Veg-Sand Feedbacks and Updates on Project C.1 and C.3

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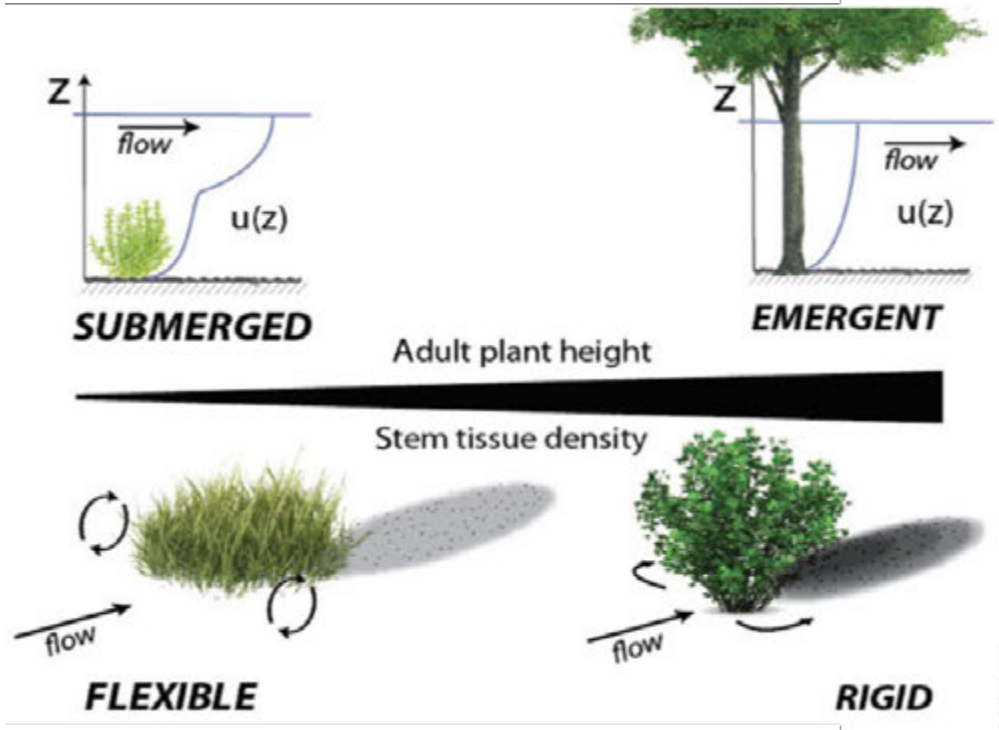
Project Elements and Objectives

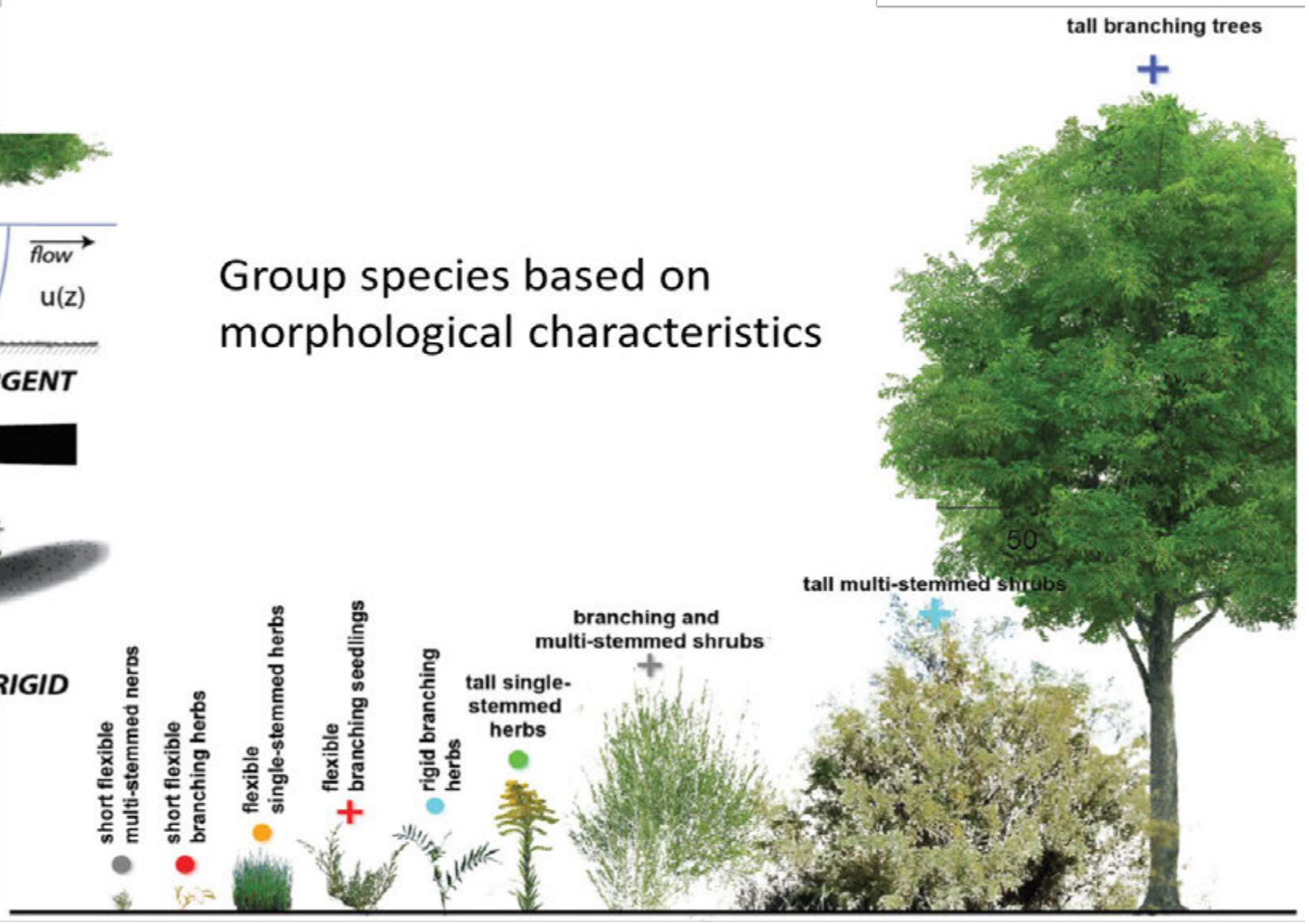
- C.1 Ground-based vegetation monitoring
  - Objective: Monitor annual changes to riparian species composition and cover
- C.3 Vegetation responses to LTEMP flow scenarios
  - Objective: Develop predictive models of vegetation composition as it relates to hydrological regime
- Riparian Vegetation Resource Objectives:
  - “Maintain native vegetation and wildlife habitat, in various stages of maturity, such that they are diverse, healthy, productive, self-sustaining, and ecologically appropriate.”

How is Vegetation Impacting Sediment?

Morphological Guilds: Diehl *et al.* 2017 *Bioscience*



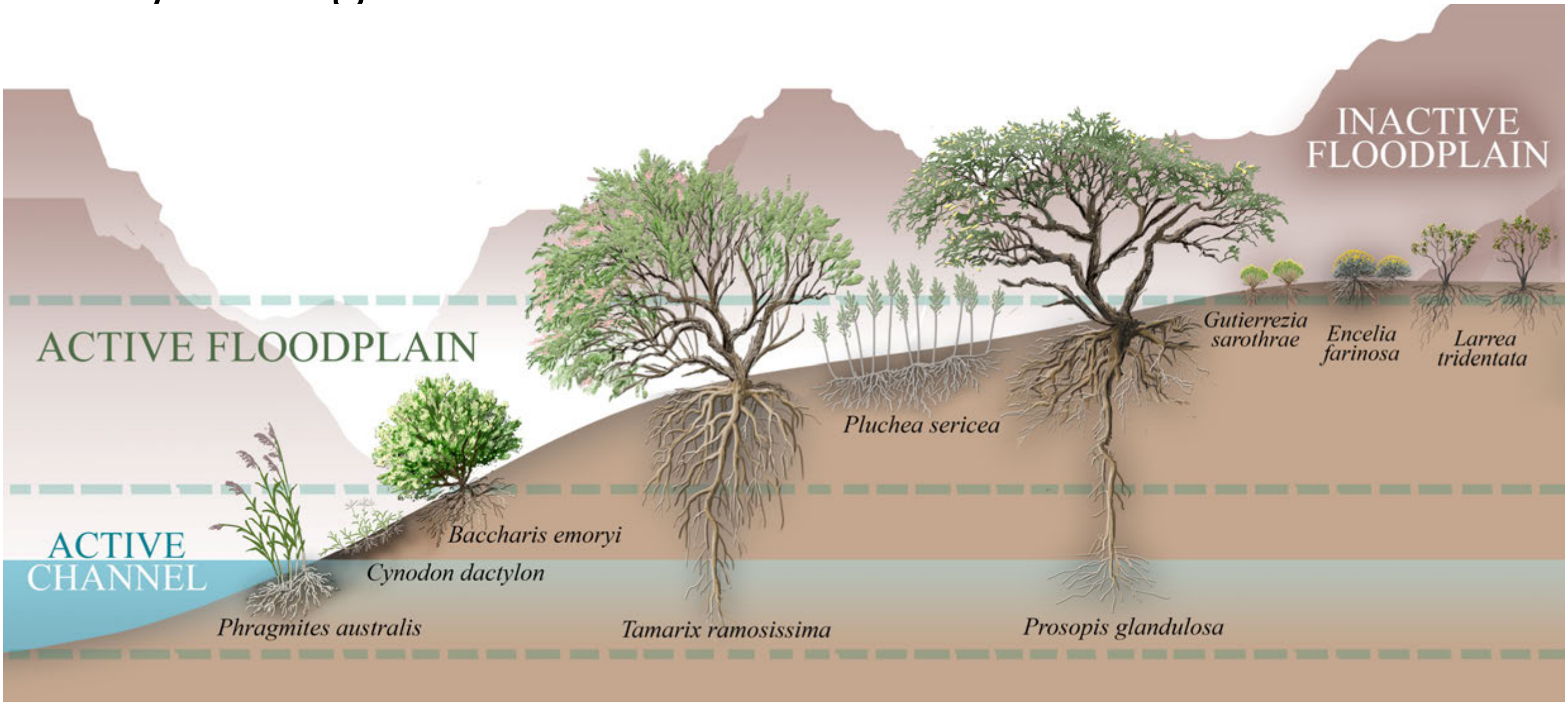
Group species based on morphological characteristics



