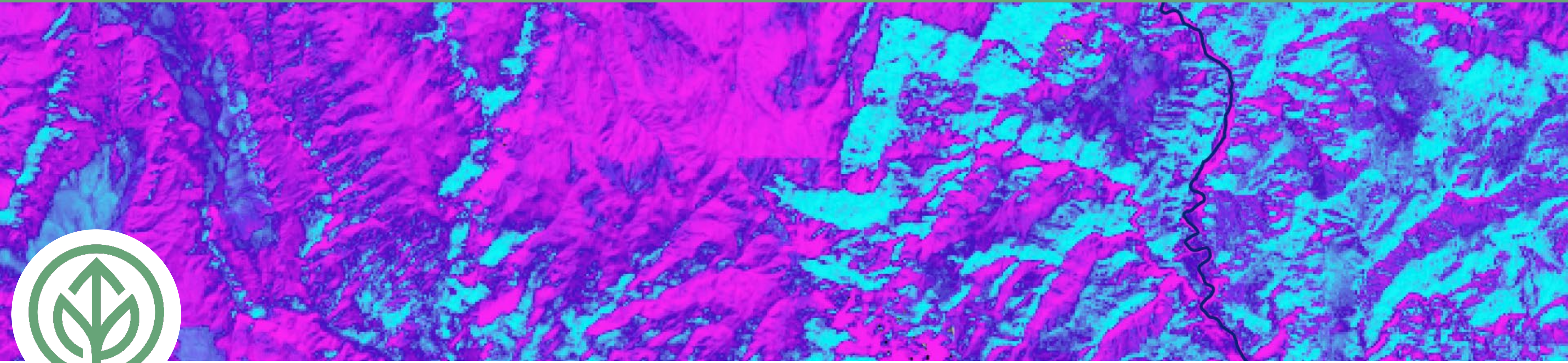
National Aeronautics and Space Administration



Paria River Ecological Conservation

Mapping Russian Olive and Tamarisk to Inform Invasive Species Management along the Paria River, Utah

Max VanArnam • Wesley Rancher • Annie Kowalski • Truman Anarella

25TH DEVELOP ANNIVERSARY

Background – Paria River

- Headwaters in Dixie National Forest and Bryce Canyon National Park
- Major tributary of the Colorado River on Utah/Arizona border
- Main source of sediment for the Grand Canyon
- Passes directly through Grand Staircase-Escalante National Monument (GSENM; est. 1996)
    - 940+ species of vegetation w/in GSENM

Image Credit: USGS

Background – *Tamarix ramosissima*

- Originally from Eurasia, brought to the United States for erosion control
- Increases soil salinity and decreases the water table
- Second most common woody riparian species in the western United States

