An Ecological Framework for Reviewing Compensatory Mitigation: Biotic Processes in Riverine Wetlands

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Outline

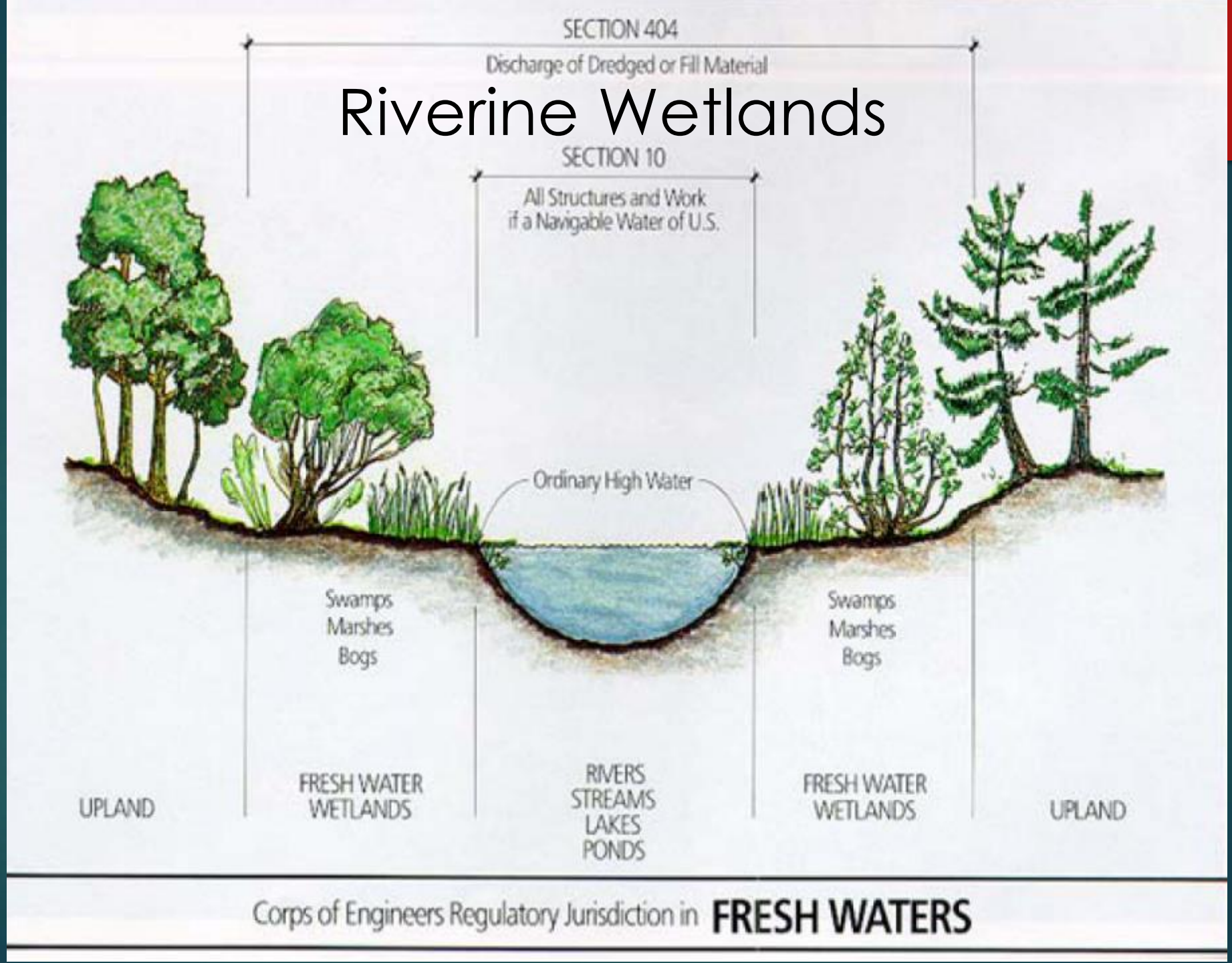
1. Introduction
2. Biotic characteristics are closely linked to hydrology and soils
3. Biotic elements provide indicators of wetland health and function
4. Measuring recovery of riverine wetlands using performance standards and reference sites
5. Summary

1. Introduction

Corps' Mitigation Regulation
33 CFR Part 332

- Use Watershed Approach
  - Involves selection of mitigation sites to help maintain and improve the quality and quantity of aquatic resources
- Consideration of what is best for the aquatic environment
- Mitigation must be directly related to the impacts and appropriate to the degree and scope of the impacts
- Survey Reference wetlands if possible to better understand hydrology, soils and dominant plants

Riverine Wetlands



Critical Biotic Characteristics of Riverine Wetlands

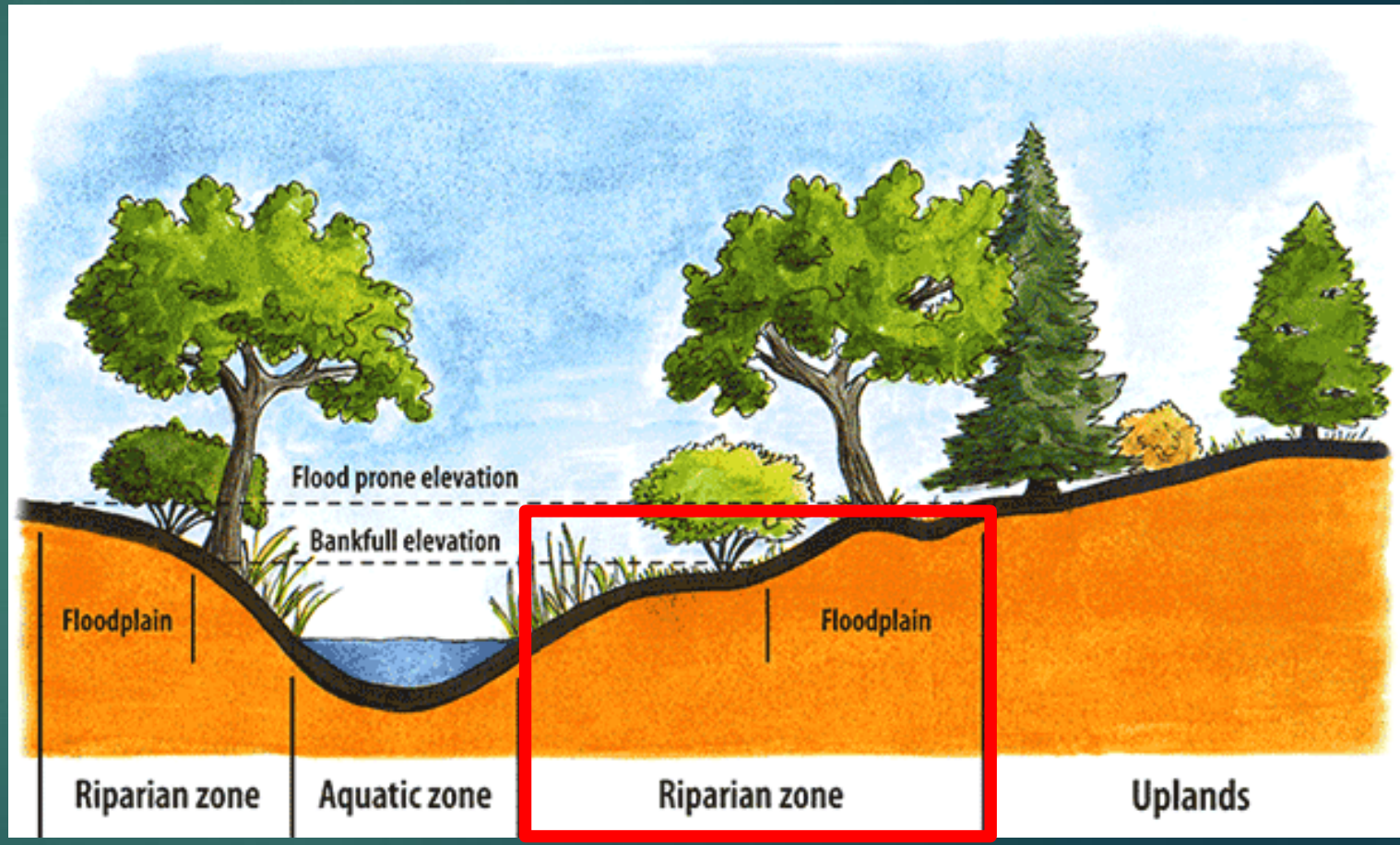
- Landscape Characteristics
  - Restoring Riparian Zone
- Linking Hydrology and Soils
- Site Location and Design
  - Historical conditions
  - Reference site conditions
- Performance Standards that reflect Ecosystem Services
- Flora and Fauna Monitoring Metrics
- Invasive Species Eradication or Control