Prediction: Larger, more rigid plants will create more sand deposition

Diehl *et al.* 2017 *Bioscience*

Hydrological Zones



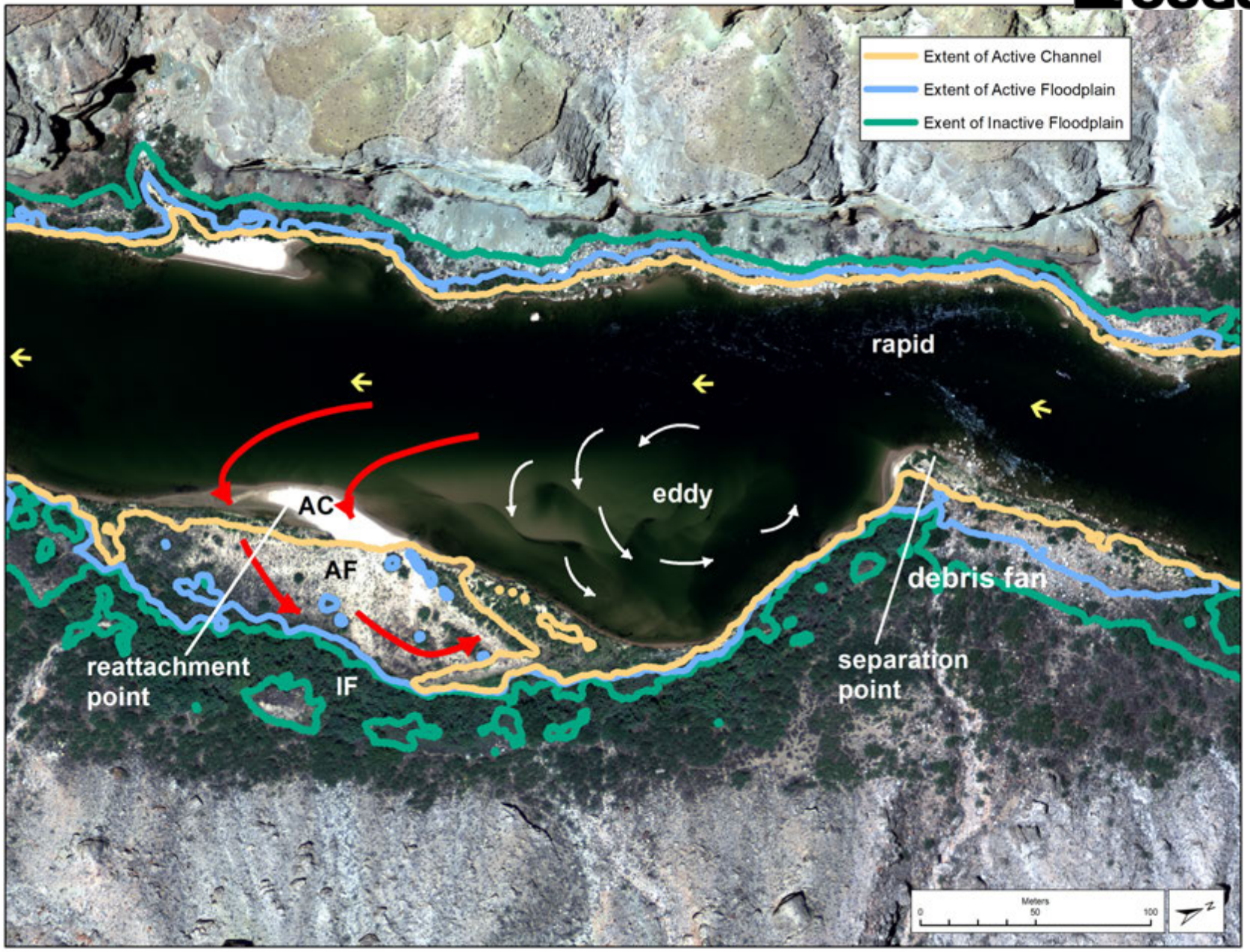
Butterfield *et al.*, In press, *River Research and Applications*

Geomorphic Position

Separation Zone

Central Zone

Reattachment Zone



Butterfield *et al.*, In press
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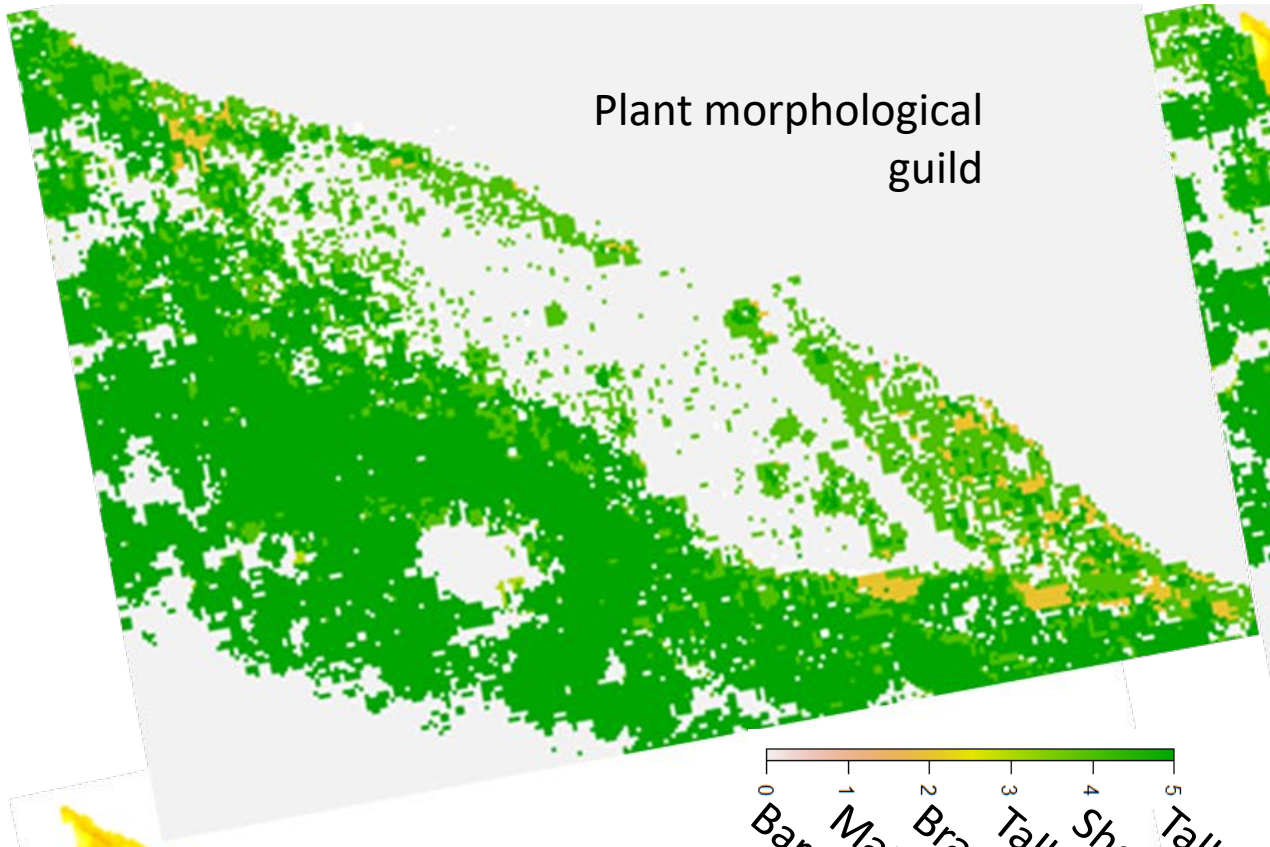

