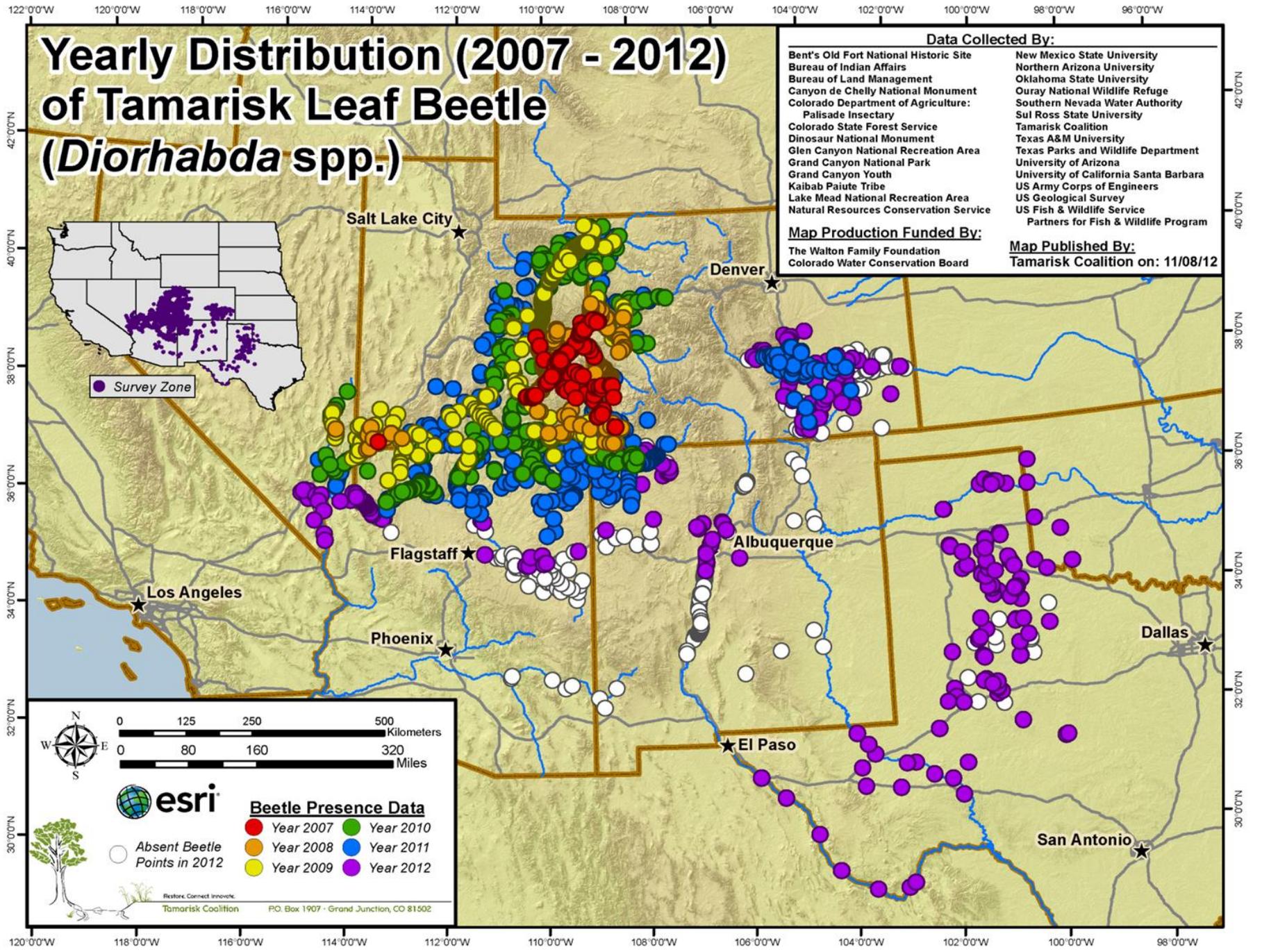
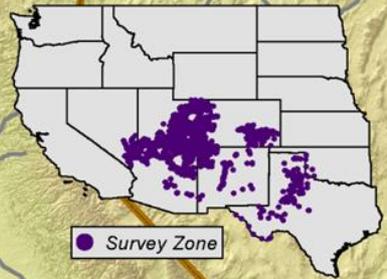
Yearly Distribution (2007 - 2012) of Tamarisk Leaf Beetle (*Diorhabda* spp.)

Data Collected By:

Bent's Old Fort National Historic Site	New Mexico State University
Bureau of Indian Affairs	Northern Arizona University
Bureau of Land Management	Oklahoma State University
Canyon de Chelly National Monument	Oura National Wildlife Refuge
Colorado Department of Agriculture:	Southern Nevada Water Authority
Palisade Insectary	Sul Ross State University
Colorado State Forest Service	Tamarisk Coalition
Dinosaur National Monument	Texas A&M University
Glen Canyon National Recreation Area	Texas Parks and Wildlife Department
Grand Canyon National Park	University of Arizona
Grand Canyon Youth	University of California Santa Barbara
Kaibab Paiute Tribe	US Army Corps of Engineers
Lake Mead National Recreation Area	US Geological Survey
Natural Resources Conservation Service	US Fish & Wildlife Service
	Partners for Fish & Wildlife Program

Map Production Funded By:
The Walton Family Foundation
Colorado Water Conservation Board

