Riparian vegetation monitoring and research in the Colorado River Ecosystem

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science for a changing world

Project Team

- Ground-based monitoring and research
  - Emily Palmquist - GCMRC
  - Sarah Sterner - GCMRC
  - Barb Ralston - GCMRC
  - David Merritt - USFS
  - Patrick Shafroth - USFS
  - Tom Kolb - NAU
  - Miles McCoy-Sulentic - NAU
- Remote-sensing monitoring and research
  - Joel Sankey - GCMRC
  - Laura Durning - NAU
  - Ash Benford - NAU
  - Temuulen Sankey - NAU

Project 11, Elements 1-2

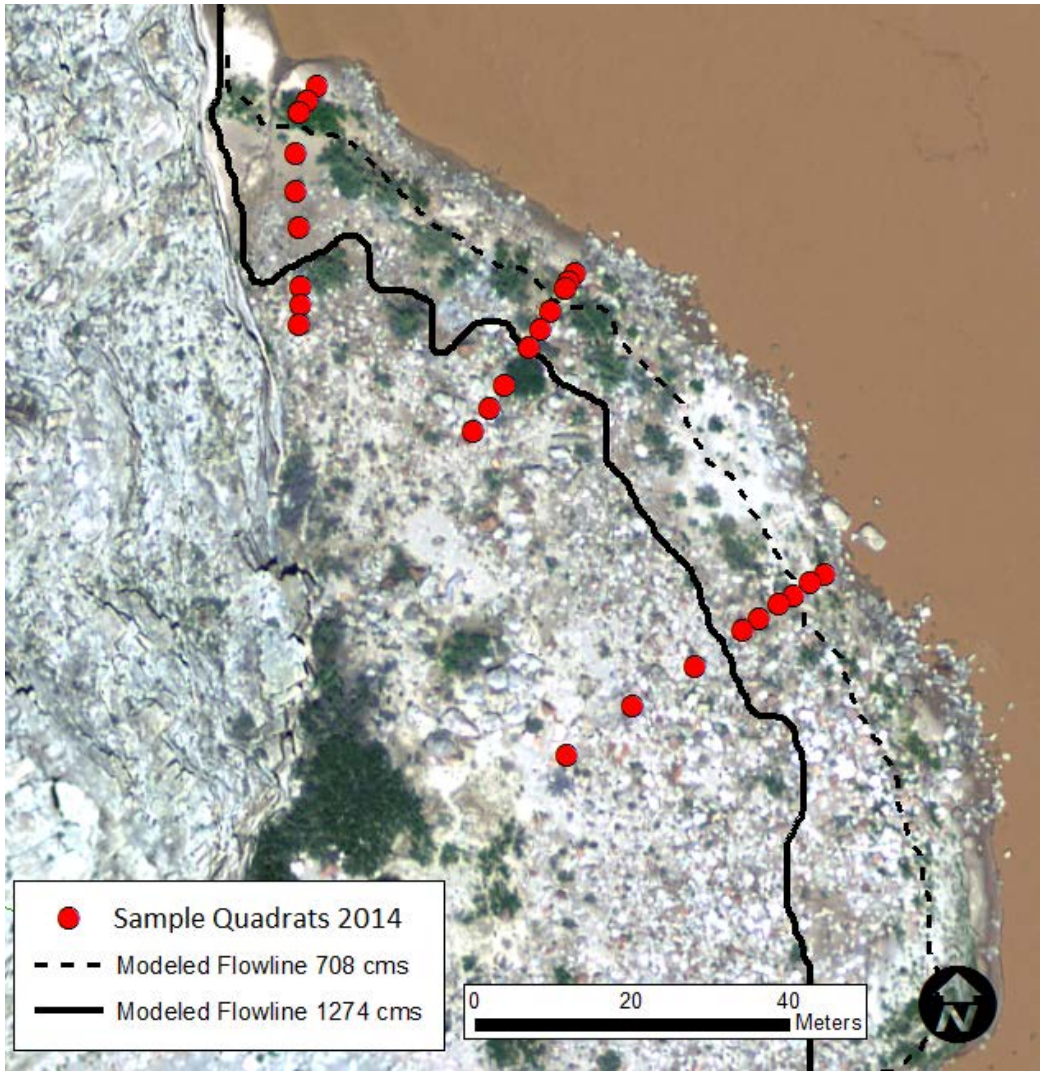
- 11.1 – Ground-based vegetation monitoring
- 11.2 – Periodic landscape scale vegetation mapping and analysis using remotely sensed data
- Other elements in Project 11
  - 11.3 – Influence of sediment and vegetation feedbacks on sandbars
    - Resumed in 2018 following loss of Daniel Sarr
  - 11.4 – Terrestrial-aquatic linkages
    - Poster by Christina Lupoli
  - 11.5 – Science review panel of vegetation control
    - Covered in previous ARM, OFR published in 2017 (Ralston and Sarr)