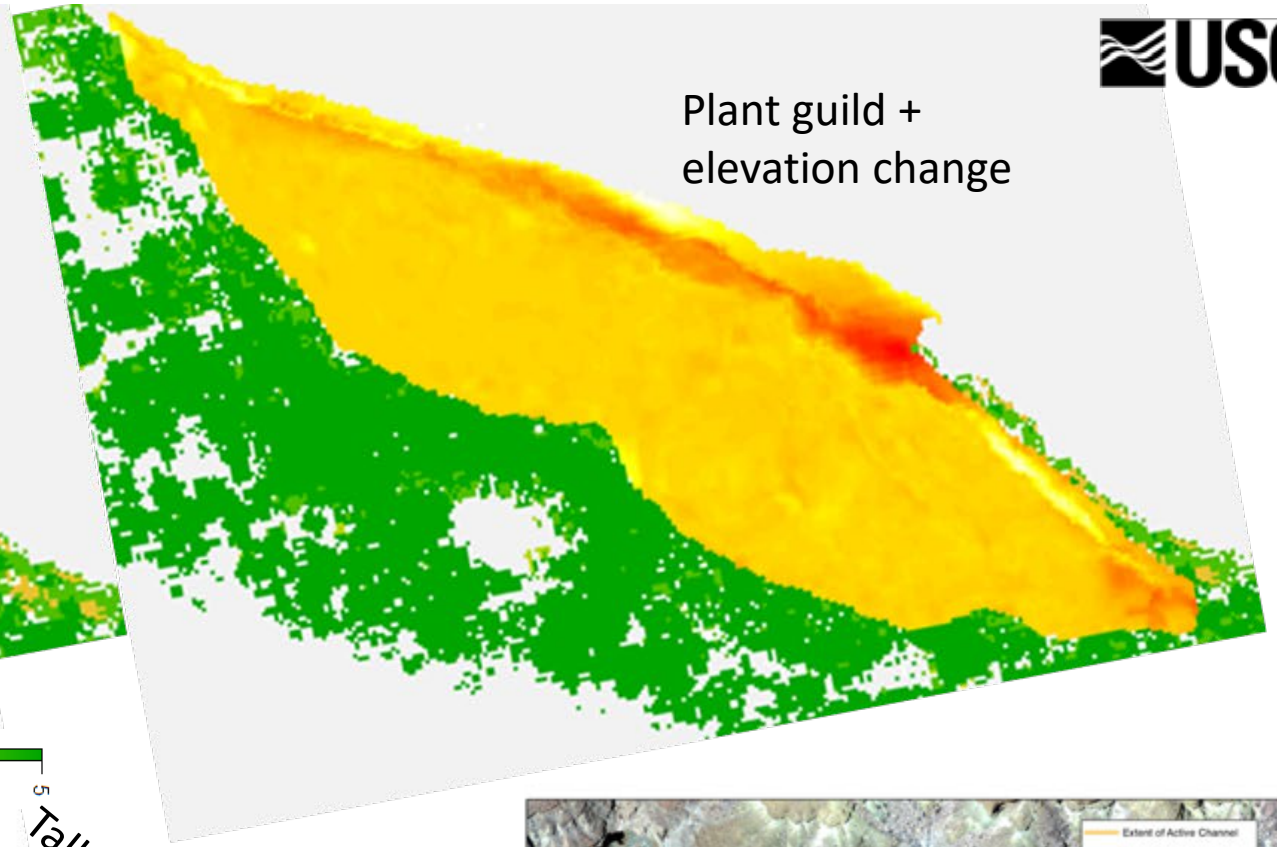

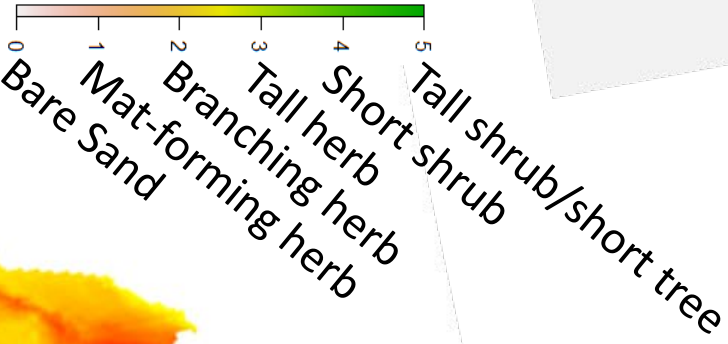

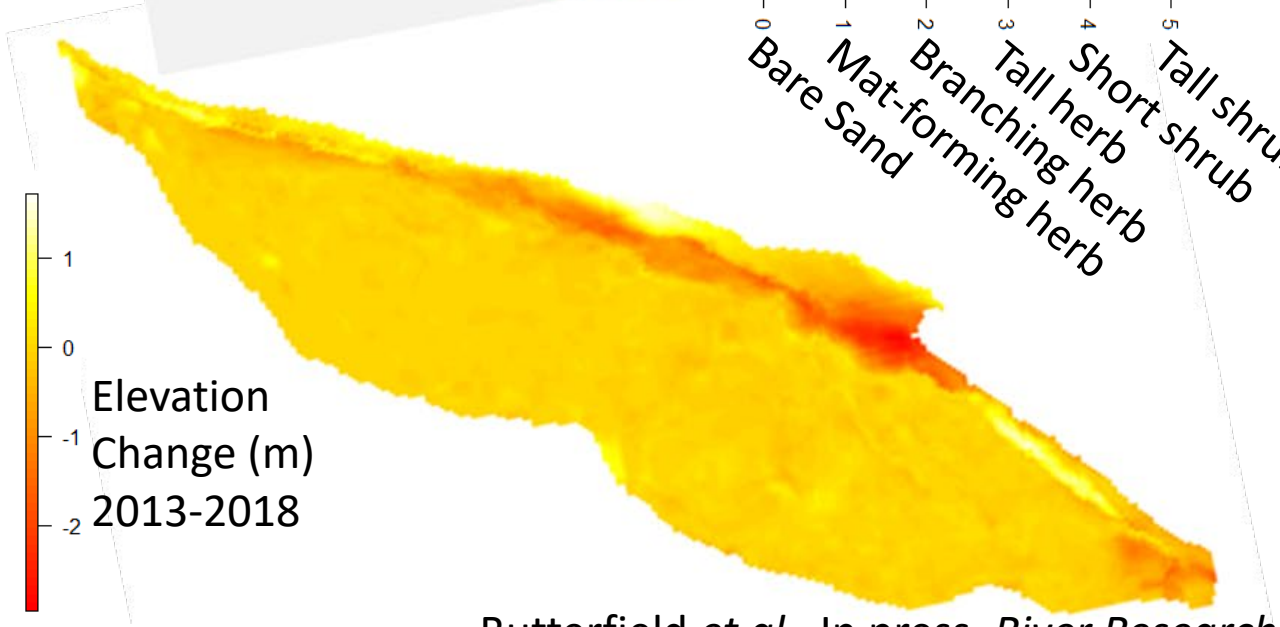

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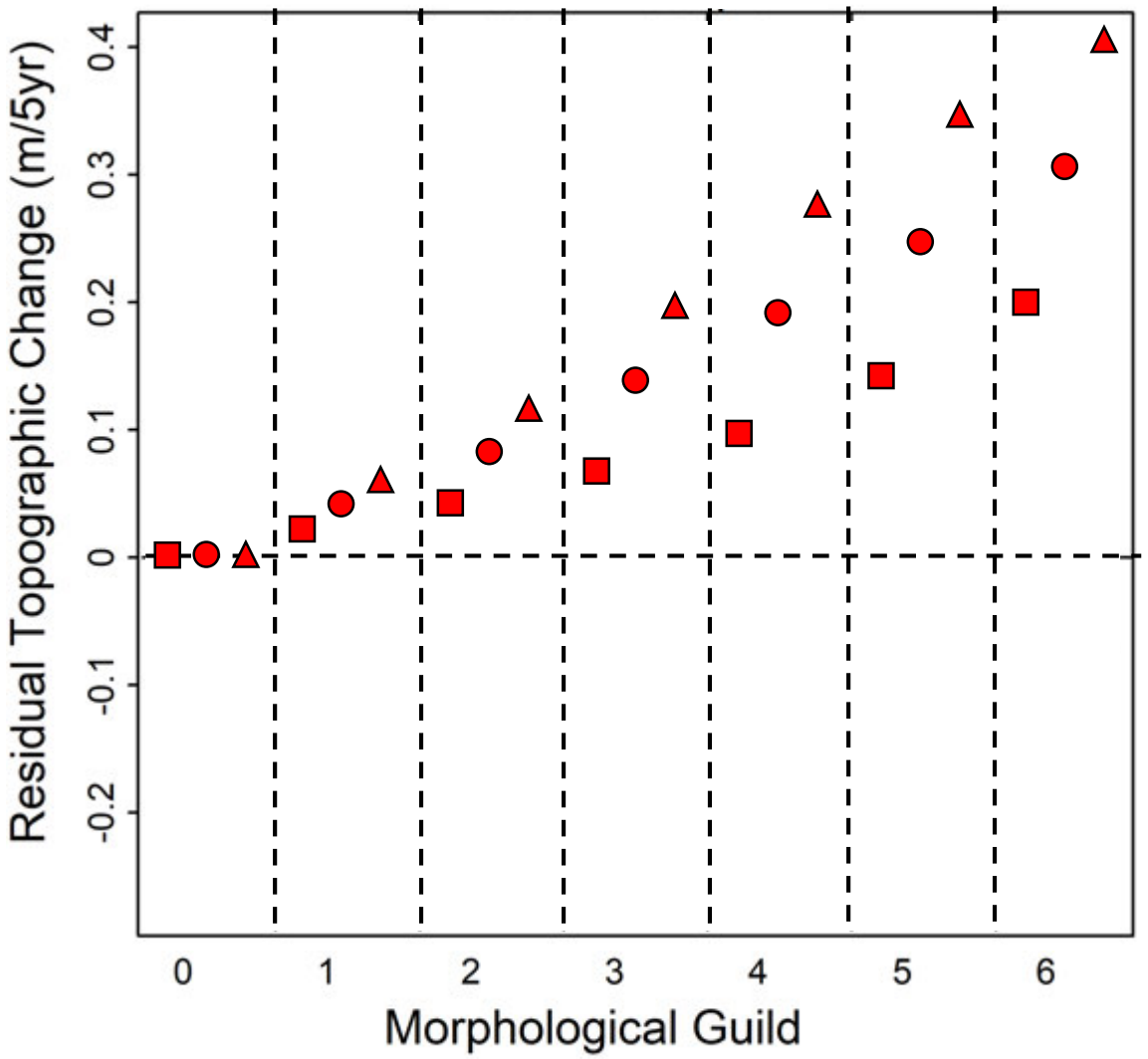
Vegetation Effects - Expectations



- Expected patterns
  - Increase in deposition (positive change) with increasing guild number (larger, more rigid)