Watershed Approach for Site Selection

- Restoration Nodes
- Wildlife Corridor

Consider Entire Riparian Zone

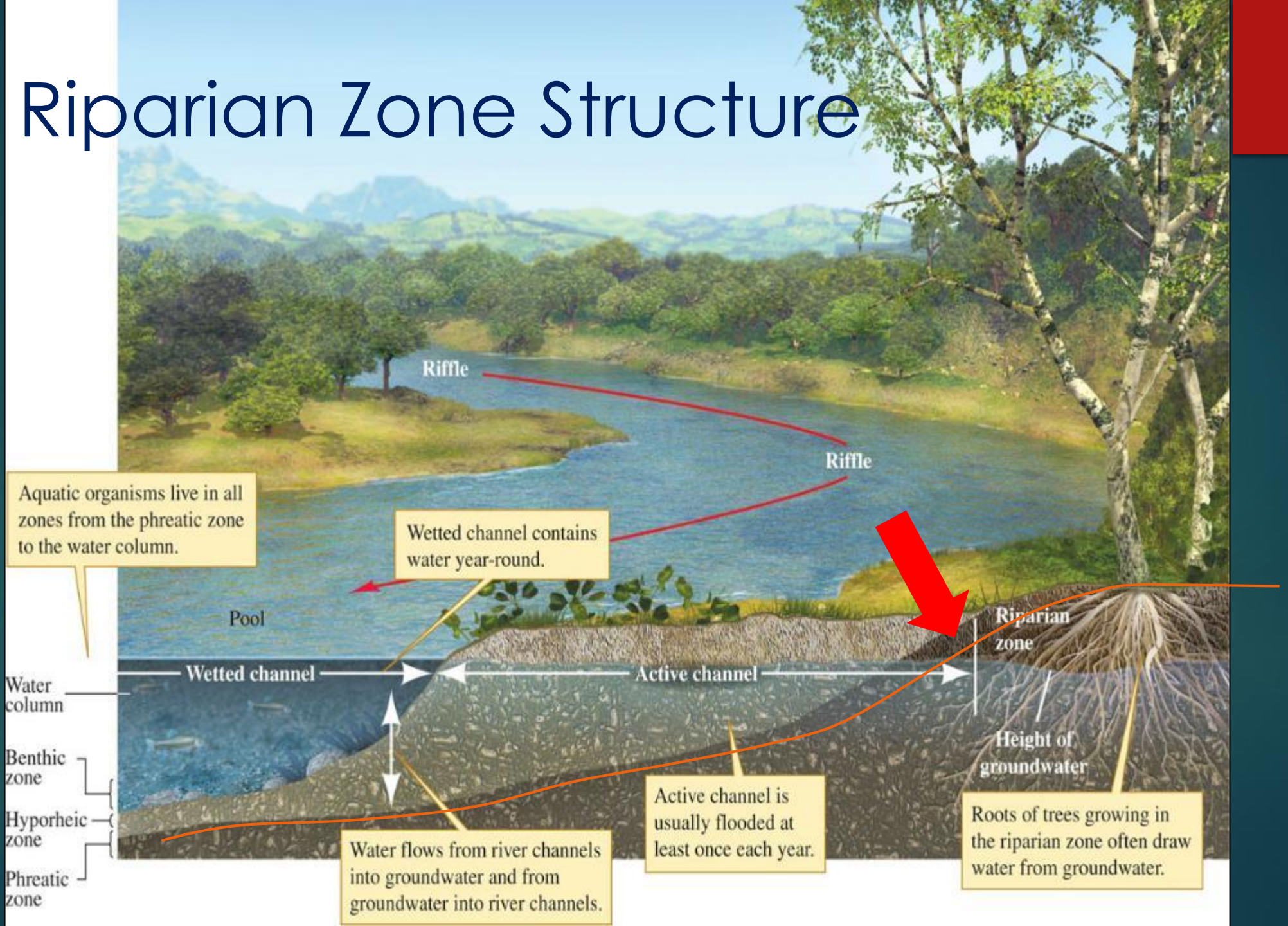
- Transitional zone between the terrestrial and aquatic ecosystems
- Hydrology is driven by the flood-pulse concept
- Vegetation is adapted to flooding (pulse) events and dry down



Source: http://slco.org/watershed/streams-101/the-riparian-zone/

Sources: Gregory et al. 1991, Junk et al. 1989

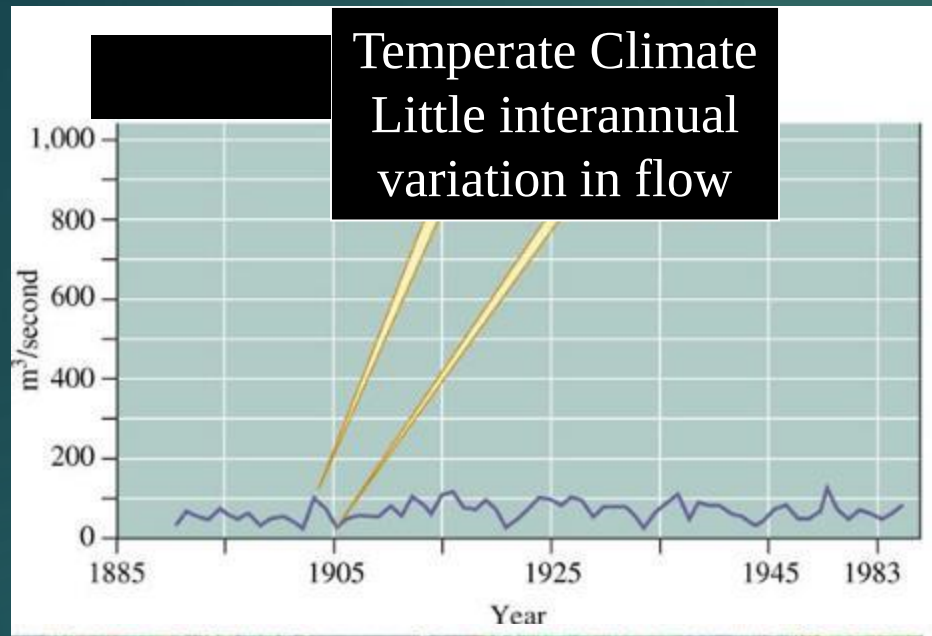
Riparian Zone Structure



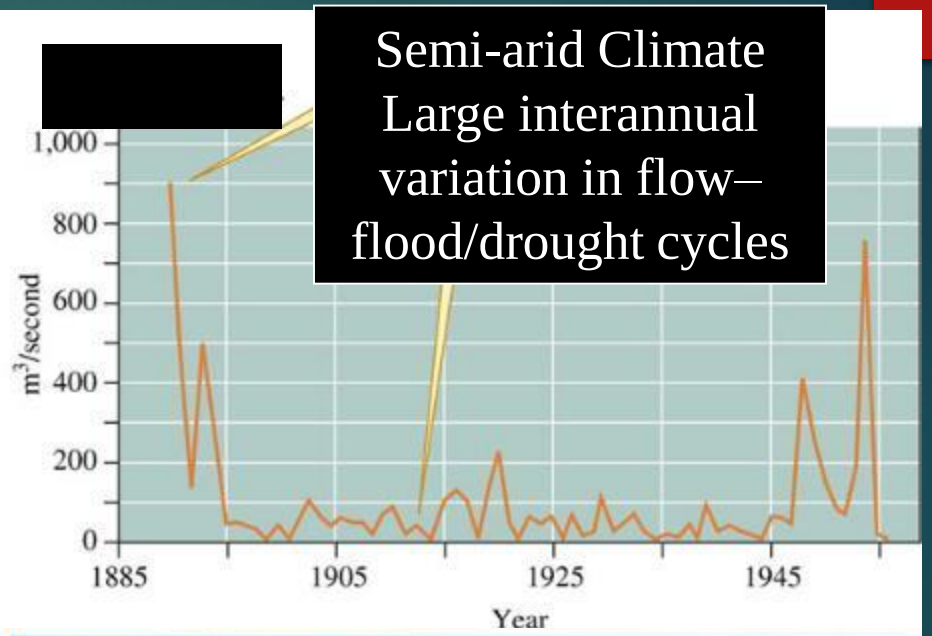
2. Linking Biotic Factors to Hydrology

- Climate varies throughout US
- Hydrology driven by climate
- Elevation and stream gradient vary
  - Mountains
  - Coastal plain
  - Deserts
- Consider plant adaptations to climate, hydrology, elevation, and soil type when designing mitigation
- Site selection and restoration design based on these factors