Map Published By:
Tamarisk Coalition on: 11/08/12



Beetle Presence Data

● Year 2007	● Year 2010
● Year 2008	● Year 2011
● Year 2009	● Year 2012

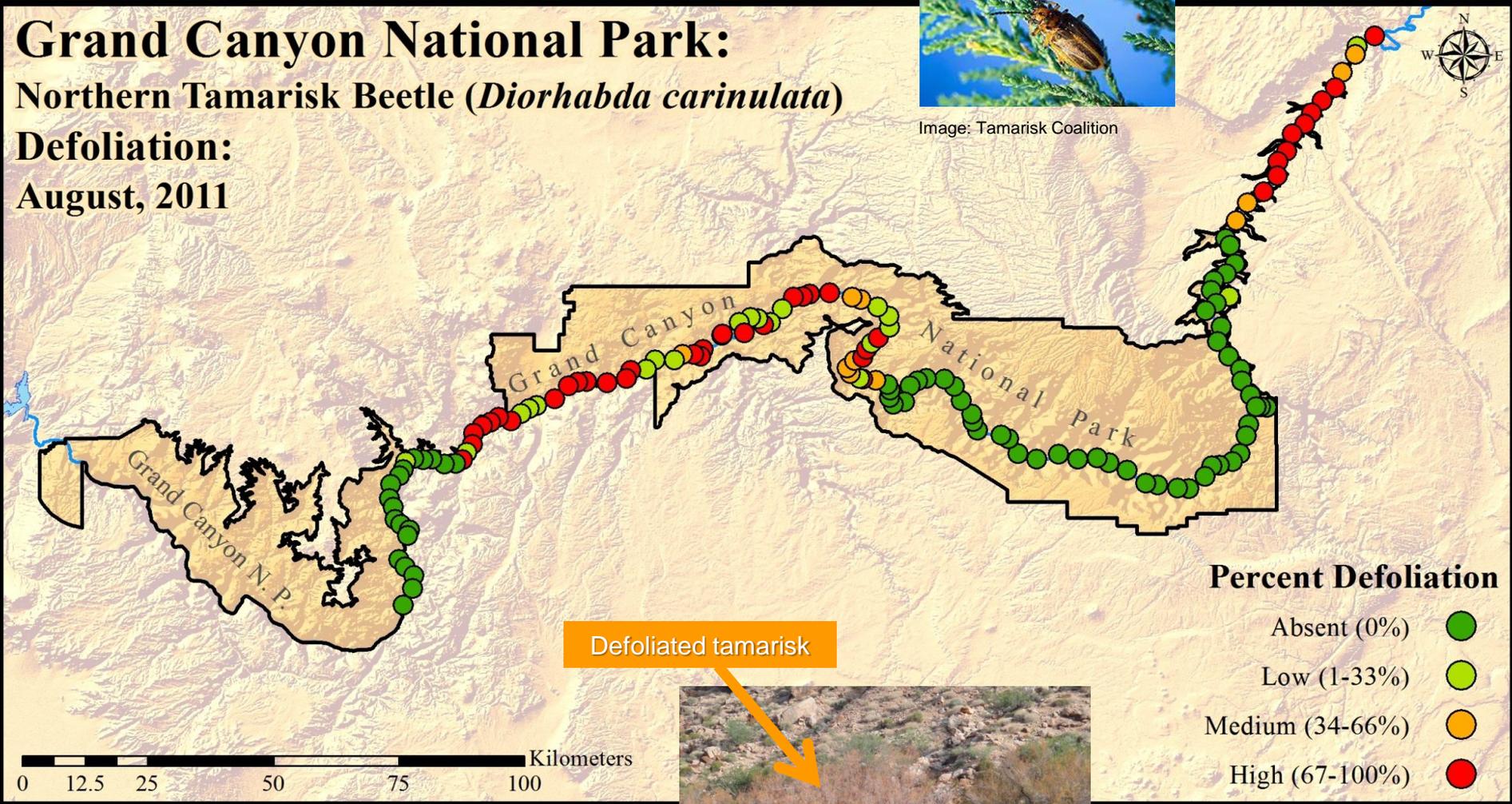
○ Absent Beetle
● Points in 2012

Restore. Connect. Innovate.
Tamarisk Coalition P.O. Box 1907 - Grand Junction, CO 81502

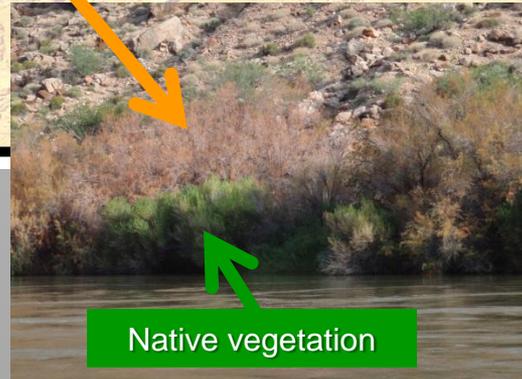
Grand Canyon National Park: Northern Tamarisk Beetle (*Diorhabda carinulata*) Defoliation: August, 2011



Image: Tamarisk Coalition



Defoliated tamarisk



Native vegetation

Map: L. Jamison



Impacts & implications of beetle-induced tamarisk mortality

- **Ecosystem patterns & processes**
 - Spatio-temporal scales
 - Flora & fauna
 - Nutrient dynamics, fire & hydrology
- **Management implications**
 - Natural & cultural resources
 - Recreation & visitor experience
 - Monitoring, mitigation & rehabilitation
 - Dam operations