  - Consistent interaction with geomorphic position

Geomorphic Position

■ Separation Zone
● Central Zone
▲ Reattachment Zone

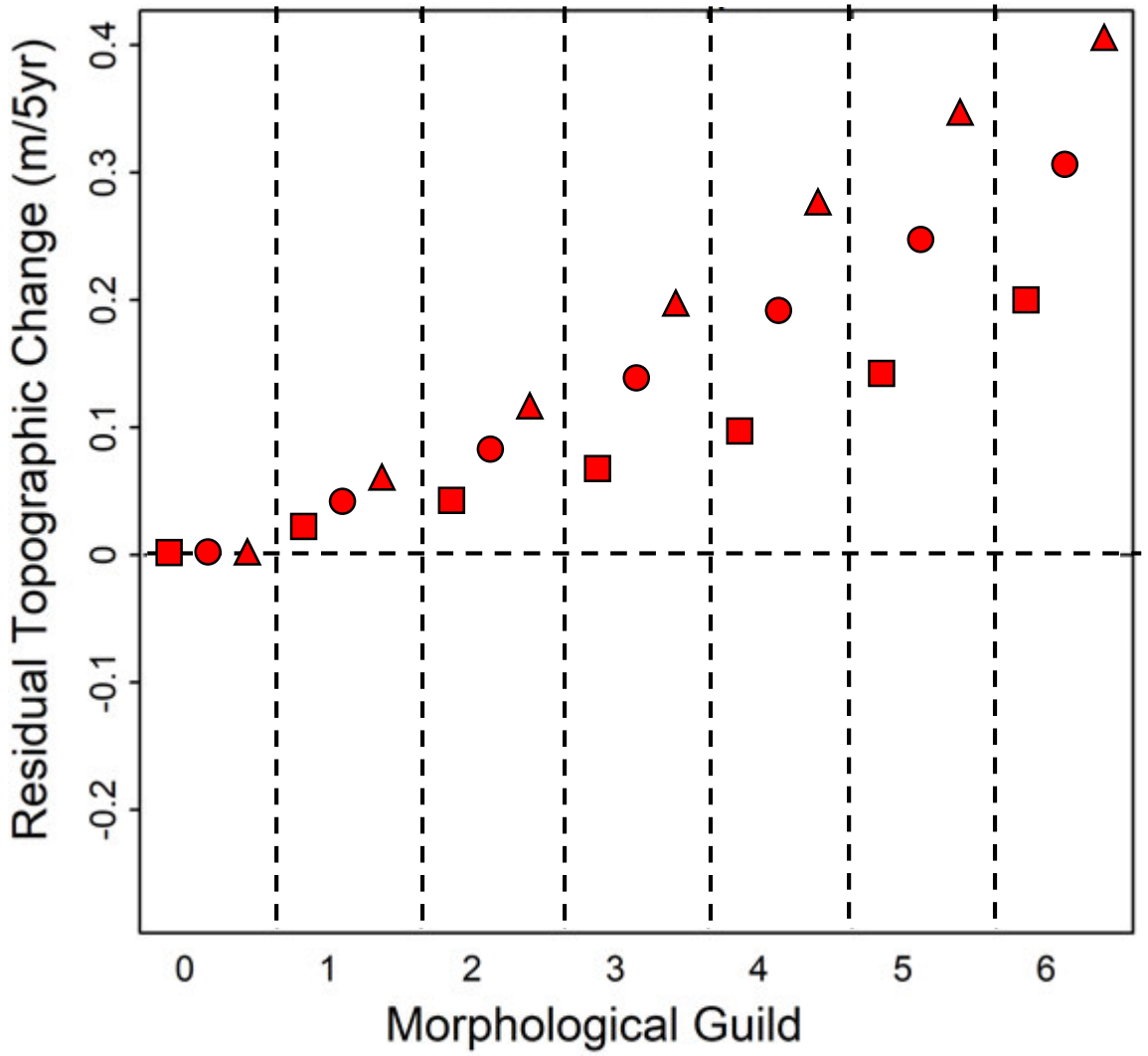
Butterfield *et al.*, In press, *River Research and Applications*

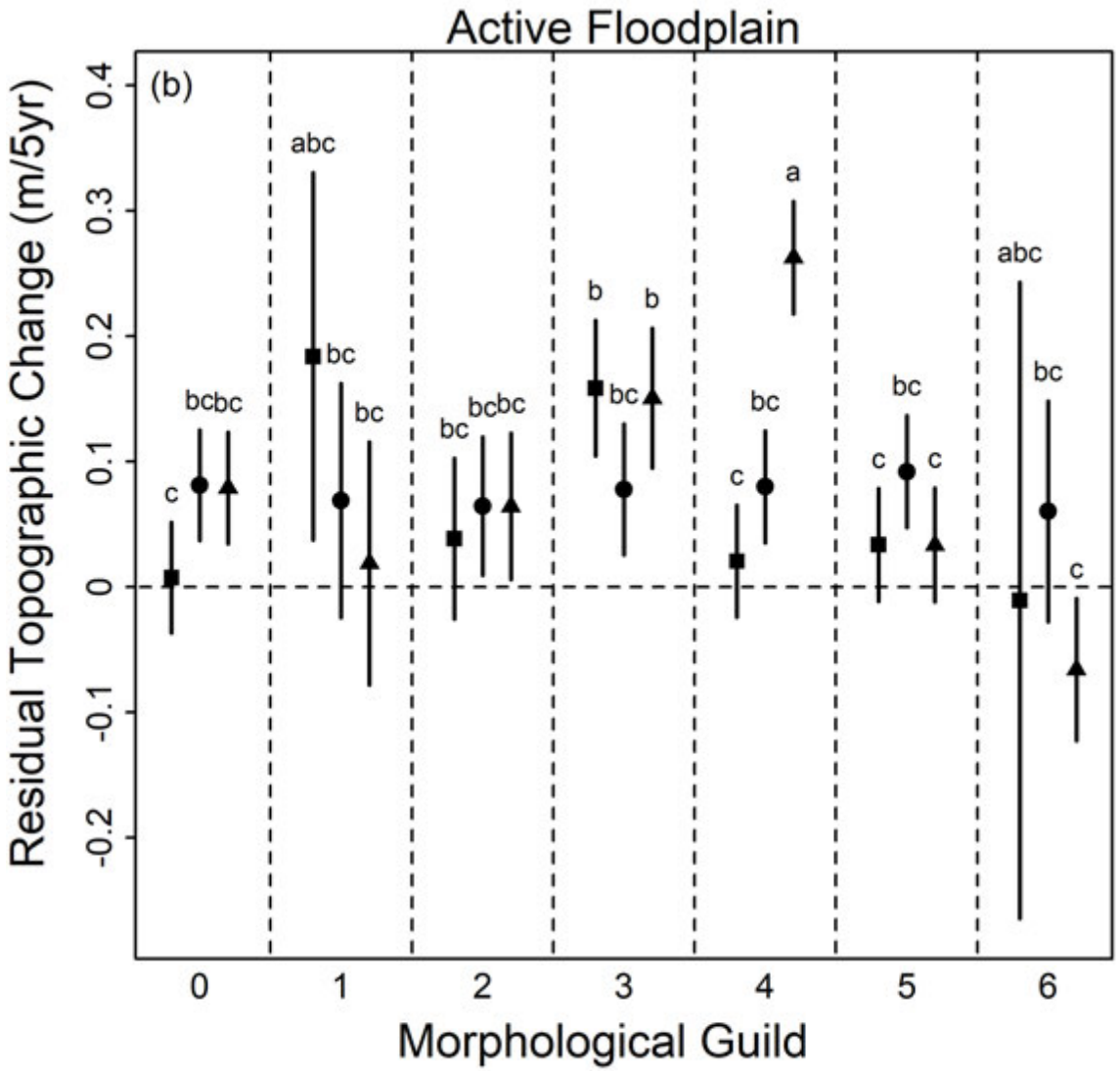
Butterfield *et al.*, In press, *River Research and Applications*