Variable Discharge due to Climate



Temperate Climate
Little interannual variation in flow

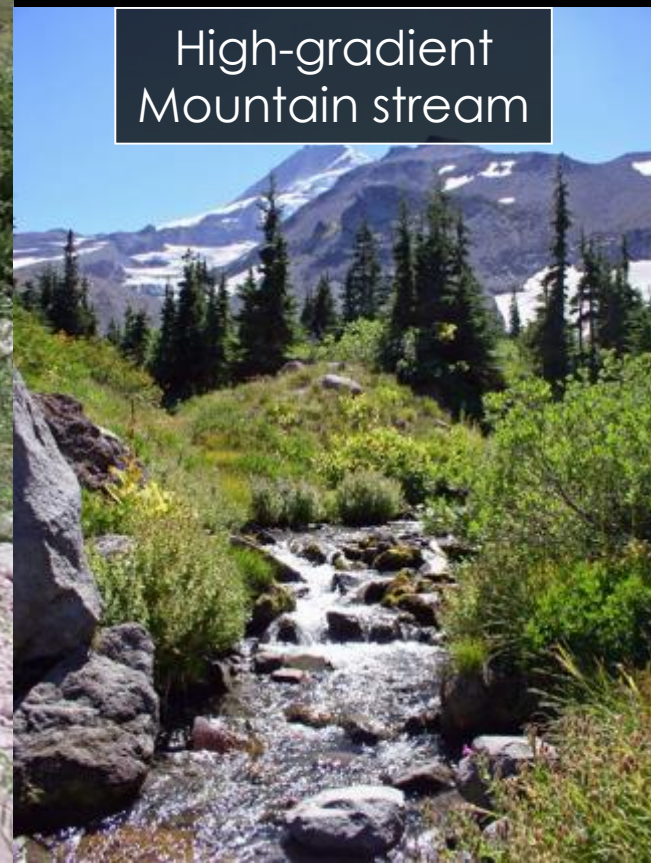


Semi-arid Climate
Large interannual variation in flow–flood/drought cycles

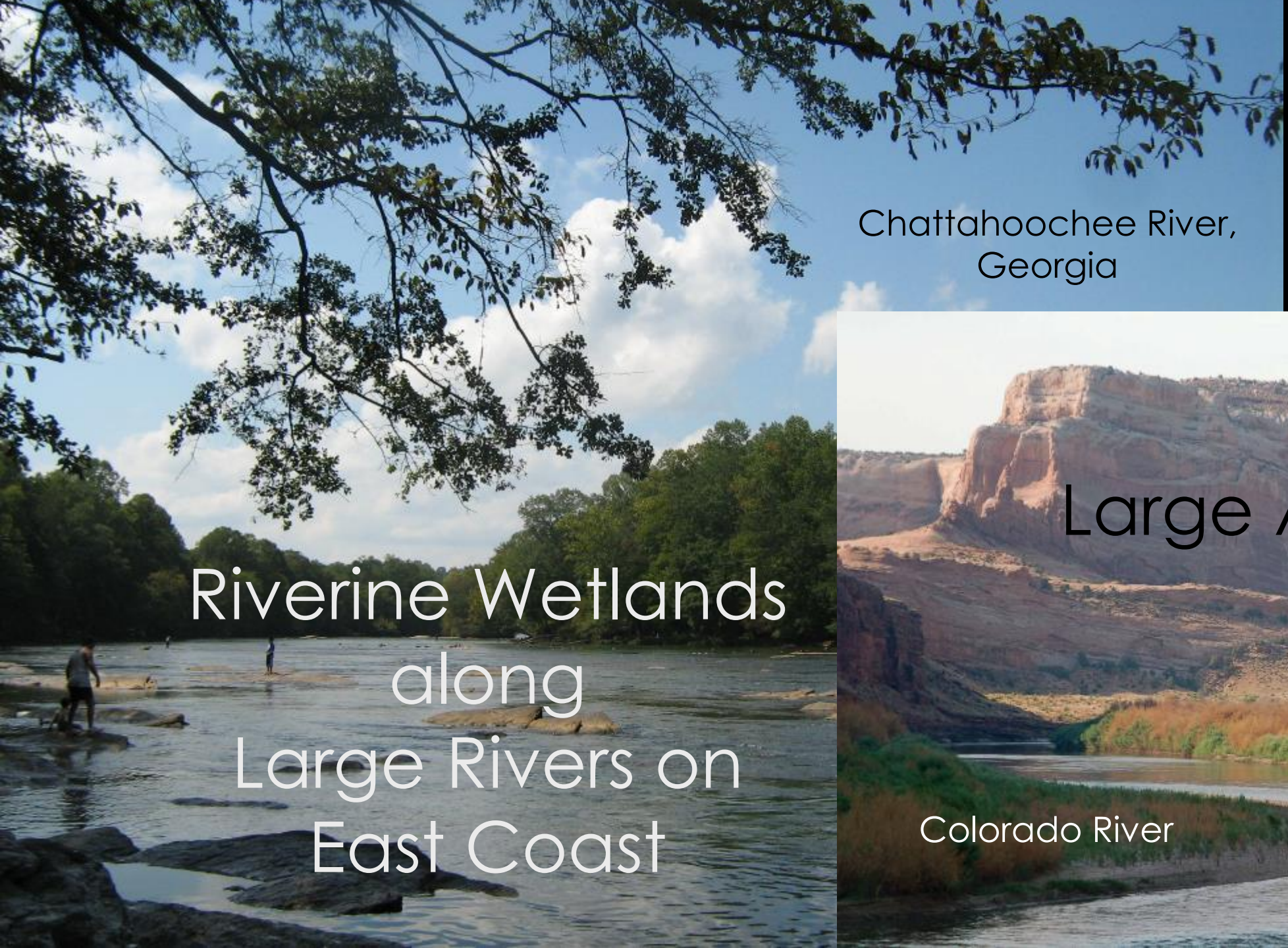
Mountain Stream

Desert Stream

Stream Gradient



High-gradient
Mountain stream



Chattahoochee River, Georgia

Riverine Wetlands along Large Rivers on East Coast

Large Arid Rivers

Colorado River

Montane Riverine Wetland

Truckee River


Small Coastal
Streams

Large Coastal Streams

- Riverine Wetlands along Dynamic Mediterraean-type Climate Rivers affected by
  - Floods
  - Fires
  - Drought
  - Invasion

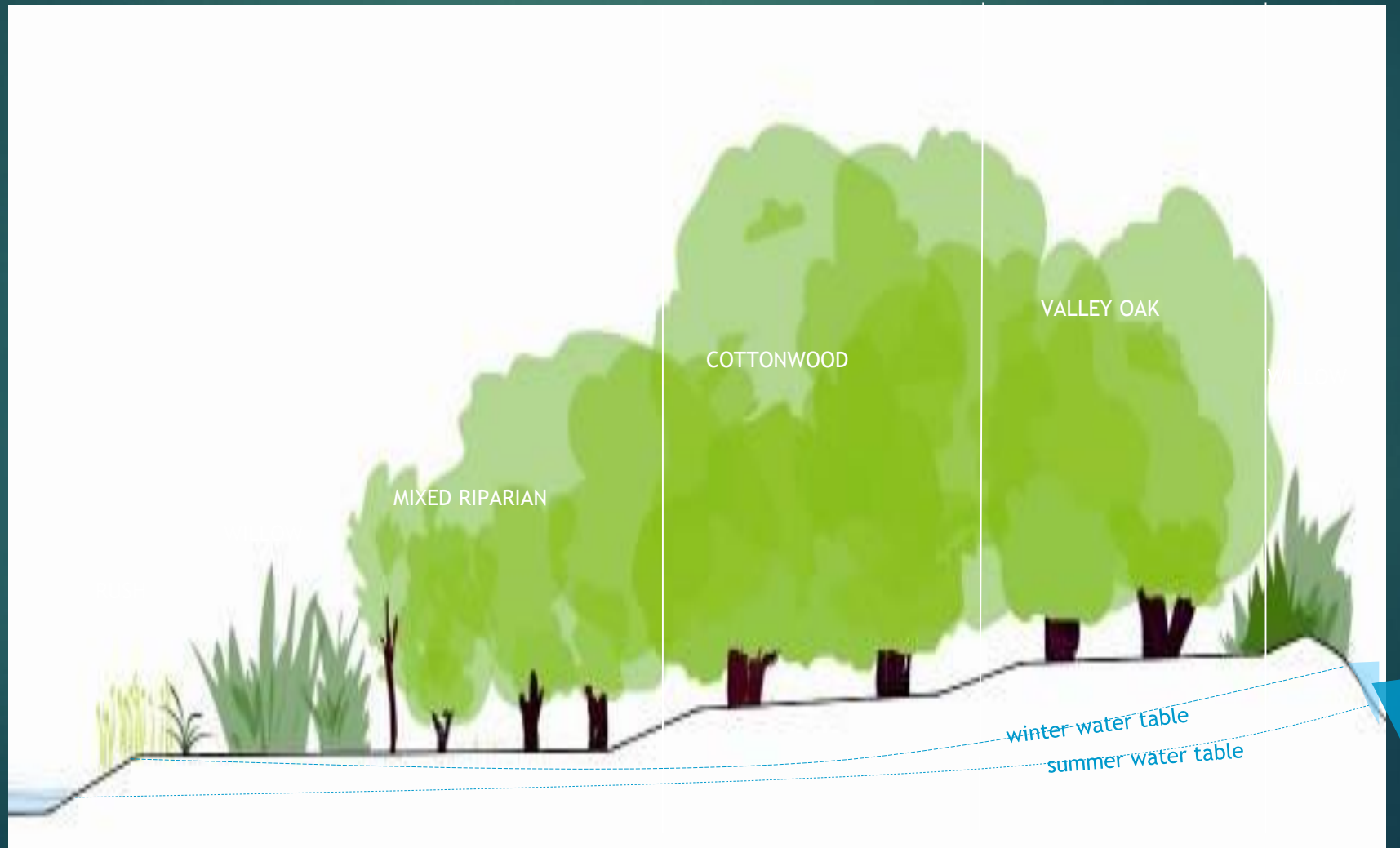
Low-gradient Coastal River

Important Stressors & Adaptations

- Low light availability
  - Shade-tolerance
  - Larger leaves
- Fluctuation in groundwater levels
  - *Phreatophytes* = water loving
  - Develop deep root systems to search for deeper water in hot, dry summer
  - Adapted to flood disturbance – spread propagules
  - Tolerate infrequent inundation

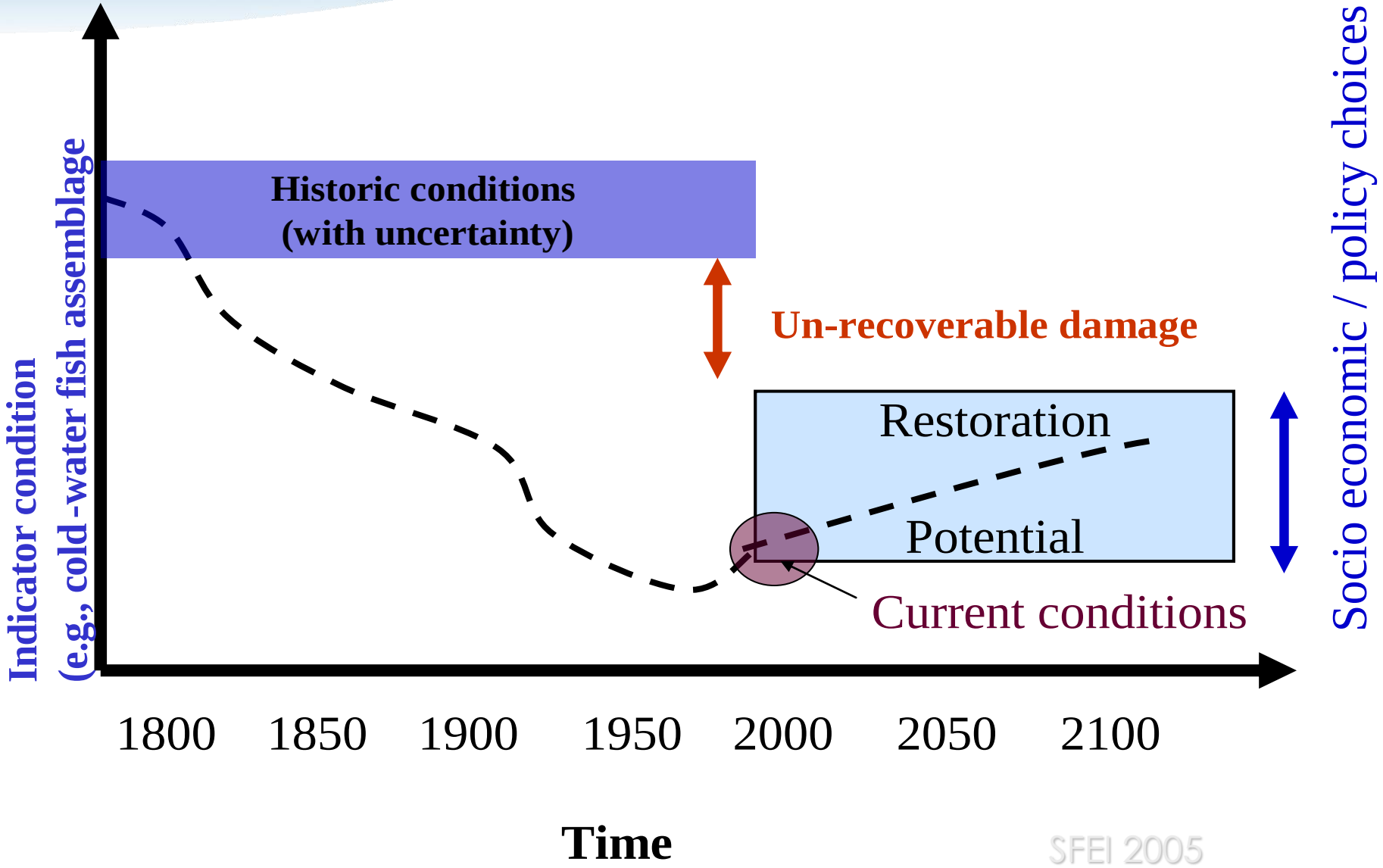
Horizontal Zonation Relates to Hydrology