Study Objectives

- Monitor status and trends of vegetation, in particular
  - Ratio of native-to-nonnative species, including impact of tamarisk beetle
  - Plant cover and species diversity
  - Variation along different river segments
- Determine vegetation responses to hydrological variation, including
  - Composition of vegetation and identification of flow-response guilds
  - Underlying drivers of flow-response guilds
  - Broad-scale variation in vegetation composition through classification of remotely sensed data

Methods – Status & Trends and Modeling

- Ground-based sampling
  - Fixed sites – NAU sandbars
  - Random sites – sandbars, debris fans and channel margins



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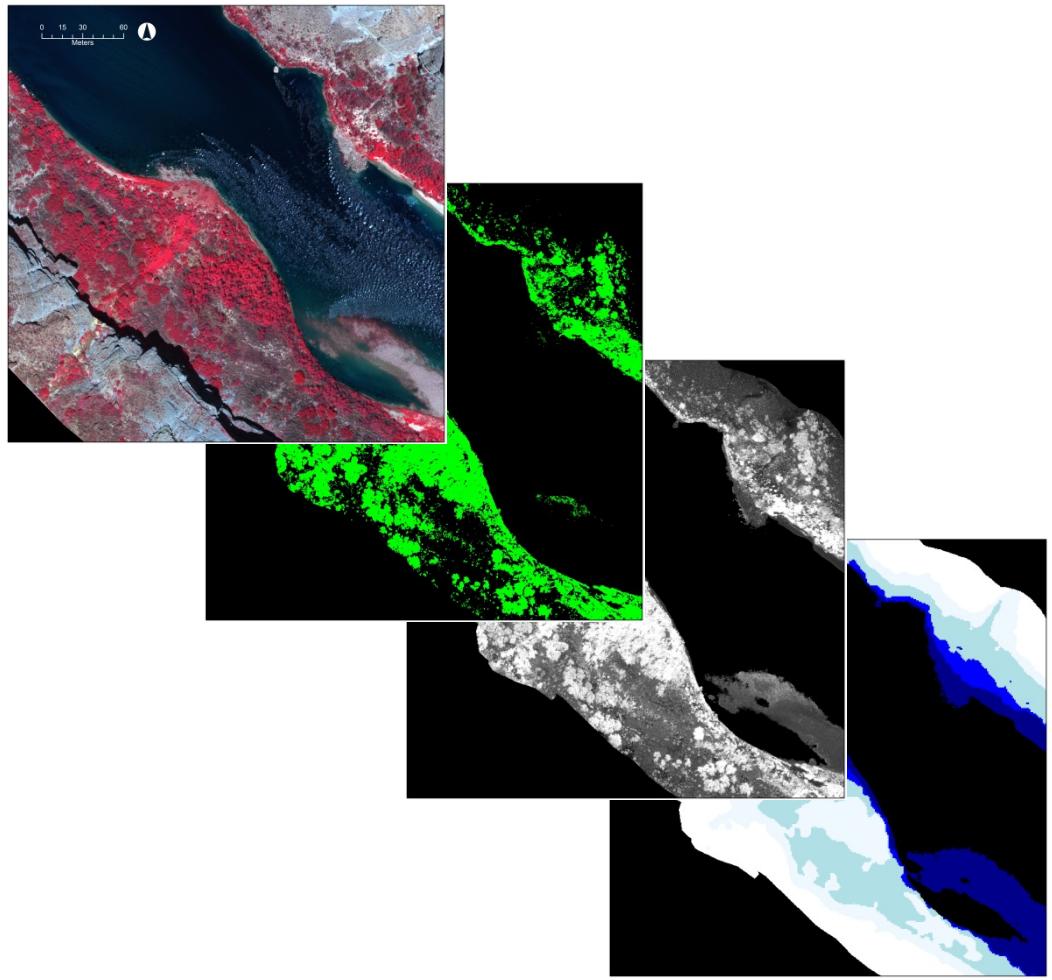
- Remotely-sensed data
  - Process and classify 2013 imagery
  - Special focus on tamarisk 2009 vs. 2013