Vegetation Effects - Observed

Geomorphic Position

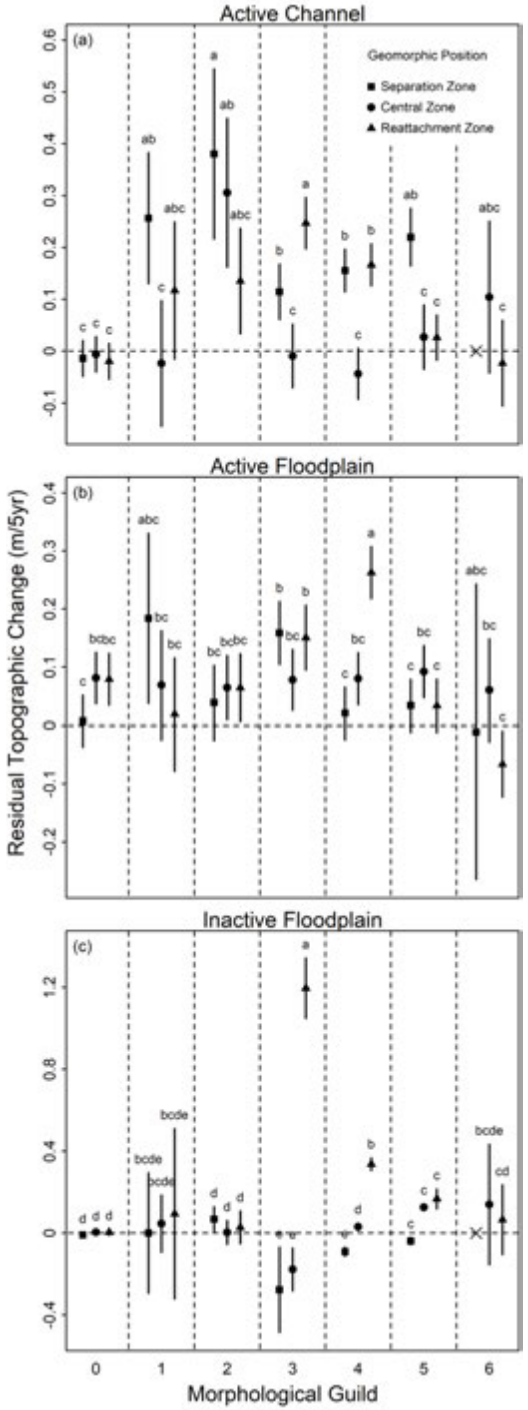
- ■ Separation Zone
- ● Central Zone
- ▲ Reattachment Zone





Vegetation Effects

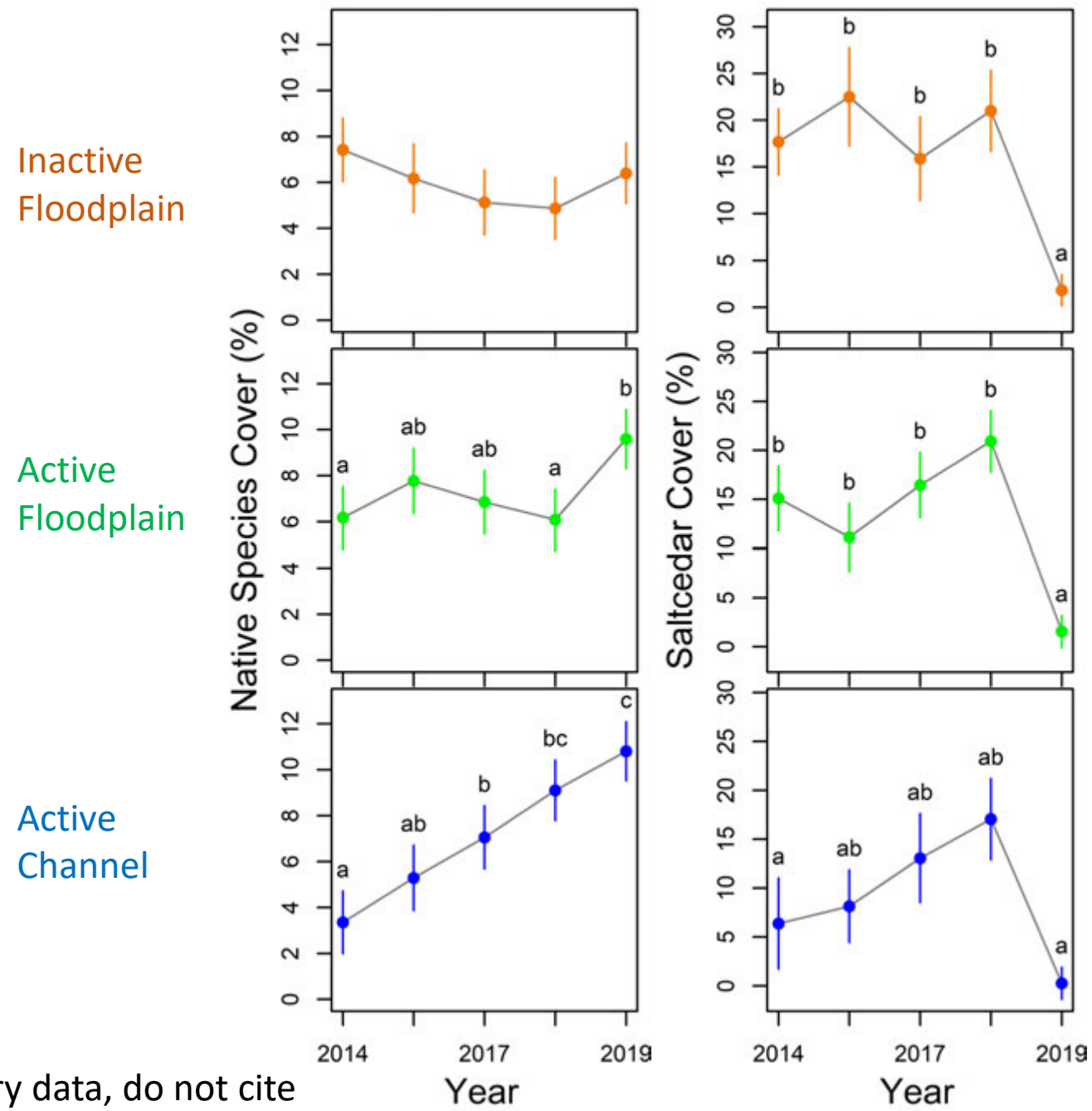
- Species effects depended on geomorphic position
- Low-statured, rhizomatous species captured sediment best in high-velocity areas (separation zone)
- Large shrubs captured sediment in low-velocity areas (reattachment zone)
- Identifies specific sediment impacts based on guild, hydrological zone, and geomorphic position that can be used to achieve sediment management targets



Butterfield *et al.*, In press, *River Research and Applications*

Project Element C.1. Ground-Based Vegetation Monitoring

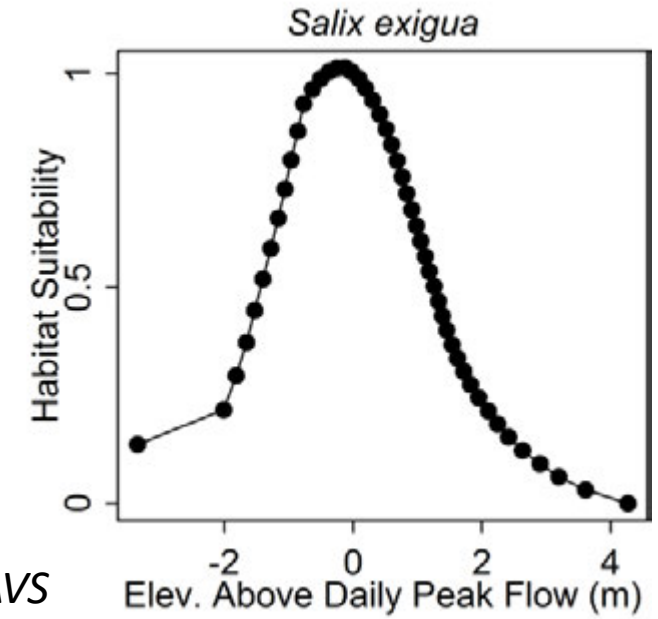
- >20,000 Plots surveyed since 2014
  - River-system-wide
  - NAU sandbars
- 5-year Status and Trends forthcoming
  - In case you missed yesterday's poster…