Image Credit: USDA APHIS Archives

Background – *Elaeagnus augustifolia*

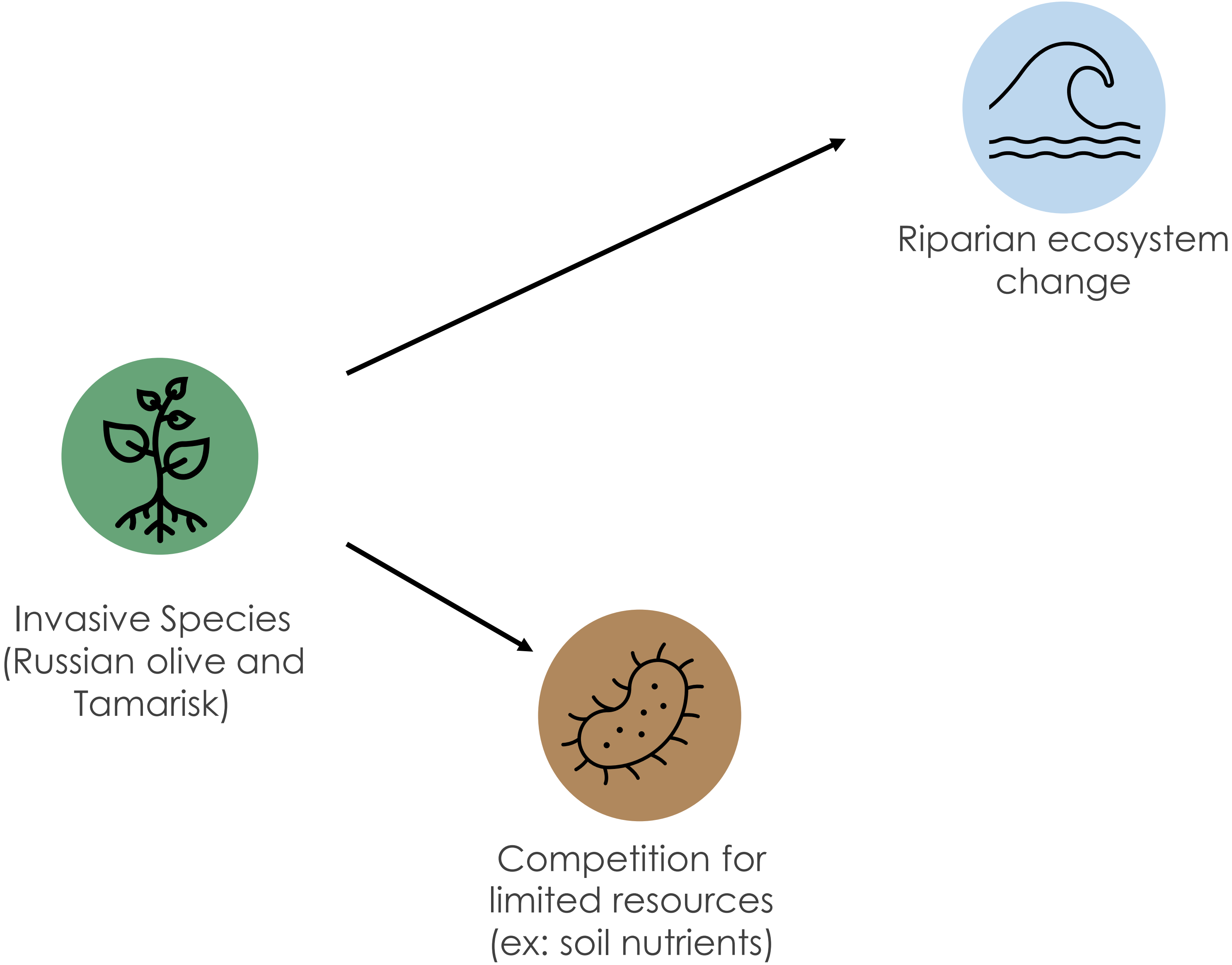
- Originally from Eurasia, brought to the United States for erosion and wind management
- Forms dense stands and easily crowds out native species
- Fourth most common woody riparian species in the western United States