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- Remotely-sensed data
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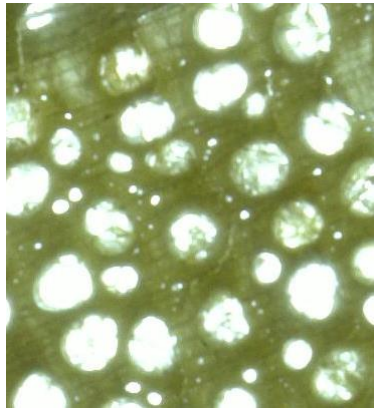
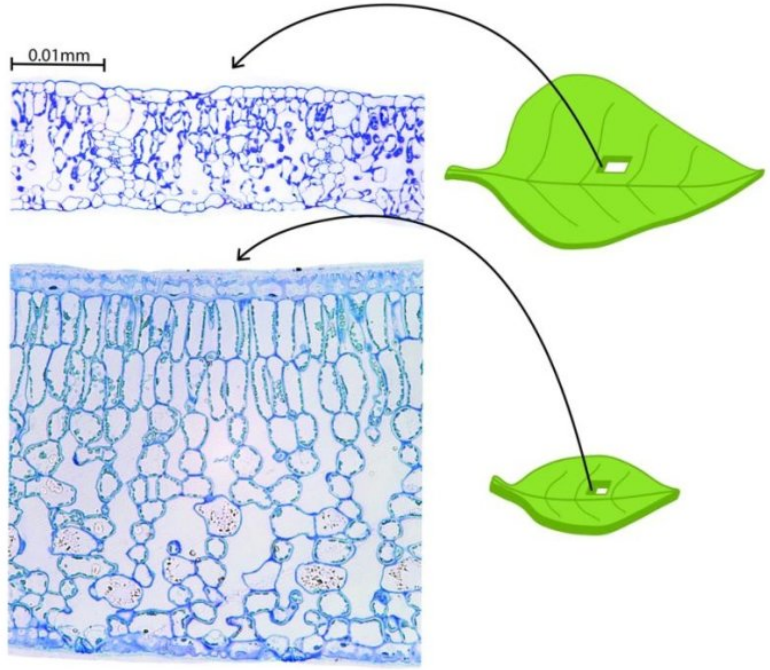
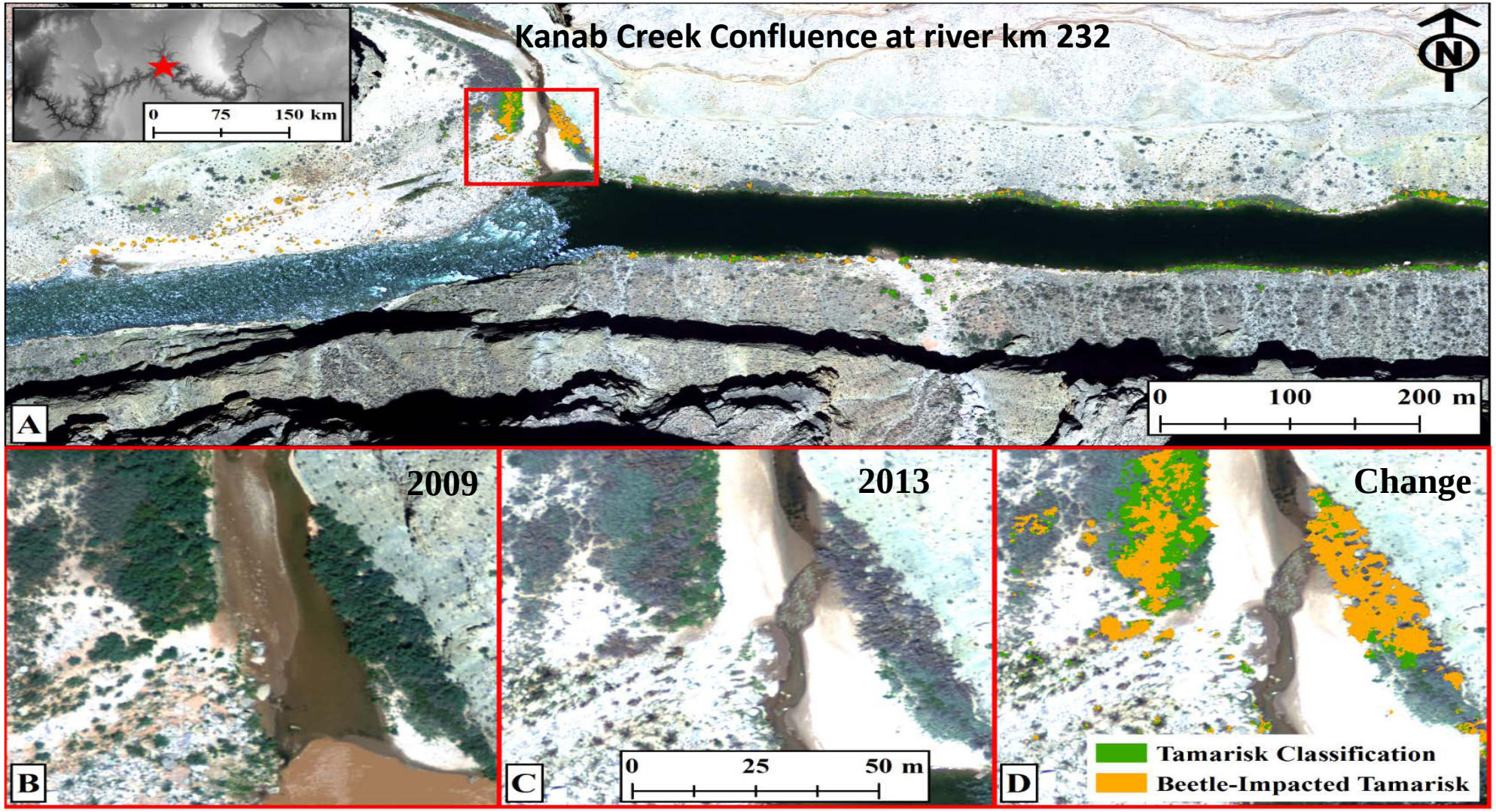
  - Special focus on tamarisk 2009 vs. 2013
- Functional trait measurements
  - Influence hydrological responses
  - Field measurements (funded by WaterSMART) and literature
  - Identify flow response guilds