Preliminary data, do not cite

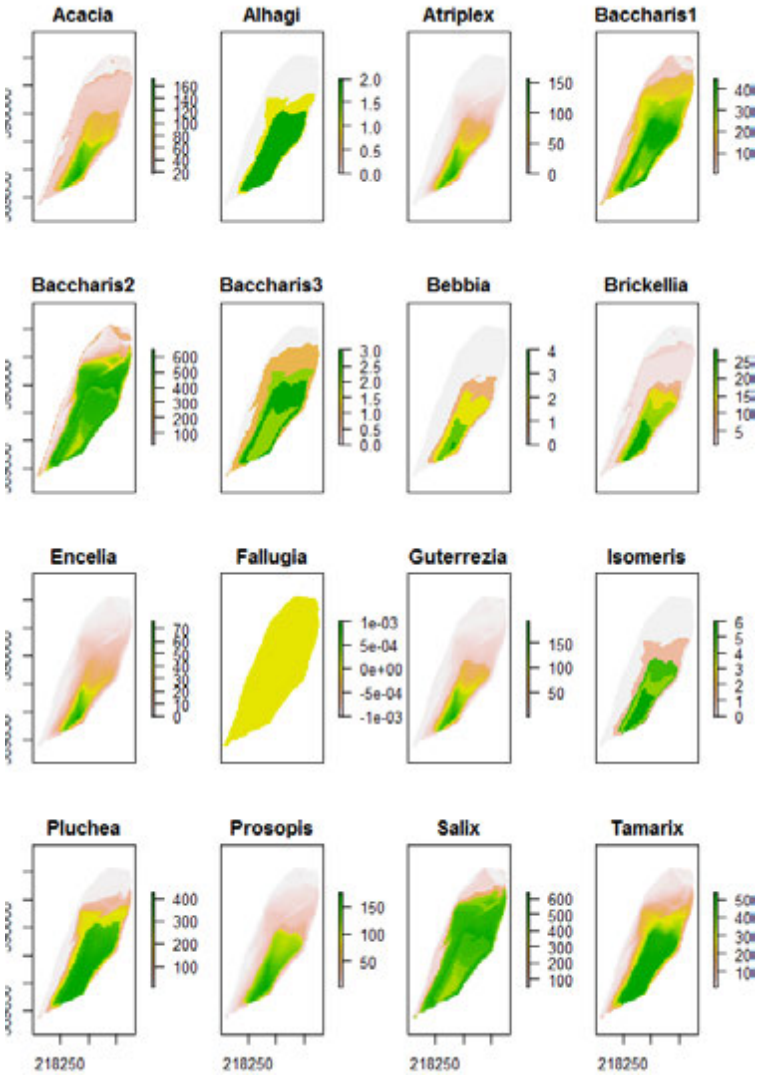
Project Element C.3. Vegetation Responses to LTEMP Flow Scenarios

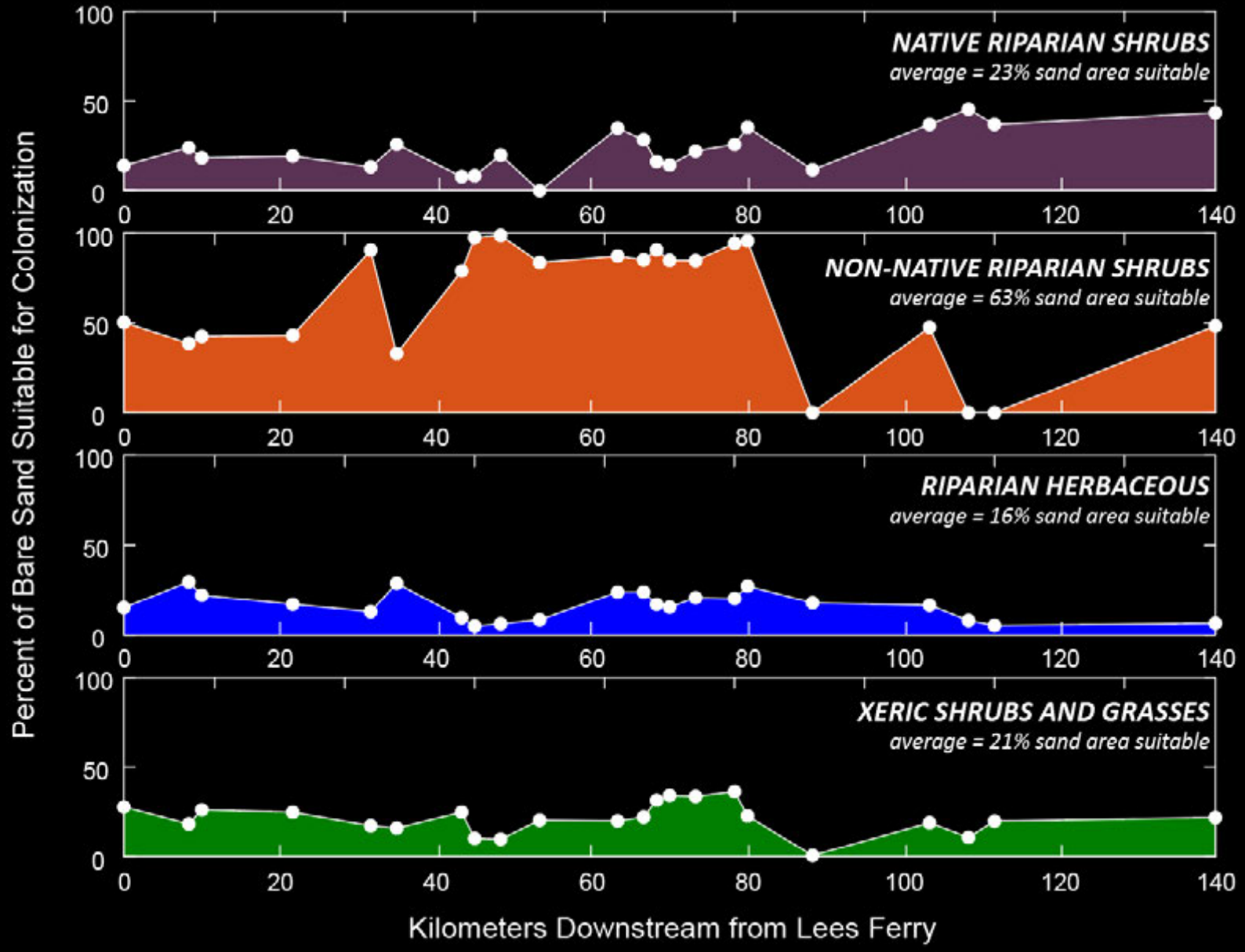
- Developed environmental niche models for common species
- First used to assess vegetation optima relative to current flow regimes
- Beginning to use these models to project habitat suitability in the future under different flow scenarios (Kasprak *et al.* In prep)



Butterfield *et al.* 2018 *AVS*

1991 at 51 Mile





NATIVE RIPARIAN SHRUBS

(e.g., baccharis, willow, mesquite)

NON-NATIVE RIPARIAN SHRUBS

(e.g., tamarisk)

RIPARIAN HERBS

(e.g., phragmites, Bermuda grass)

XERIC SHRUBS/GRASSES

(e.g., brittlebush, creosote, annual/perennial grasses)