- Monitor vegetation along cross section



3. Biotic Elements Provide Indicators of Wetland Health and Function

Scientific–Based Approach

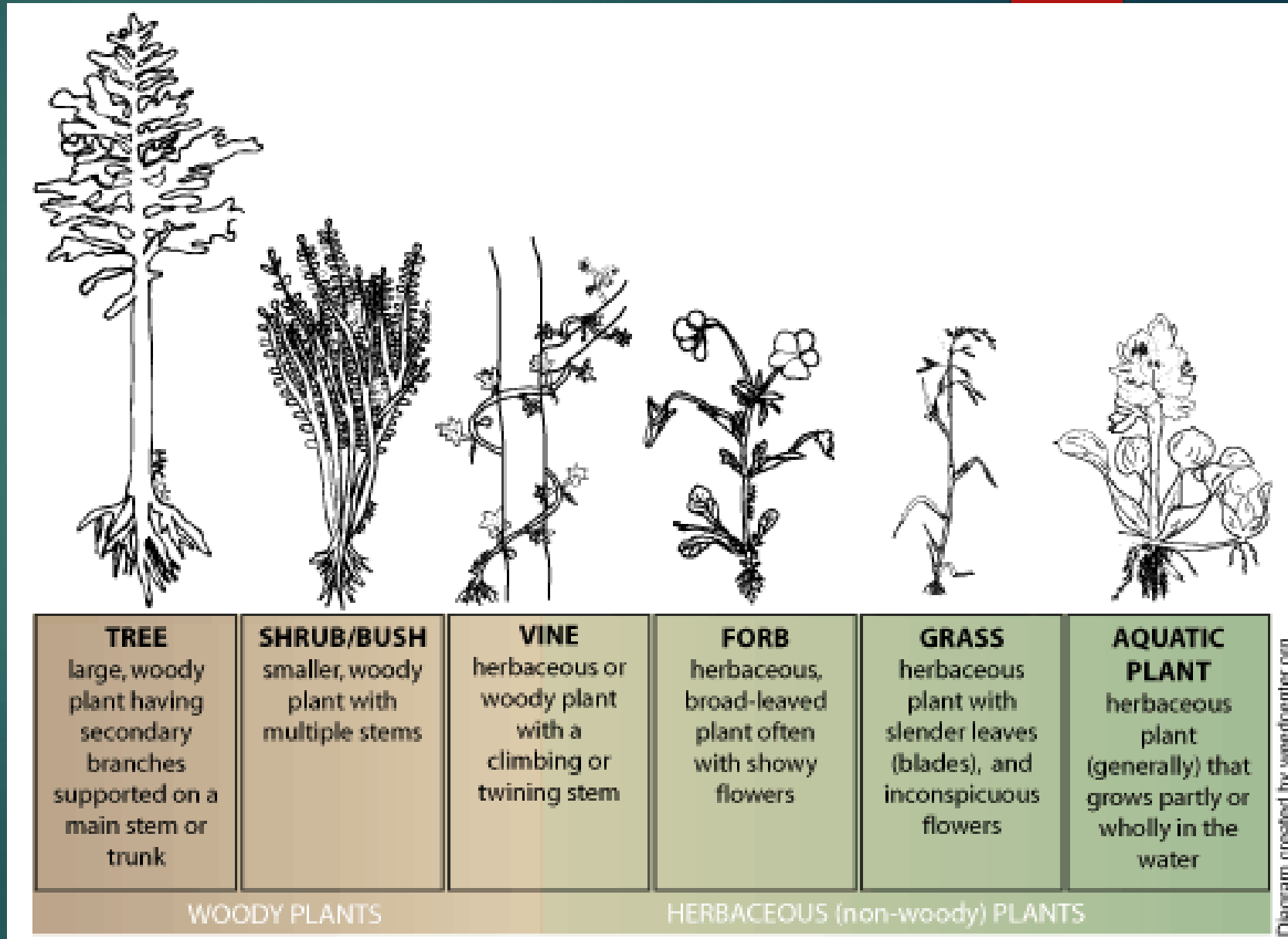


Biotic Monitoring Metrics

- Flora
  - Survivorship
  - Percent cover
  - Native vs. Nonnative
  - Species diversity
  - Structure
  - Health
- Fauna
  - Presence
  - Species diversity

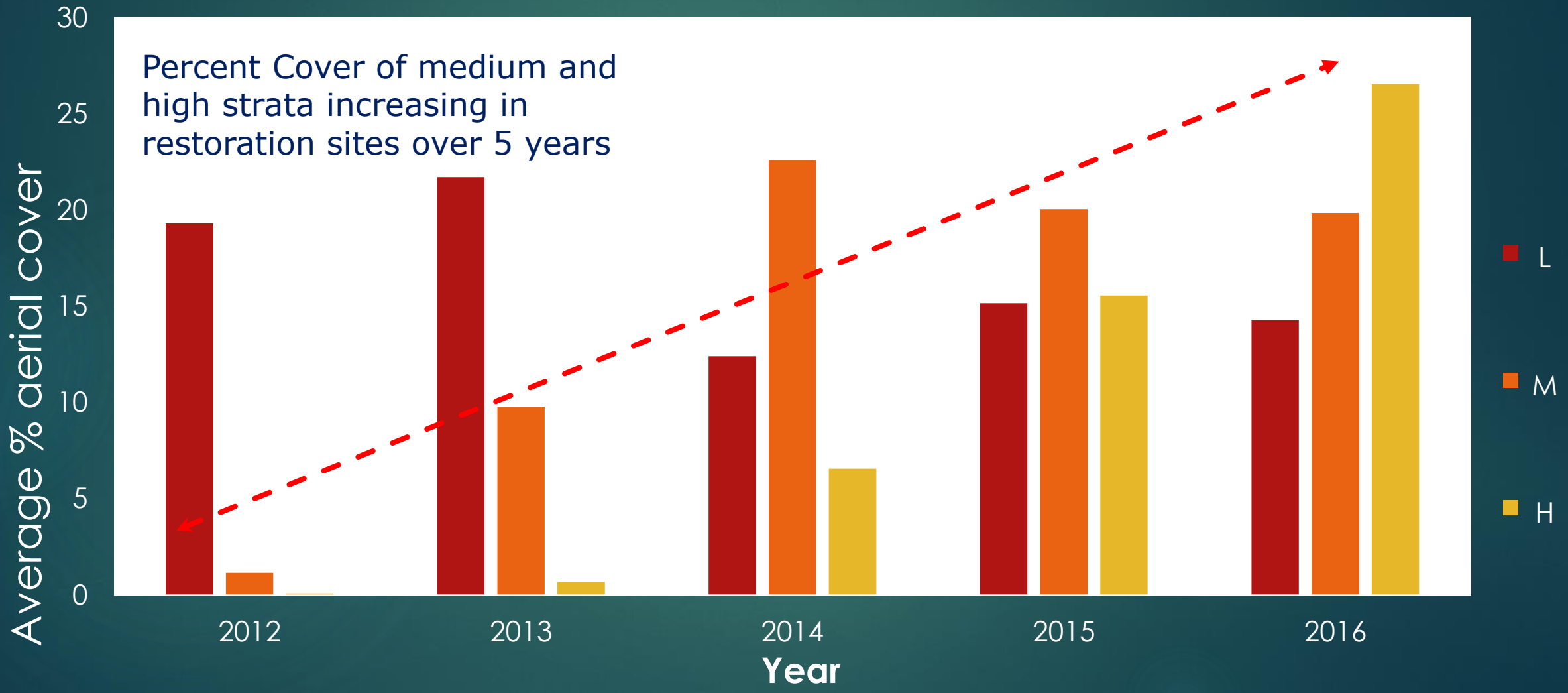
Riparian Vegetation Structure

- Multiple layers or strata
  - Trees (canopy)
  - Shrubs (understory)
  - Vines (woody and herbaceous)
  - Herbaceous plants (forbs)
  - Grasses



Riparian Zone Structure

Measuring Structure



What about other Metrics like Health?