Results – Beetle Impacts on Tamarisk

Bedford et al. (2018) *Ecological Indicators*



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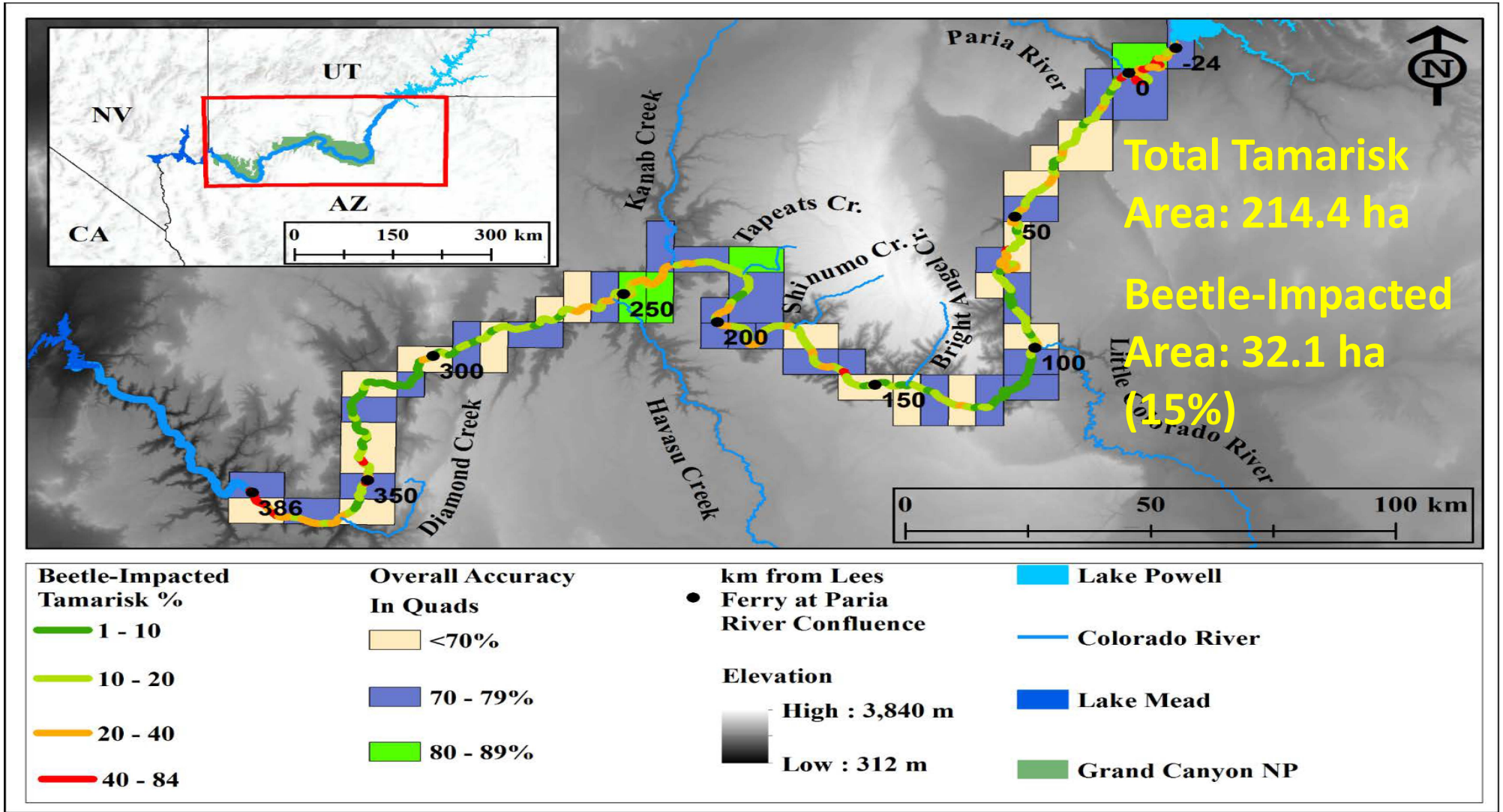
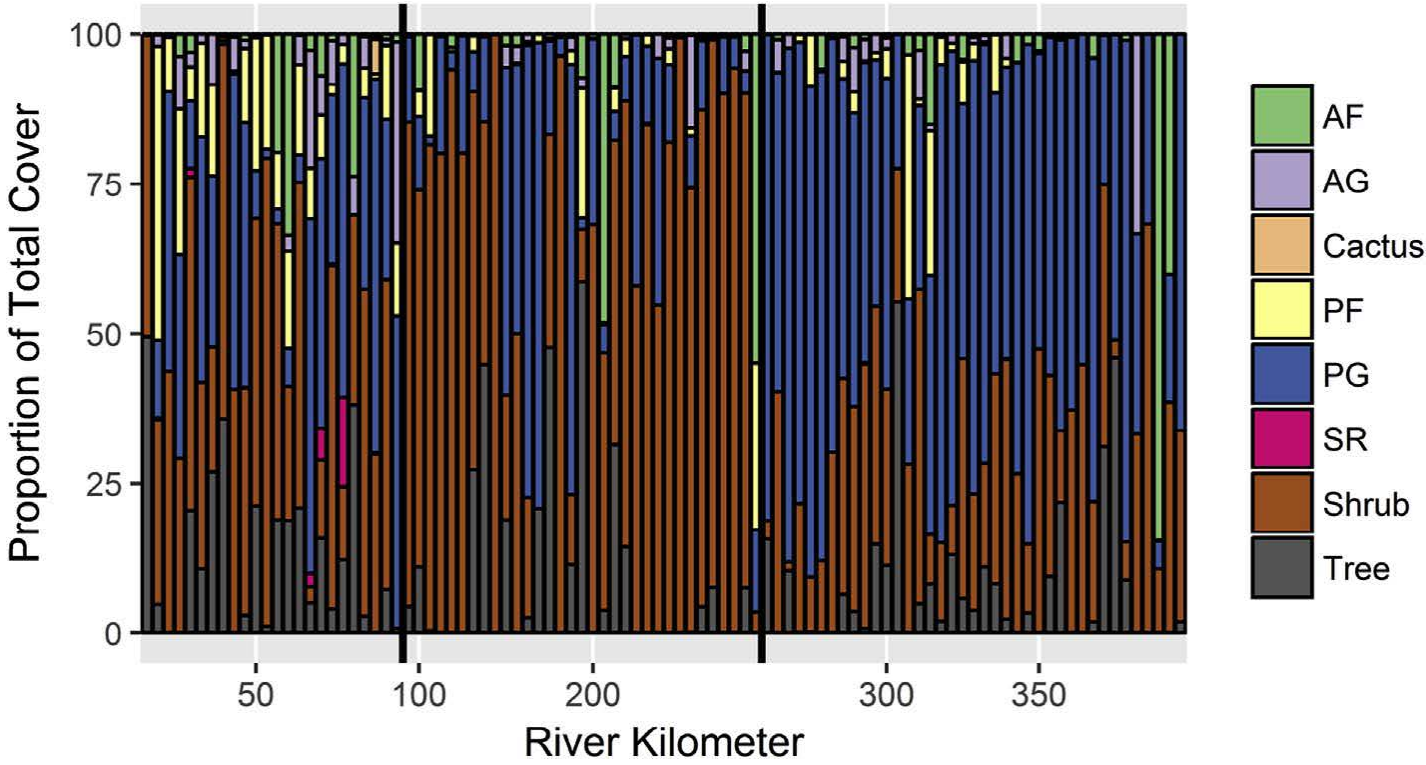