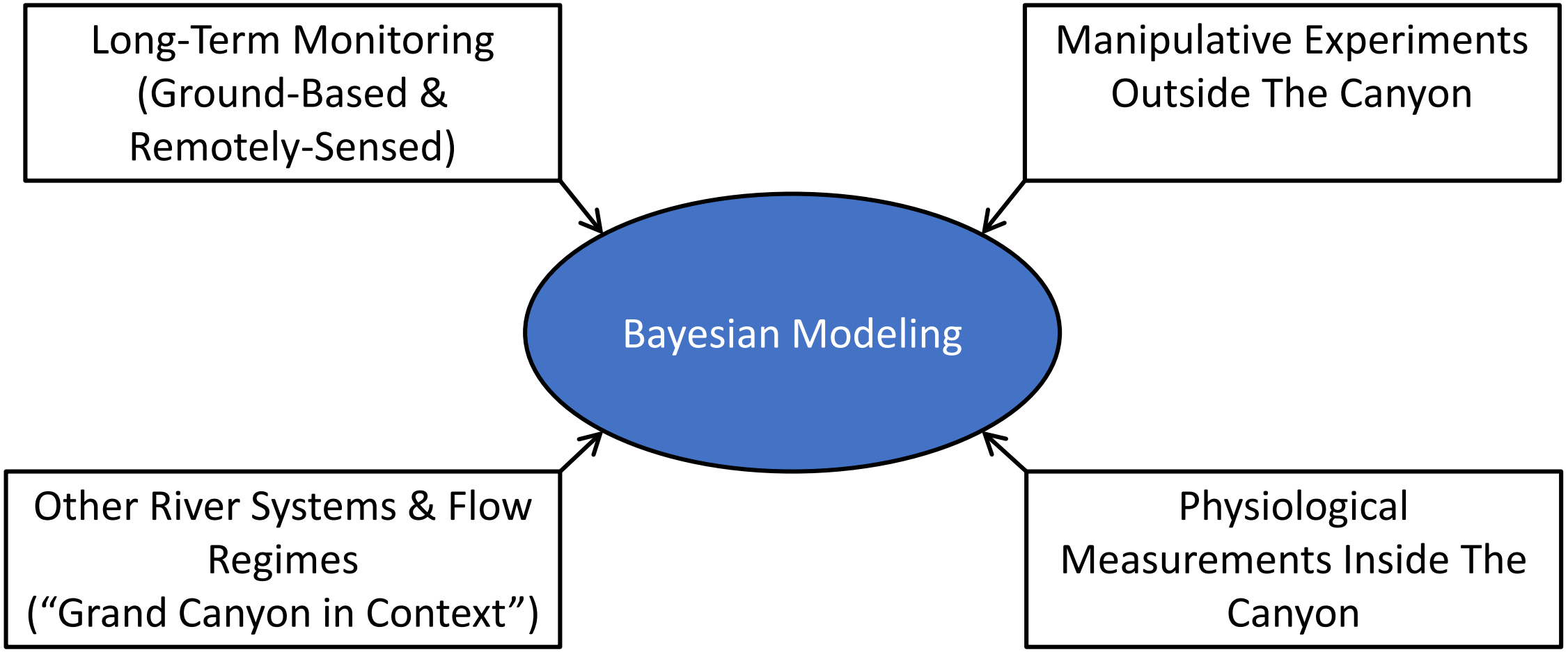
In many locations,

Vegetation is likely to colonize most of the remaining bare sand area

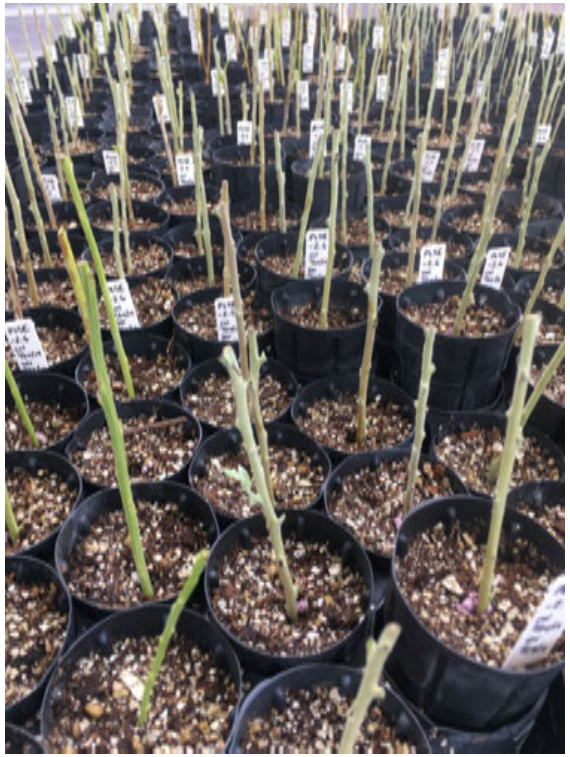
Kasprak *et al.* In prep

Preliminary data, do not cite

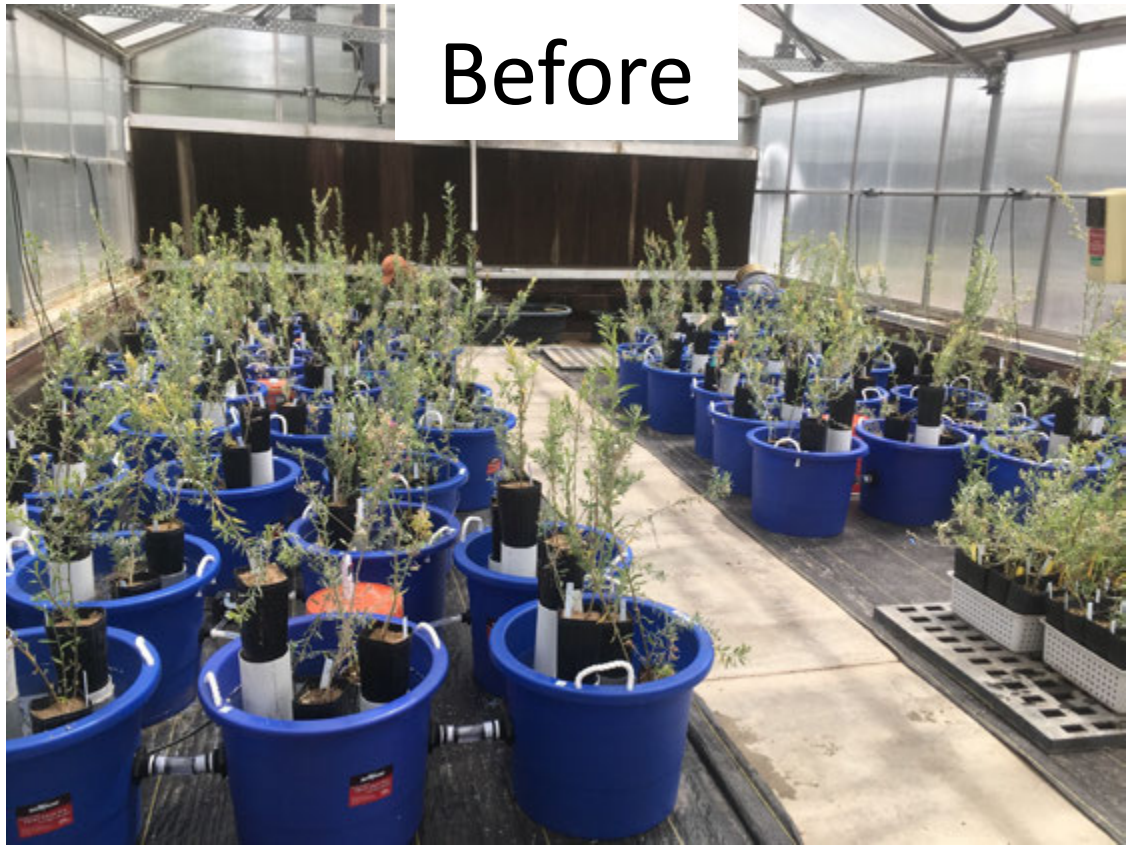
Approaches to Predicting Flow Responses

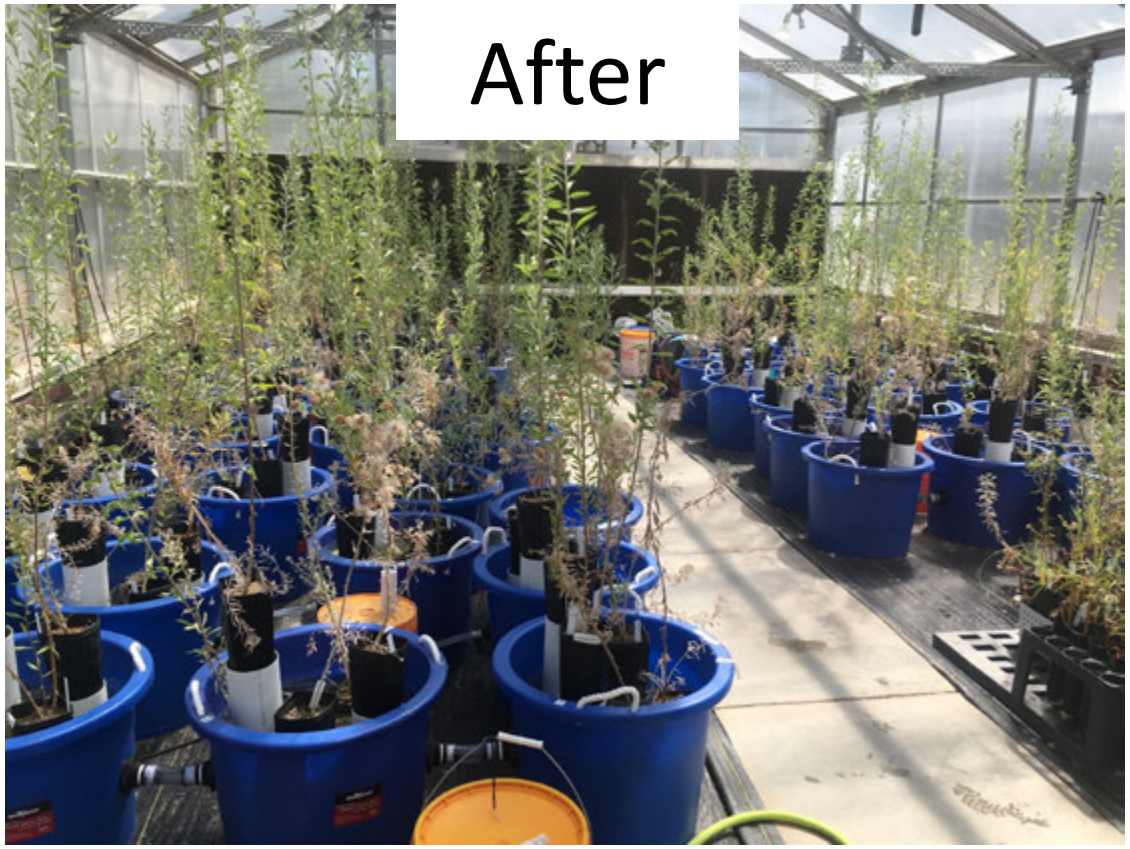


Manipulative Experiments Outside The Canyon



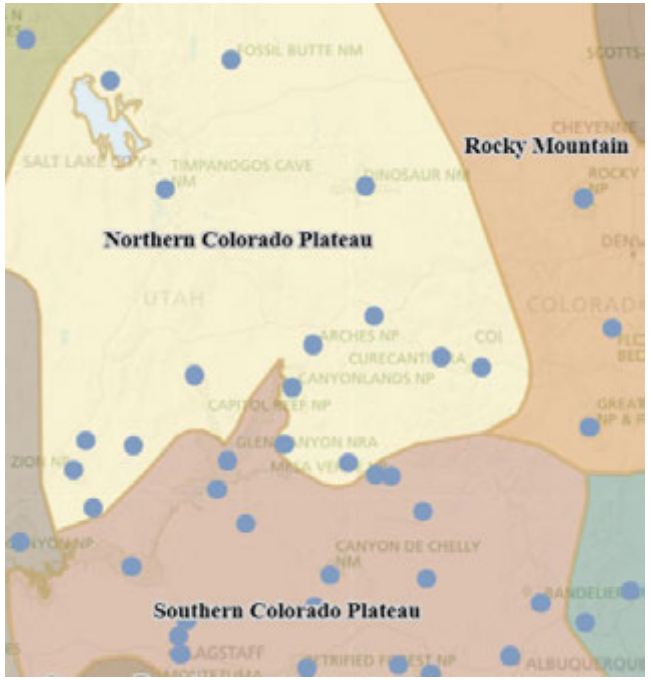
Manipulative Experiments Outside The Canyon, cont.





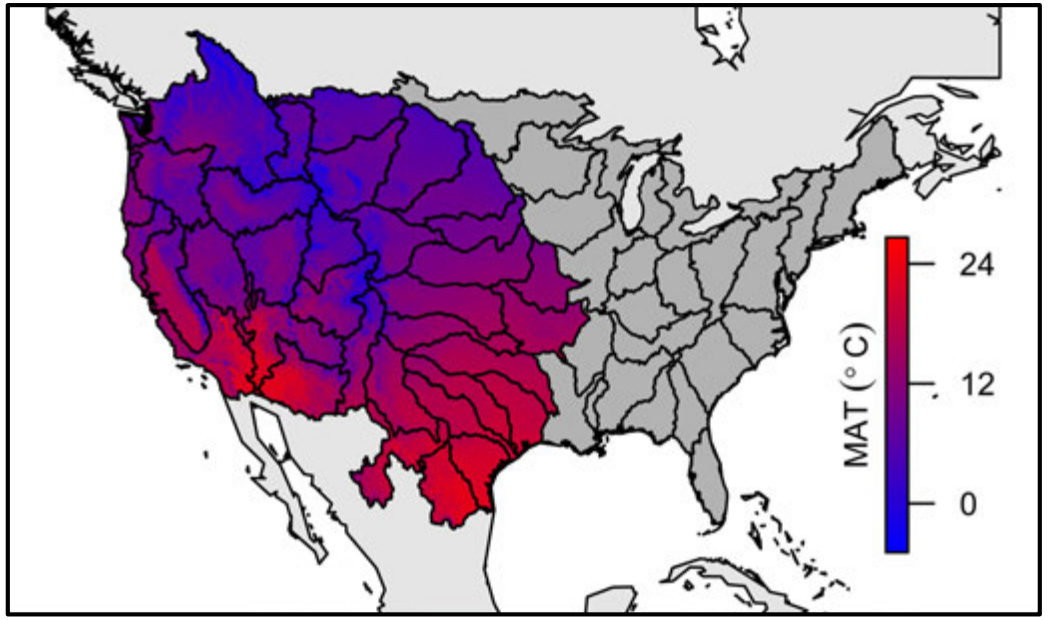
“Grand Canyon in Context”

- Monitoring data from other relevant river systems
  - NCPN
  - Big Rivers



- What flow regimes represent suitable conditions for species in Grand Canyon?

- Harnessing “big data” by merging extensive datasets