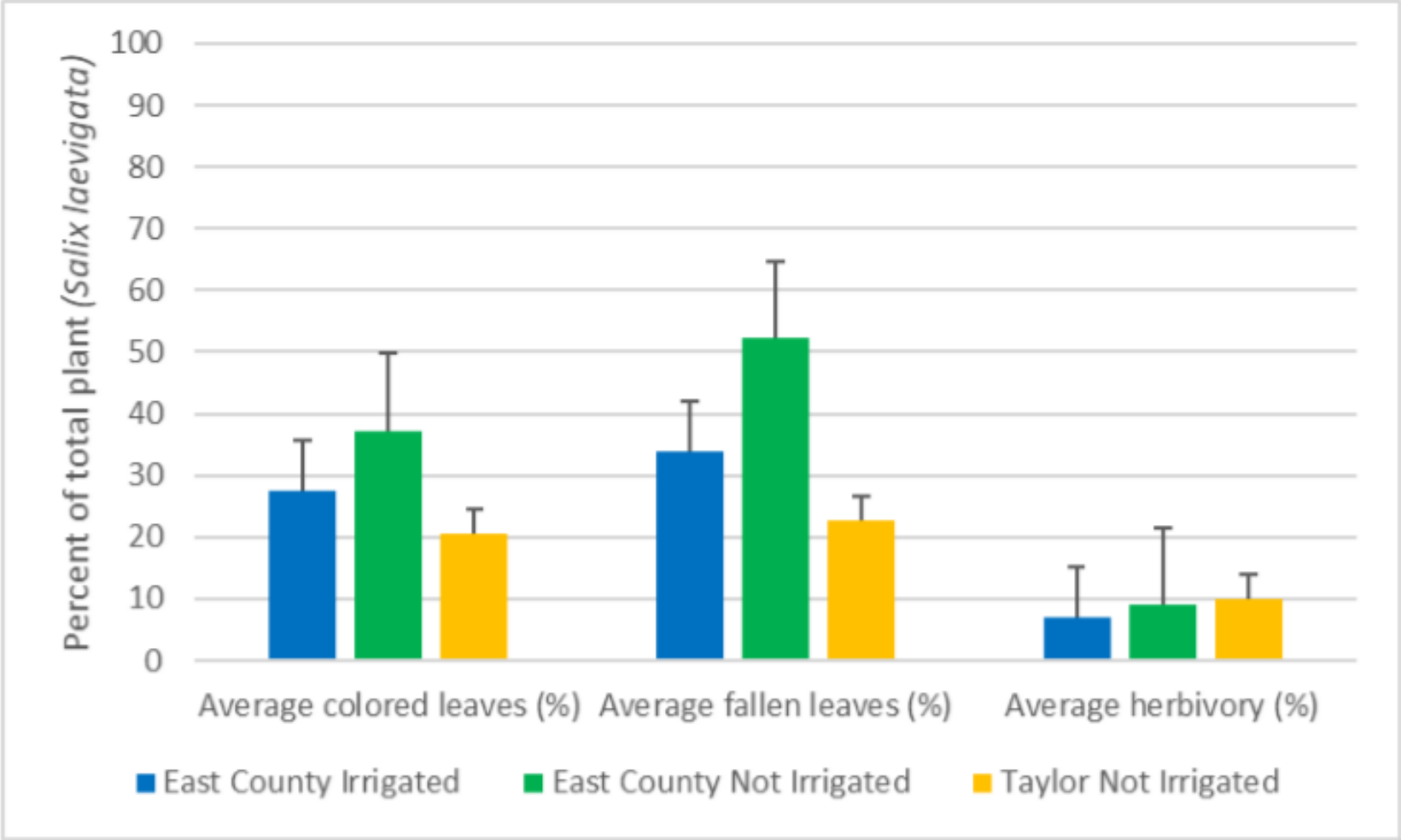


Figure 15. Mean percent of leaves that are colored, fallen, or have evidence of herbivory for Salix laevigata.

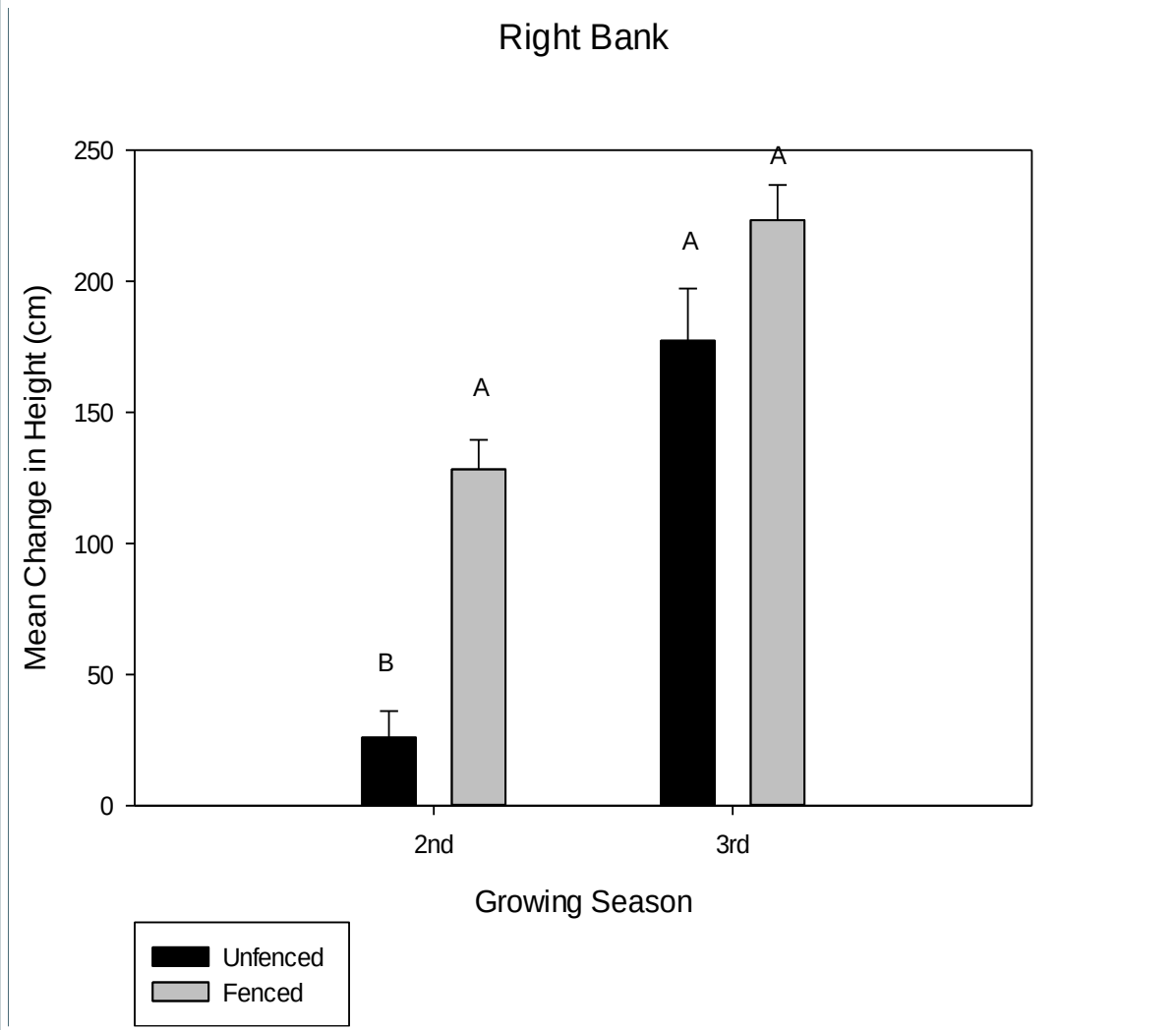
Monitoring Riparian Dependent & Special Status Wildlife

Western Pond Turtle (*Actinemys marmorata*)

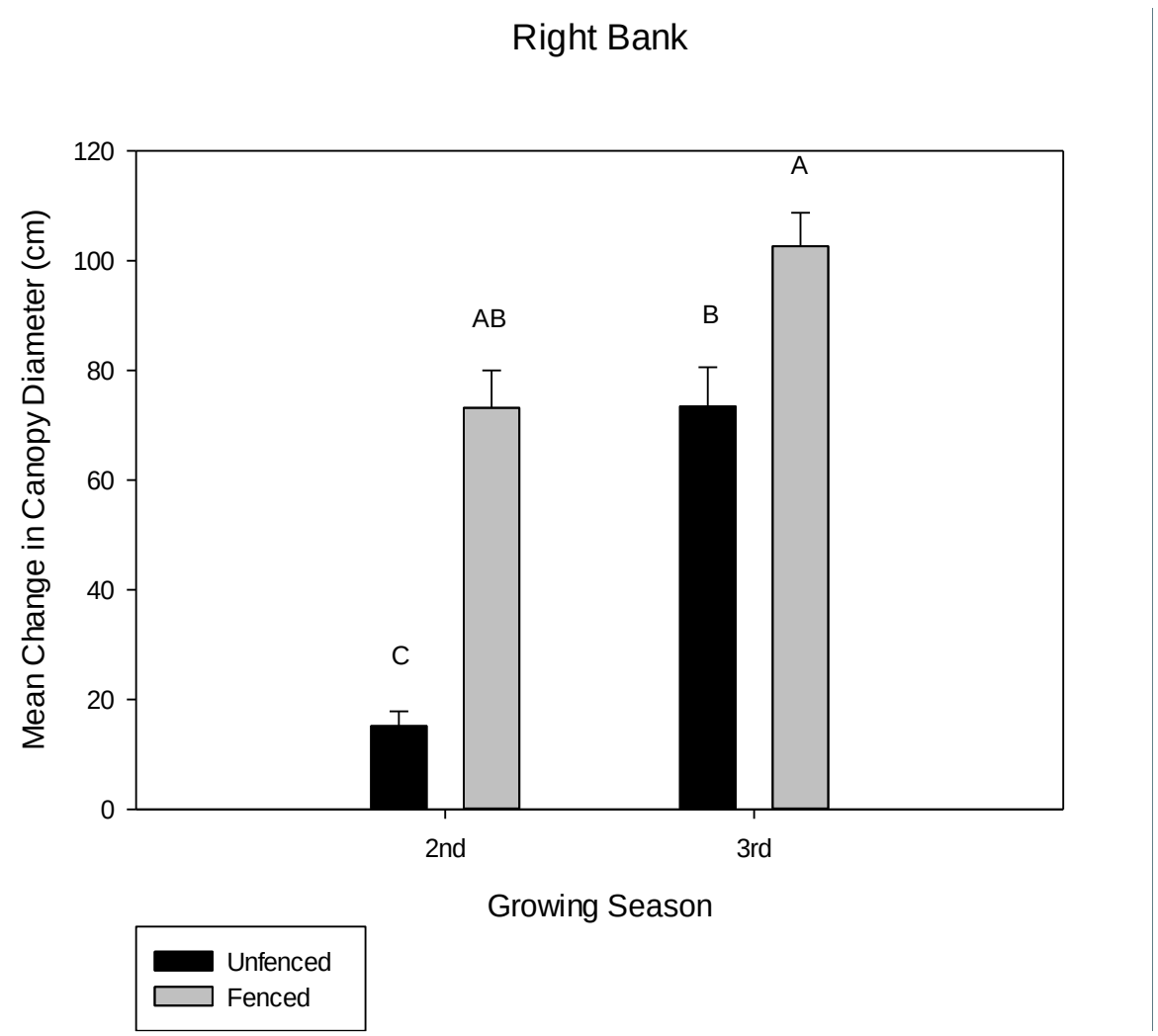
Riparian Brush Rabbit (*Sylvilagus bachmani riparius*)