Results – Vegetation Responses

- Marble Canyon is more floristically rich than rest of canyon
- Segments vary in floristic composition and may respond differentially to operations
- Climatic variation along river influences hydrological responses (Butterfield et al., In review)
- Please see poster by Sarah Sterner for additional results

<u>Variation in Proportional Cover by Plant Functional Group</u>

Palmquist *et al.* 2017 *Journal of Arid Environments*

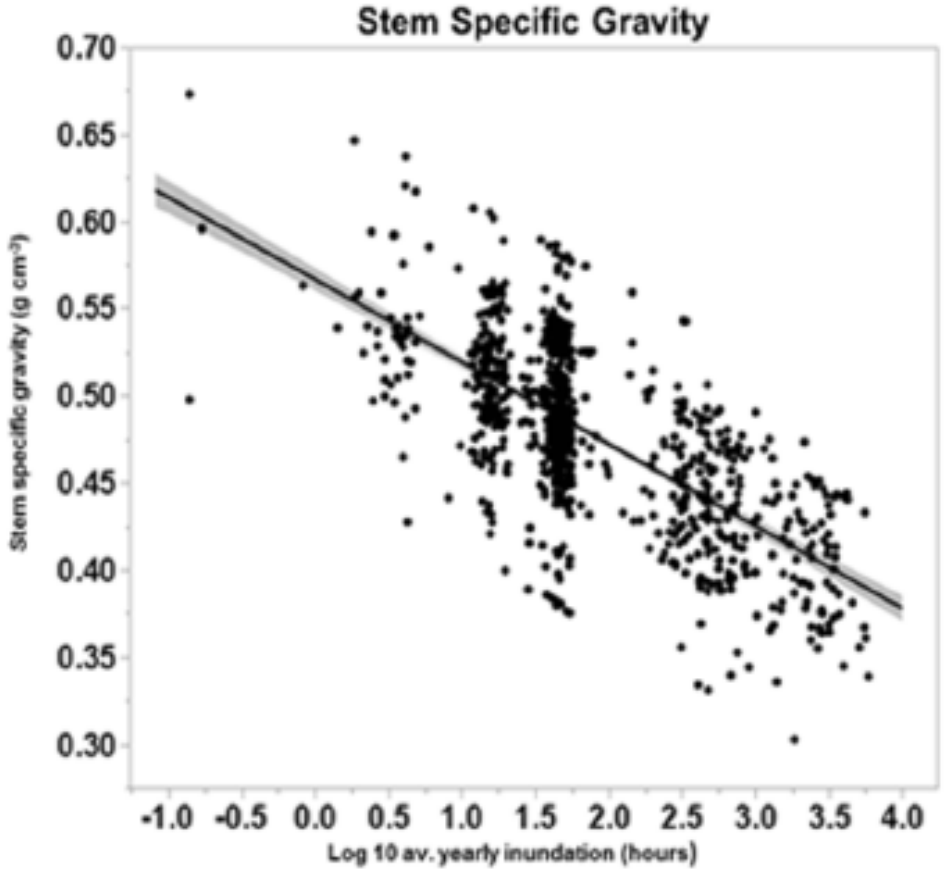


Results –Traits and Guilds

- Reveal underlying physiological and life-history factors that determine plant responses to dam operations
- Used to identify 16 flow-response guilds (Merritt *et al.*, In prep) from 104 species
- Flow-response guilds will help to simplify modeling responses to dam operations