Image Credit: Janna Kruse

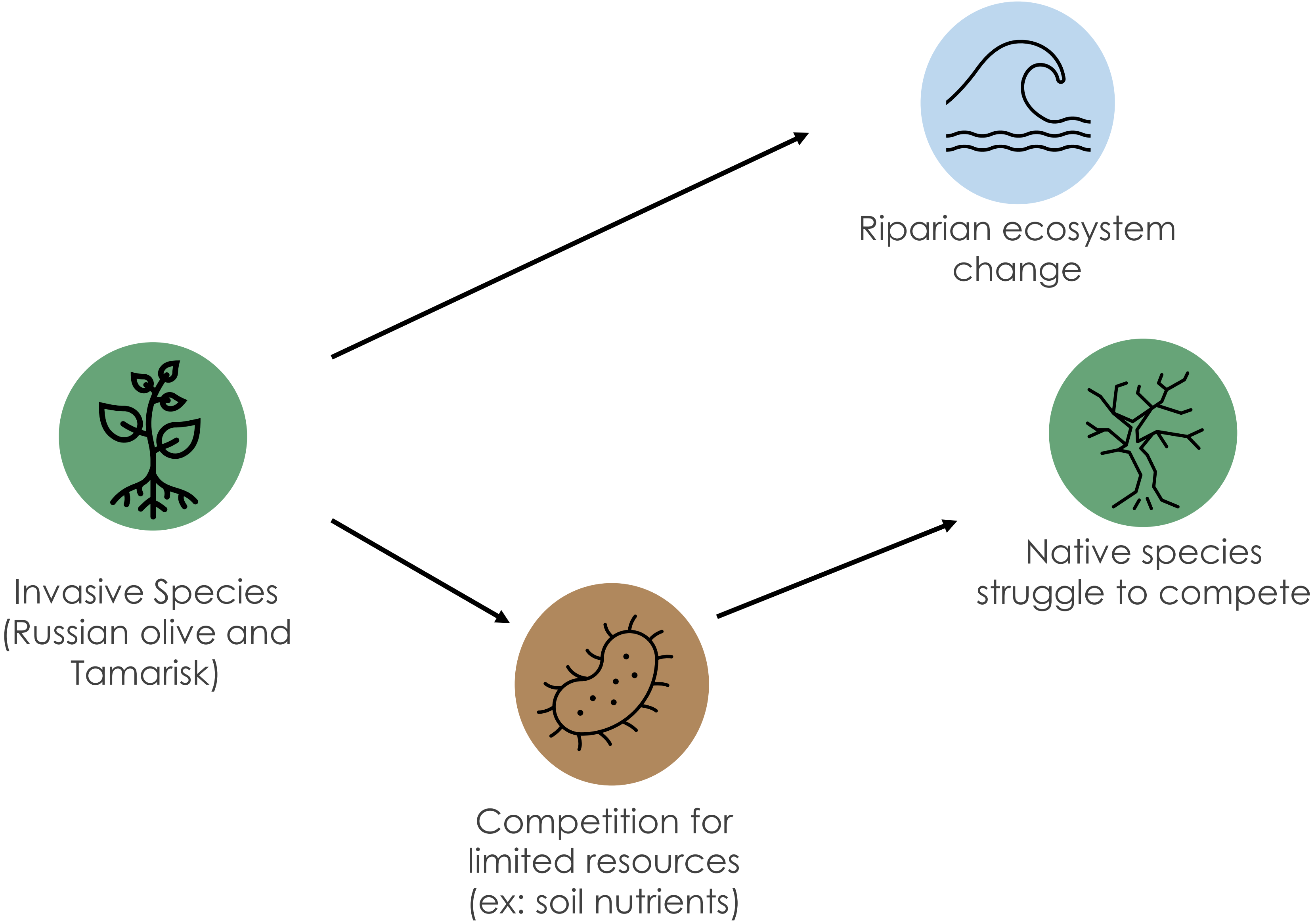
Community Concerns

Invasive Species (Russian olive and Tamarisk)