Fencing Experiment for Deer Browsing

Mean Height



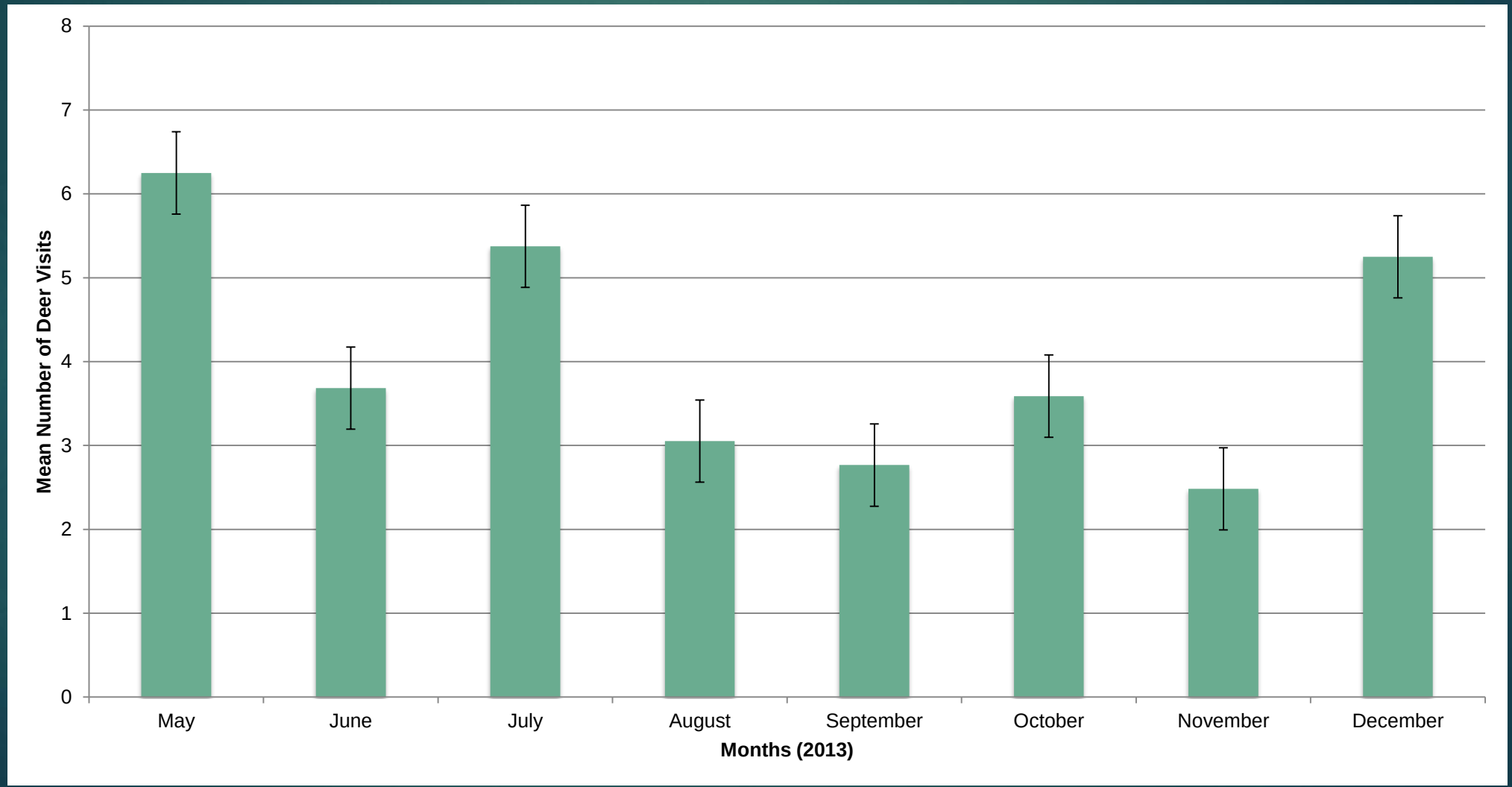
Mean Canopy Diameter



Wildlife Camera Trapping

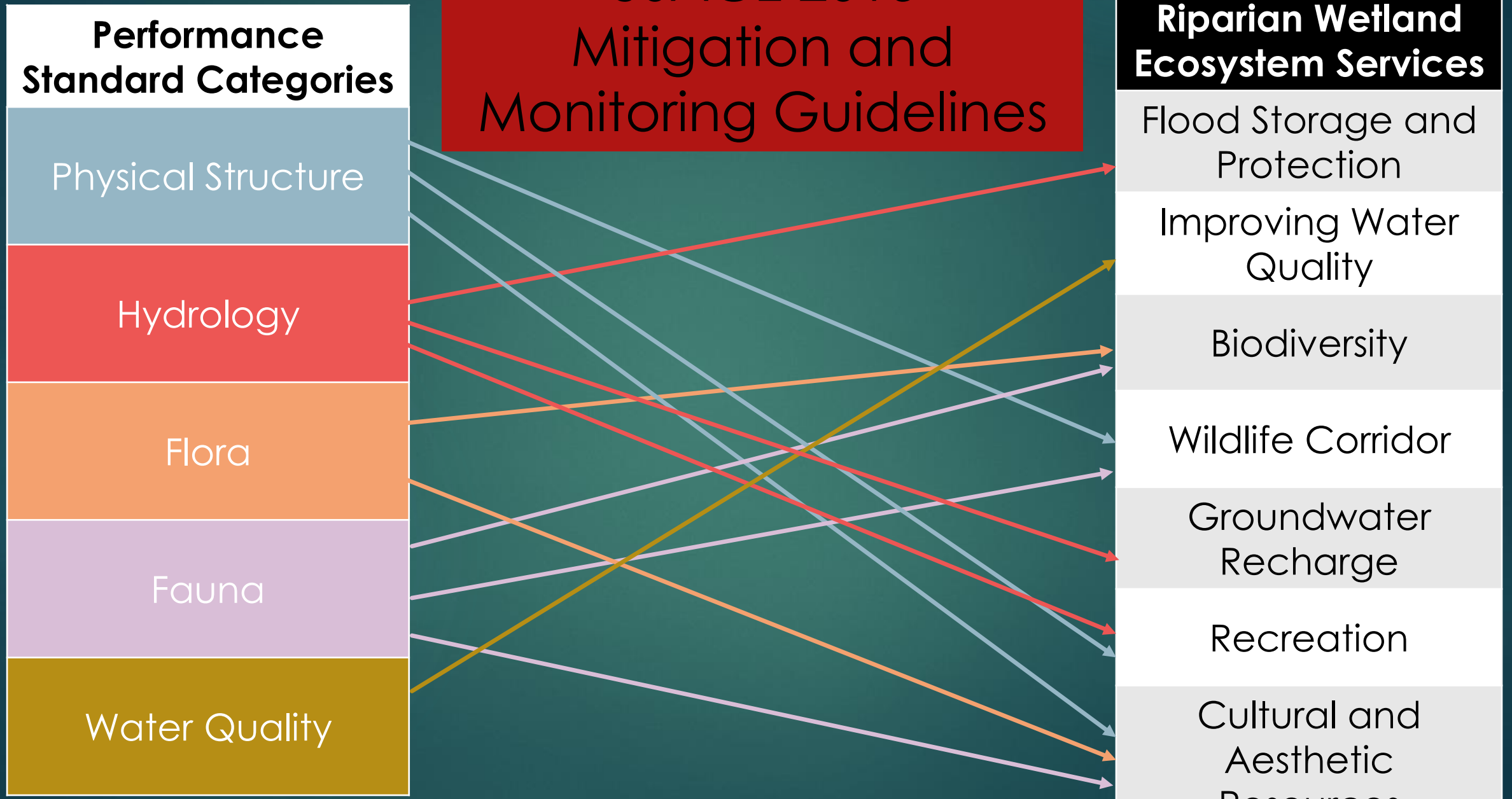
- Remote motion and heat sensor cameras
- Duration: 8 months (May-December 2013)
- Photo documentation of deer browsing on willows
- Highest frequency of deer visits during months of May, July and December