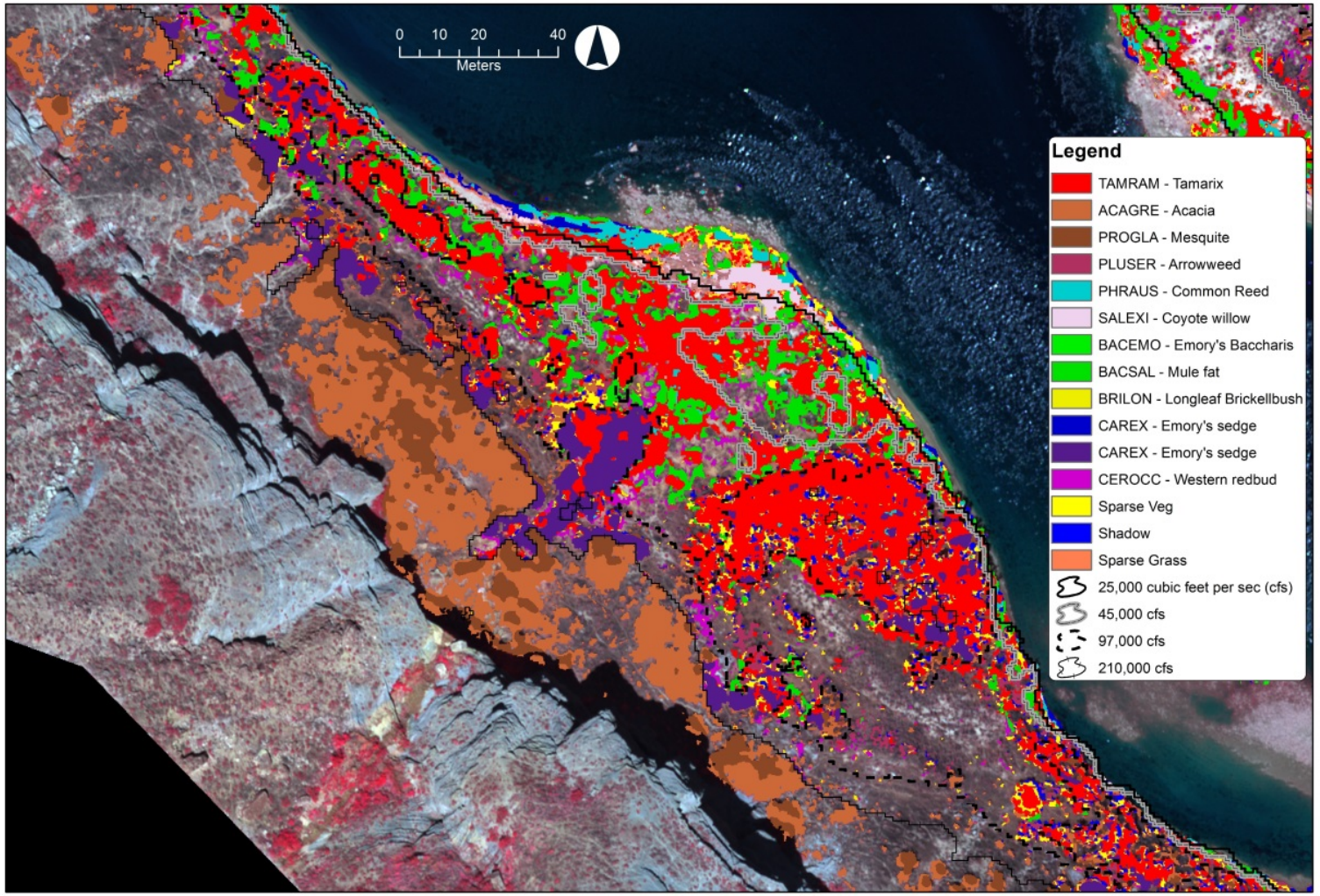
<u>Example of trait response to inundation</u>

McCoy-Sulentic *et al.* 2017 *Wetlands*



Results – Remote Sensing Classification

- Please see poster by Laura Durning
- Classification results overlap nicely with guild delineations
- Will facilitate future integration between remotely-sensed and ground-based monitoring and modeling

