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

Prediction: Larger, more rigid plants will create more sand deposition.
Hydrological Zones

Butterfield et al., In press, River Research and Applications
Geomorphic Position

Separation Zone
Central Zone
Reattachment Zone

Butterfield *et al.*, In press
*River Research and Applications*
Elevation Change (m) 2013-2018

Plant morphological guild

Plant guild + elevation change

Butterfield et al., In press, River Research and Applications
Vegetation Effects - Expectations

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

Butterfield et al., In press, River Research and Applications
Vegetation Effects - Observed

Butterfield et al., In press, River Research and Applications
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Preliminary data, do not cite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
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

NATIVE RIPARIAN SHRUBS (e.g., baccharis, willow, mesquite)

NON-NATIVE RIPARIAN SHRUBS (e.g., phragmites, Bermuda grass)

RIPARIAN HERBS (e.g., tamarisk)

XERIC SHRUBS/GRASSES (e.g., brittlebush, creosote, annual/perennial grasses)
Approaches to Predicting Flow Responses

- Long-Term Monitoring (Ground-Based & Remotely-Sensed)
- Manipulative Experiments Outside The Canyon
- Other River Systems & Flow Regimes ("Grand Canyon in Context")
- Physiological Measurements Inside The Canyon

Bayesian Modeling
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 season (Smith et al., 1998 Wetlands)

• 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.

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Bayesian Modeling