Mean Number of Dear Visits per Day at Redwood Creek May 2013 - December 2013



4. Measuring Recovery using Performance Standards and Reference Sites

USACE 2015 Mitigation and Monitoring Guidelines



USACE 2015

Performance Standard Category	WET		HGM		CRAM	
	Function Evaluated	Potential?	Function Evaluated	Potential?	Function (Metric) Evaluated	Potential?
Physical Structure	Recreation	No	Maintain spatial structure of habitat	Yes	Structural patch richness	Yes
	Uniqueness/heritage	No	Maintain interspersion and connectivity	Yes	Topographic complexity	Yes
	-	-	-	-	Aquatic area abundance	No
	-	-	-	-	Buffer	No
Hydrology	Groundwater recharge and discharge	No	Groundwater recharge and discharge	No	Water source	No
	Floodflow alteration	Yes	Flood protection/energy dissipation	Yes	Channel stability	Yes
	-	-	Surface water storage	No	Hydrologic connection	Yes
Flora	-	-	Maintain characteristics plant communities	Yes	Plant community	Yes
	-	-	Maintain characteristic detrital biomass	Yes	Horizontal interspersion	Yes
	-	-	-	-	Vertical biotic structure	Yes
Fauna	Aquatic diversity and abundance	Yes	Maintain distribution and abundance of invertebrates	Yes	-	-
	Wildlife diversity and abundance	Yes	Maintain distribution and abundance of vertebrates	Yes	-	-
Water Quality	Sediment stabilization	Yes	Retention of particles	Yes	-	-
	Sediment/toxicant retention	No	Removal of imported elements and compounds	No	-	-
	Nutrient removal/transformation	Yes	Nutrient cycling	Yes	-	-
	Product export	No	Organic carbon export	No	-	-

(Mecke 2018)

Recommendations

Permittee-Responsible Riparian Restoration Projects in the Central Valley of California:

Performance Standard Category	Assessment Method	Function
Physical structure	CRAM	Structural patch richness
Hydrology	HGM	Flood protection and energy dissipation
Flora	CRAM	Plant community
Fauna	WET	Wildlife abundance and diversity
Water quality	WET/HGM	Sediment stabilization/retention of particles

Developing Performance Standards based on Hydrology & Soil Conditions

Soil moisture

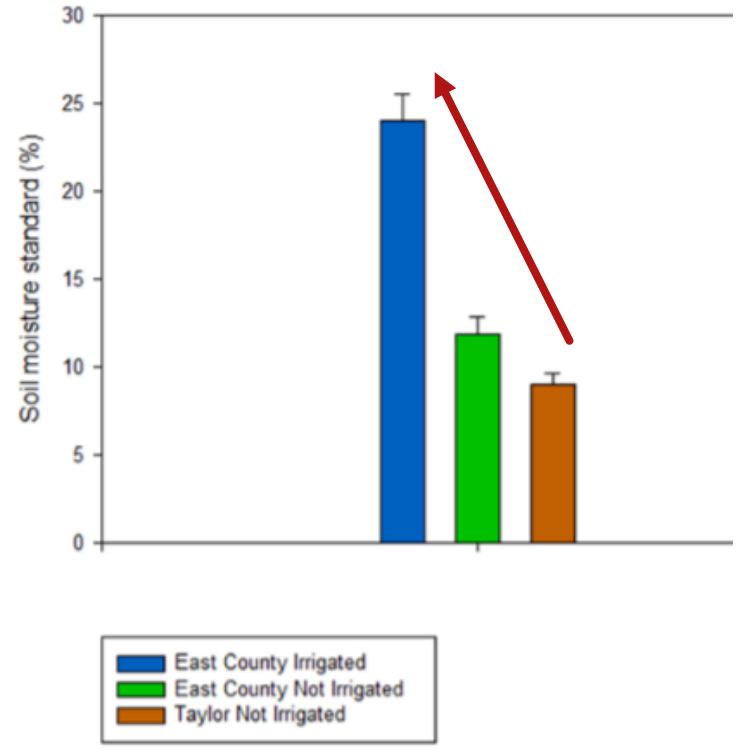


Figure 1. Mean soil moisture for the three experimental treatments. Measurements were taken on the north and south side of each plant using a TDR 300 field scout with 20cm probes.

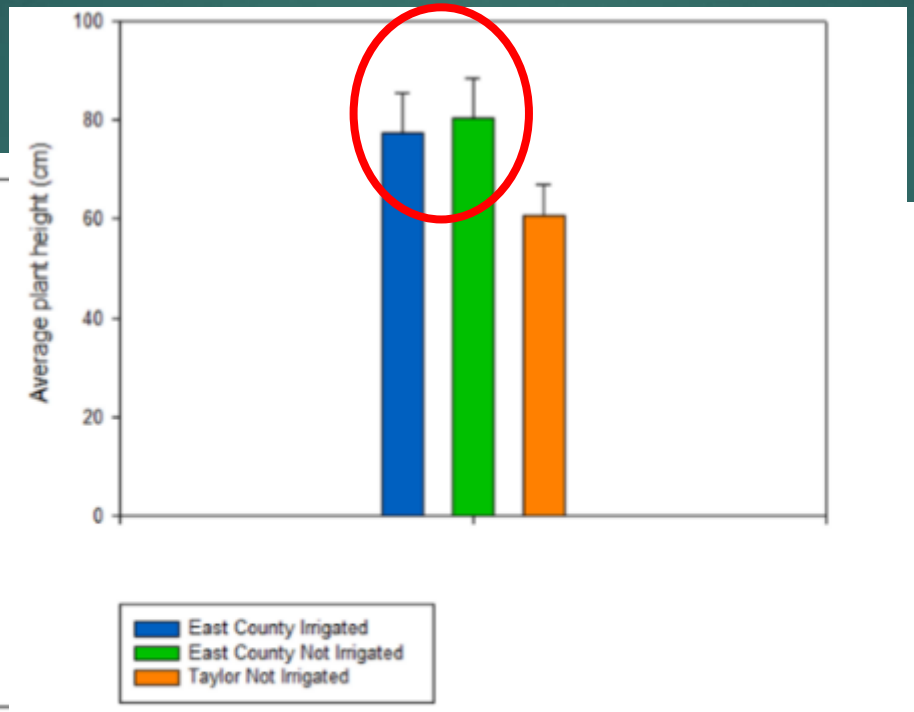


Figure 2. Mean plant height for all species in the three experimental treatments. The non-irrigated treatment on the East country property has the highest mean plant height.

Clay loam soil

Sandy loam soil

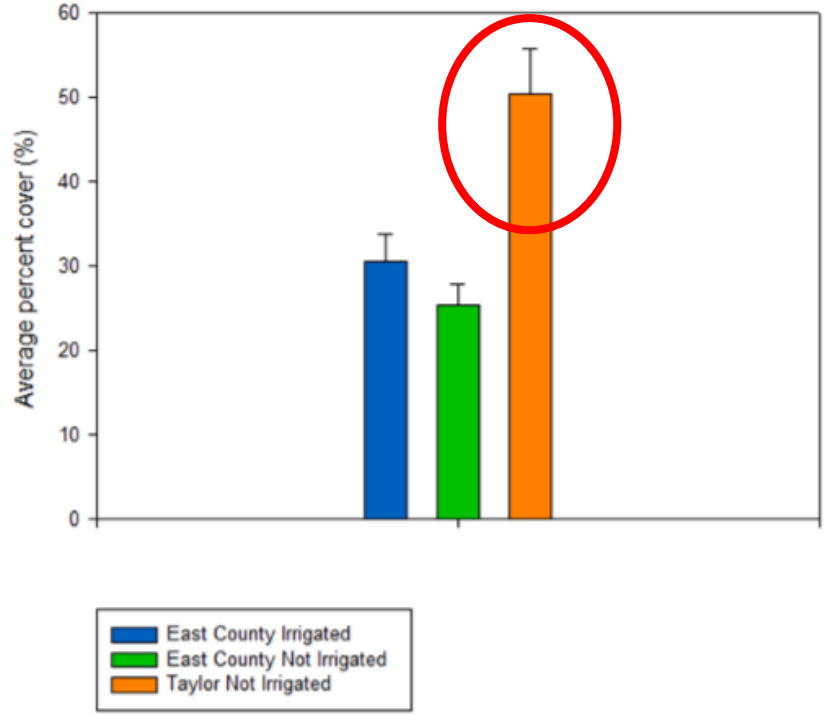
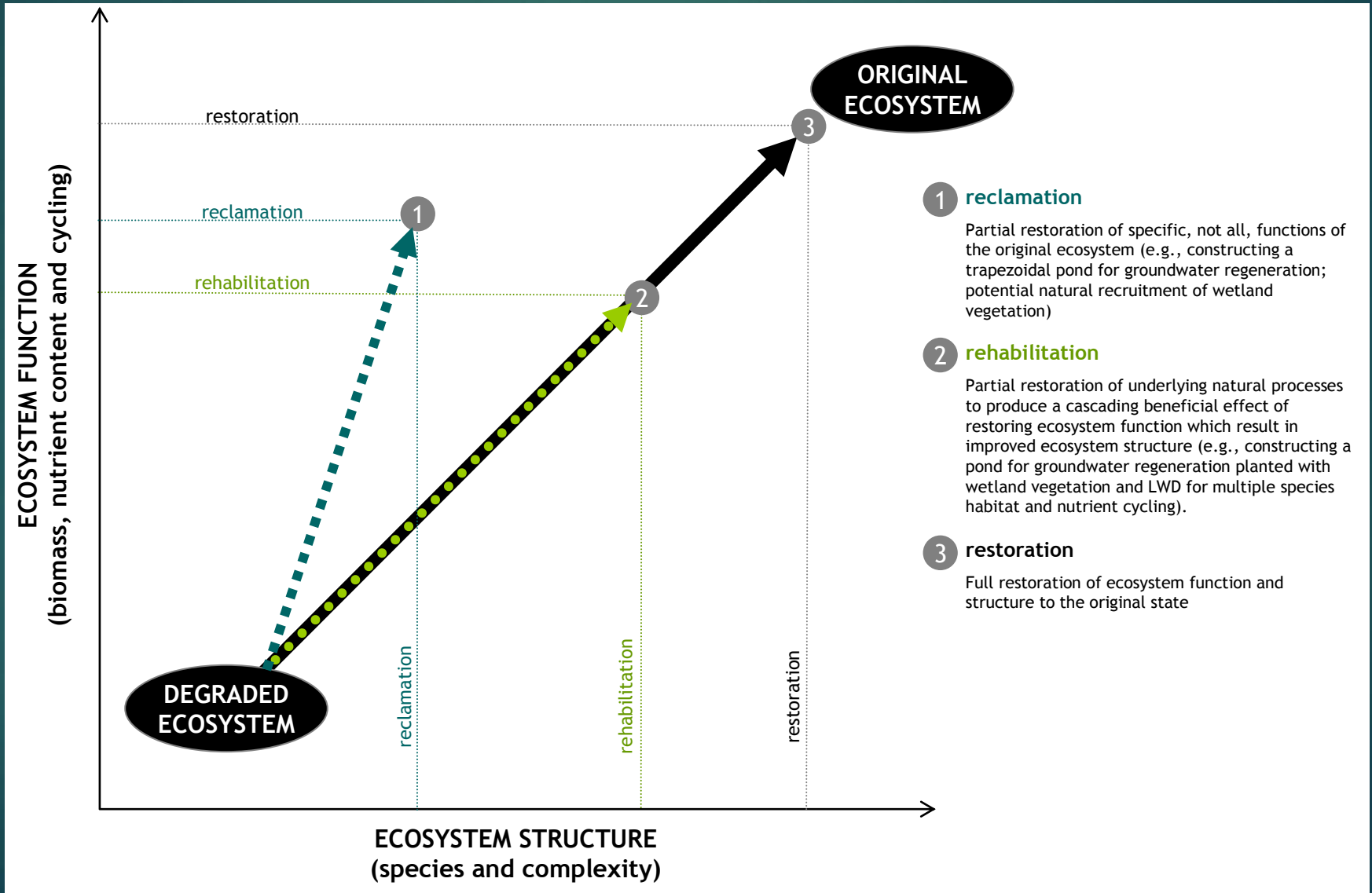