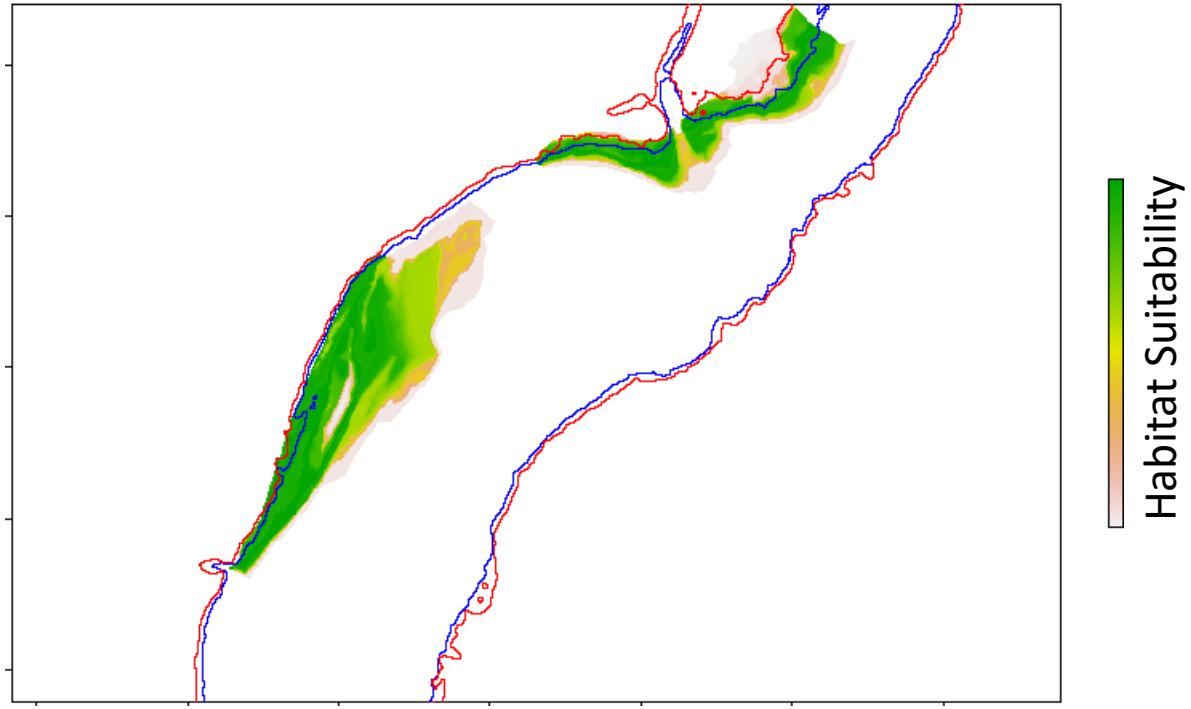


Durning *et al.*, In prep

Results - Integration

- Data and models at varying resolution and extent
  - Remotely sensed classifications
  - Guilds
  - Species-specific models e.g. ⇨
- Can tailor analyses to specific resource questions

Modeled Habitat Suitability for Seepwillow (*Baccharis emoryi*) at Buck Farm



Butterfield *et al.*, Unpublished data

Conclusions and Future Research

- Beetle impacts are extensive but highly variable
  - Somewhat associated with tributaries
  - Future areas of inquiry:
    - Genetic variation in susceptibility
    - Environmental drivers

Conclusions and Future Research

- Beetle impacts are extensive but highly variable
- Vegetation composition is distinctly different among river segments
  - What are the environmental drivers of these differences?
  - How does this impact responses to dam operations?

Conclusions and Future Research

- Beetle impacts are extensive but highly variable
- Vegetation composition is distinctly different among river segments
- Physiological tradeoffs underlie responses to hydrological variation
  - Closer to mechanistic understanding of vegetation responses
  - Planned experiments using external funding to better understand responses to hydrology and climate, and underlying genetic basis

Conclusions and Future Research

- Beetle impacts are extensive but highly variable
- Vegetation composition is distinctly different among river segments
- Physiological tradeoffs underlie responses to hydrological variation
- Remotely-sensed classifications align well with flow-response guilds
  - This will allow us to extrapolate results from ground-based monitoring to broader extents

2017 Publications

- Bedford *et al.* (2018) Remote sensing of tamarisk beetle (*Diorhabda carinulata*) impacts along 412 km of the Colorado River in the Grand Canyon, Arizona, USA. *Ecological Indicators*, 89:365-375
- Bedford *et al.* (2018) Remote sensing derived maps of tamarisk (2009) and beetle impacts (2013) along 412 km of the Colorado River in the Grand Canyon. USGS data release, Arizona, USA, 10.5066/F72B8X71
- Palmquist *et al.* (2017) Landscape-scale processes influence riparian plant composition along a regulated river. *Journal of Arid Environments*, 148:54-64.
- Palmquist *et al.* (2017) Functional traits and ecological affinities of riparian plants along the Colorado River in Grand Canyon. *Western North American Naturalist*, 77:22-30.
- McCoy-Sulentic *et al.* (2017) Variation in species-level plant functional traits over wetland indicator status categories. *Ecology and Evolution*, doi: 10.1002/ece3.2975.
- McCoy-Sulentic *et al.* (2017) Change in community-level riparian plant traits over inundation gradients, Colorado River, Grand Canyon. *Wetlands*, doi: 10.1007/s13157-017-0895-3.
- Ralston and Sarr (2017) Case studies of riparian and watershed restoration in the Southwestern United States – principles, challenges, and successes. OFR 2017-1091.
- Ralston *et al.* (2017) Taxonomic and compositional differences in ground-dwelling arthropods in riparian habitats in Glen Canyon, Arizona, USA. *Western North American Naturalist*, 77:369-384.