  - Georeferenced herbarium records
  - National Hydrography Database
  - Climate data
- Is Grand Canyon hot and dry for this species? Or cold and wet? How does that affect flow response?

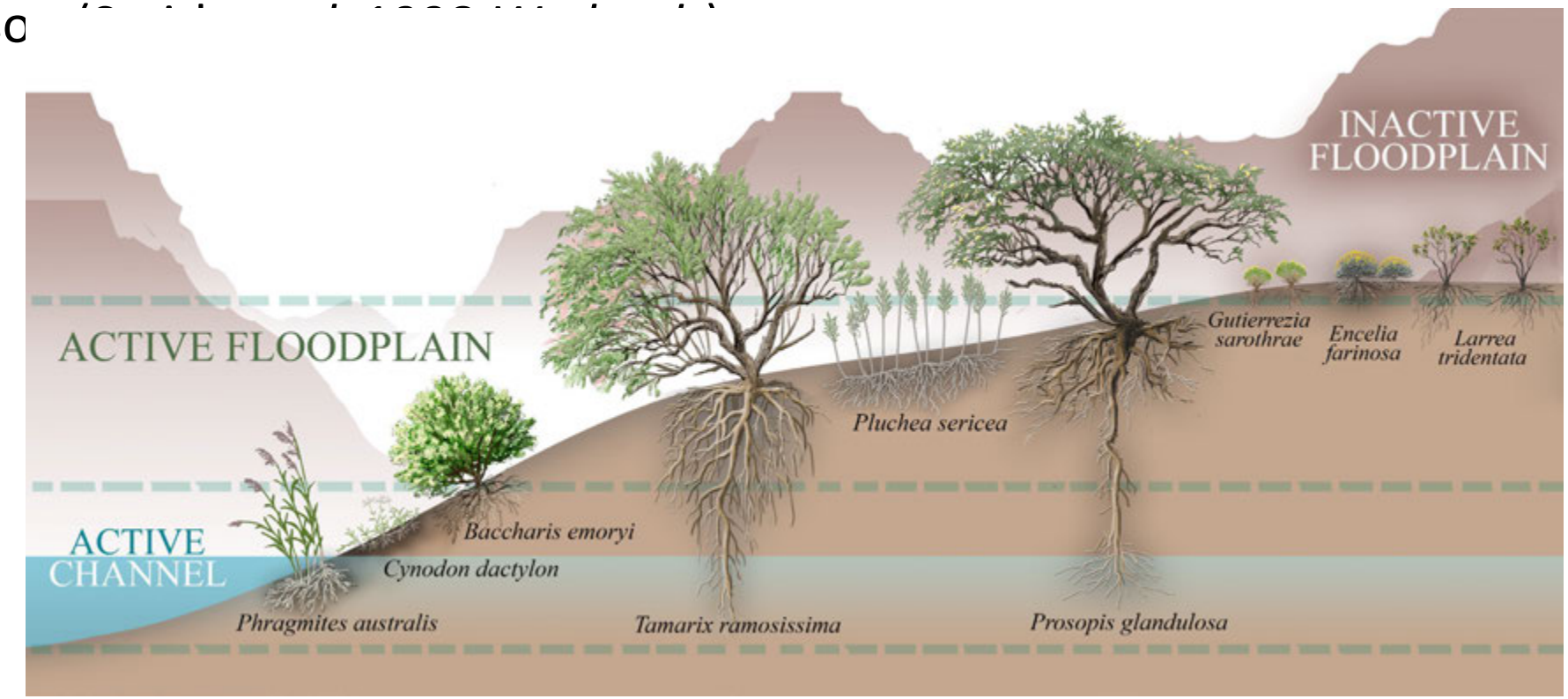


Preliminary data, do not cite

Butterfield, Palmquist and Hultine *In prep*

Physiological Measurements Inside The Canyon

- Water isotopes: Which species are using river water, and to what degree?
  - Different deuterium signatures in river water versus precipitation-derived moisture
  - Can vary with seaso
- Transpiration and photosynthesis
  - Seasonal timing of activity
  - Responses to changes in flow
    - Seasonal
    - Diurnal
    - HFEs



Butterfield *et al.,* In press, *River Research and Applications*

Approaches to Predicting Flow Responses, cont.