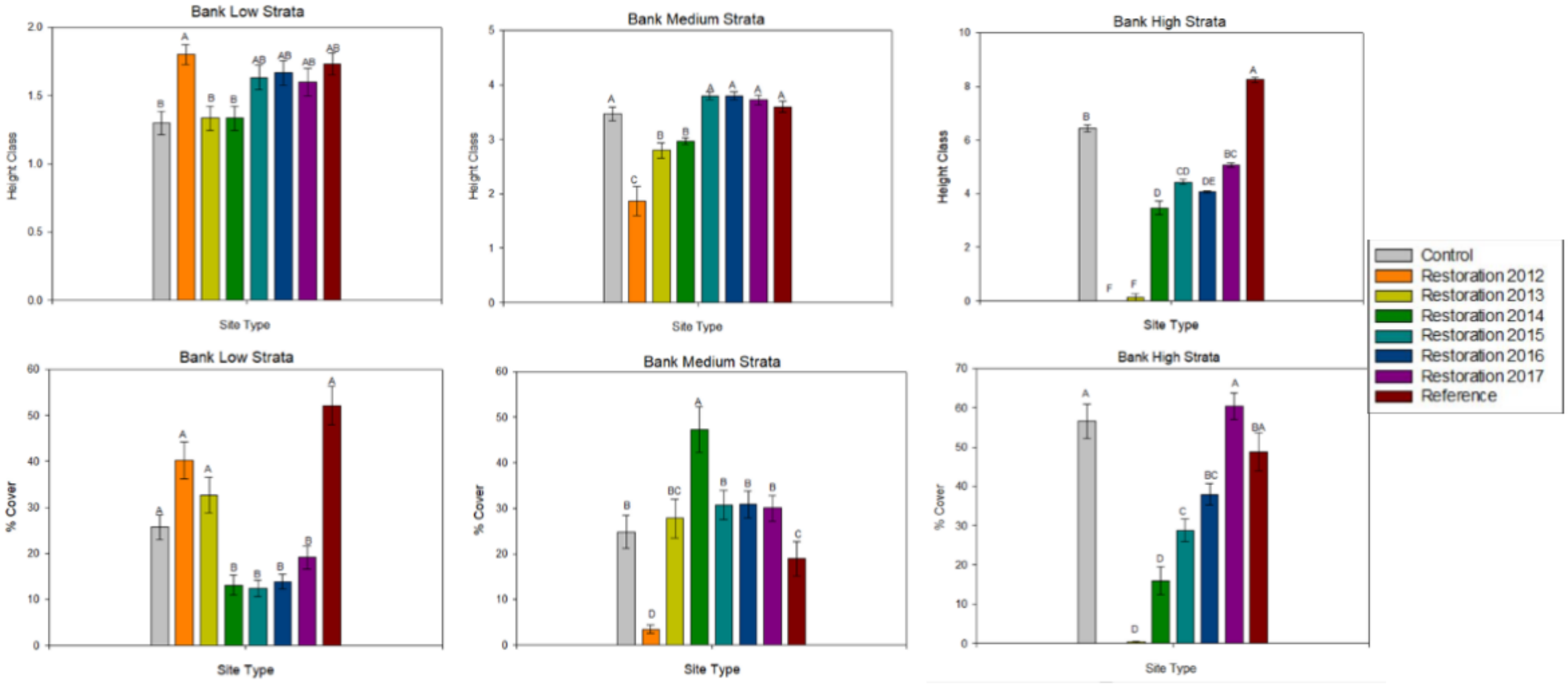
Figure 3. Mean percent cover for all species in the three experimental treatments. The non-irrigated treatment at the Taylor property has the highest mean percent cover.

Ecological Trajectory

- Describes the development pathway of an ecosystem through time.



Comparing Restoration to Reference & Control Sites



Choosing Reference Sites

- Use to develop Plant Palette and compare to recovery of restoration site over time
- If possible find at least one or more
- Most similar hydrology, gradient, and geomorphology
- Least impacted by humans
- Data sharing

Using Historical Maps, Photos, and Records as Reference Conditions

(SFEI 2011)

Reconstruct Historical Ecology of Rivers & Riverine Wetlands

- Mediterranean-climate
- Dynamic hydrology
- Braided channels
- Intermittent reaches
- Riparian vegetation shaped by episodic flooding disturbance regime

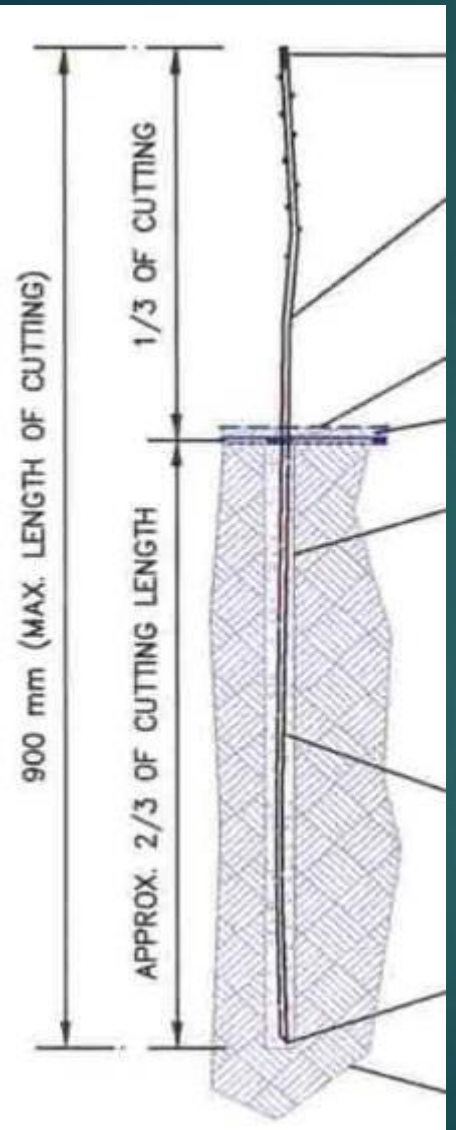
Fairchild 1934
(courtesy of UCLA)

5. Reviewing Compensatory Mitigation & Monitoring Plans

- Linking Revegetation to Hydrology and Soils
- Relate Timing of Planting to Climate
- Consideration of Reference Site Conditions when designing projects (Van den Bosch and Matthews 2017)
- Performance Standards should be
  - Easily measurable
  - Robust – not just plant survivorship and % cover
  - Linked to ecosystem services
  - Use Assessment methods like HGM, WET and California Rapid Assessment Method
- Develop interim standards for monitoring to ensure restoration is on the right trajectory (Matthews and Endress 2008)


Questions?

Active Revegetation

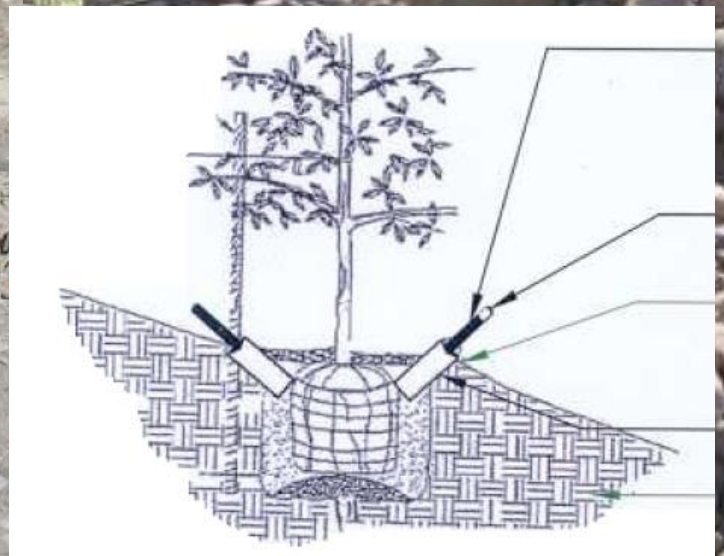


- Types of propagation
  - Pole cuttings of trees and shrubs - easy and cost effective
  - Grow from seeds
  - Divisions of perennial herbs and grasses with rhizomes
  - Direct seeding

Pole cuttings

Seeding stream bank

How to Select Irrigation?



- Drip system
- Water truck
- Driwater
- Natural

Sometimes You Get Lucky with Passive Restoration