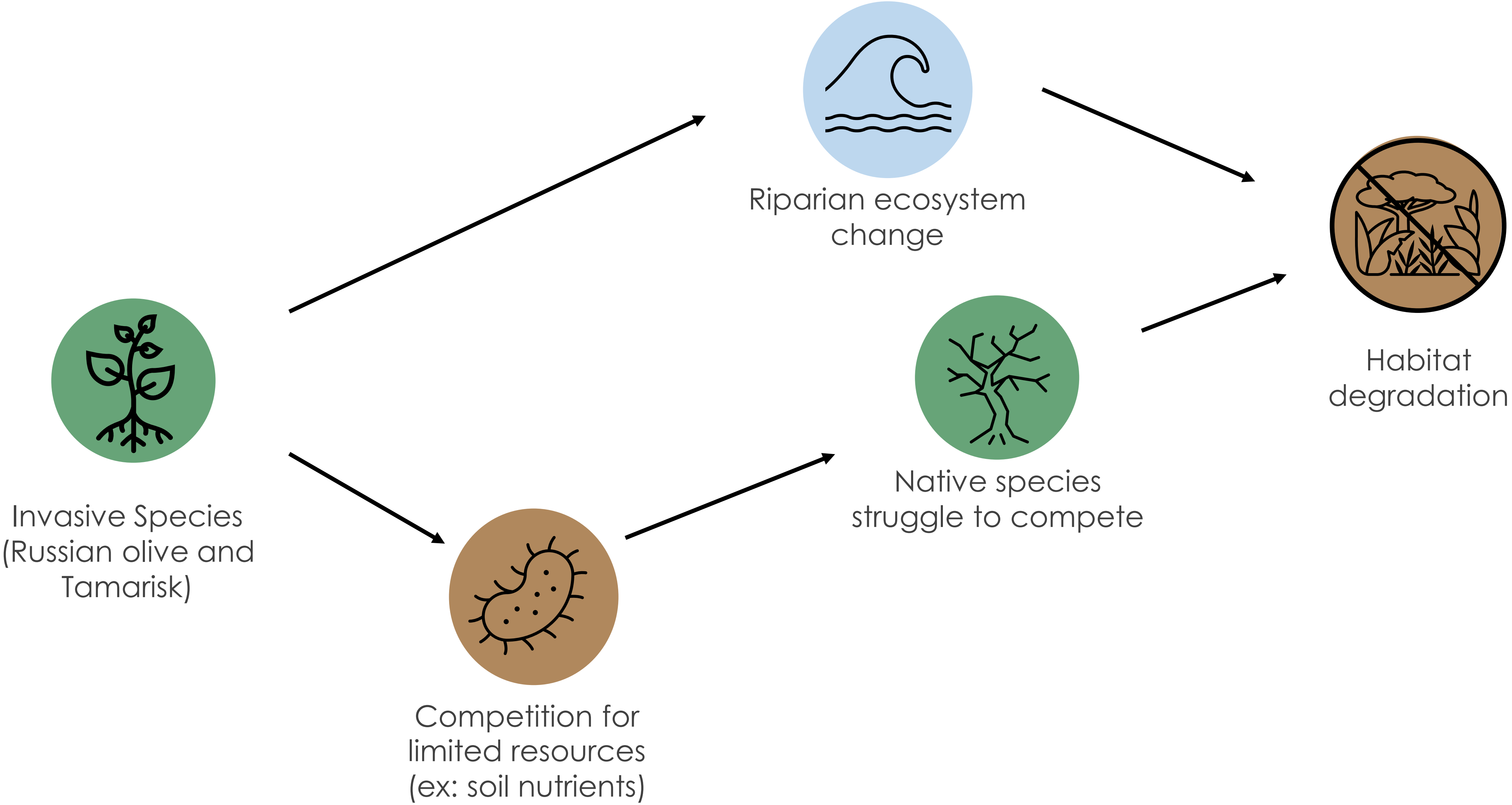
Community Concerns



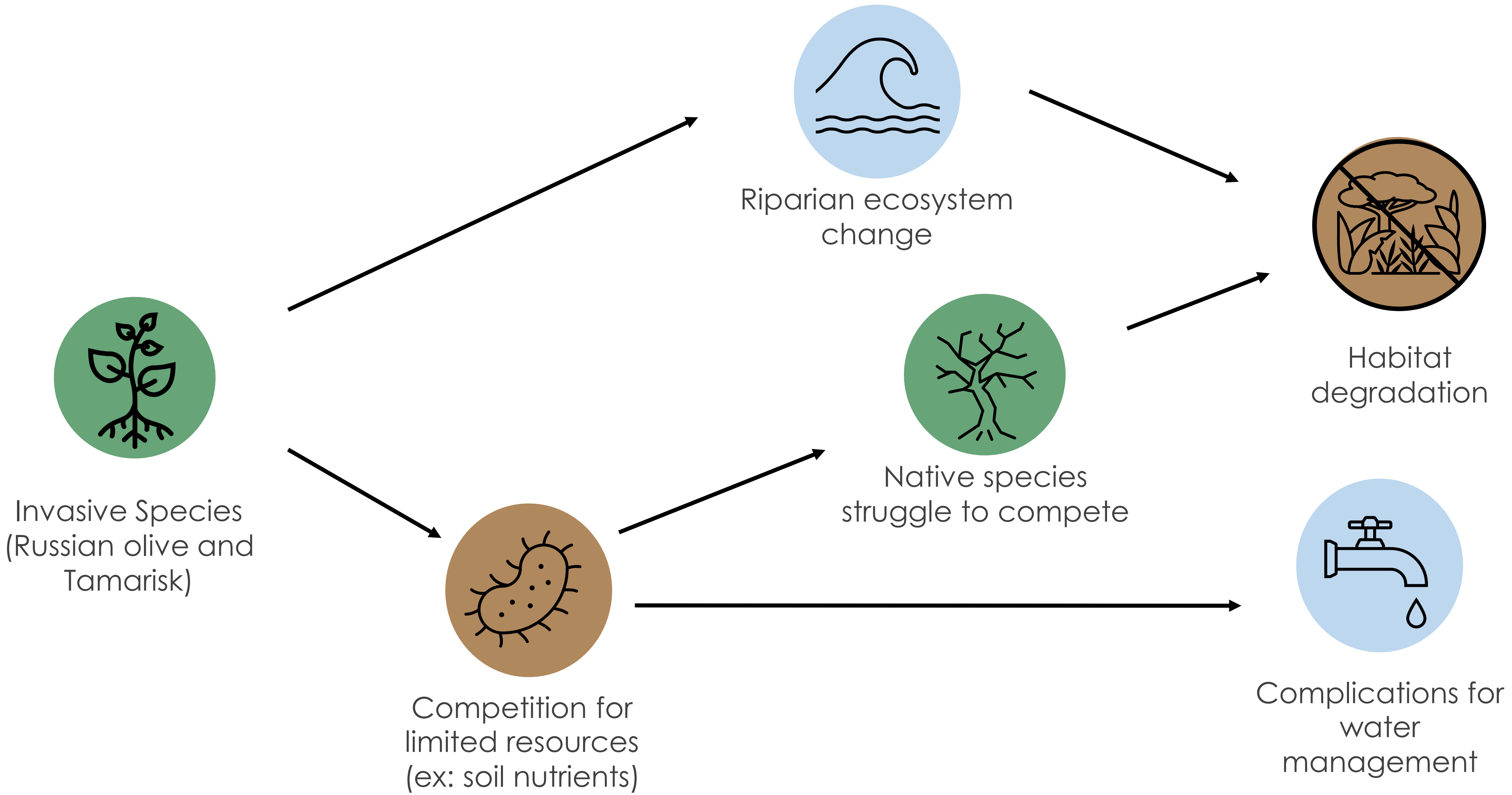
Community Concerns



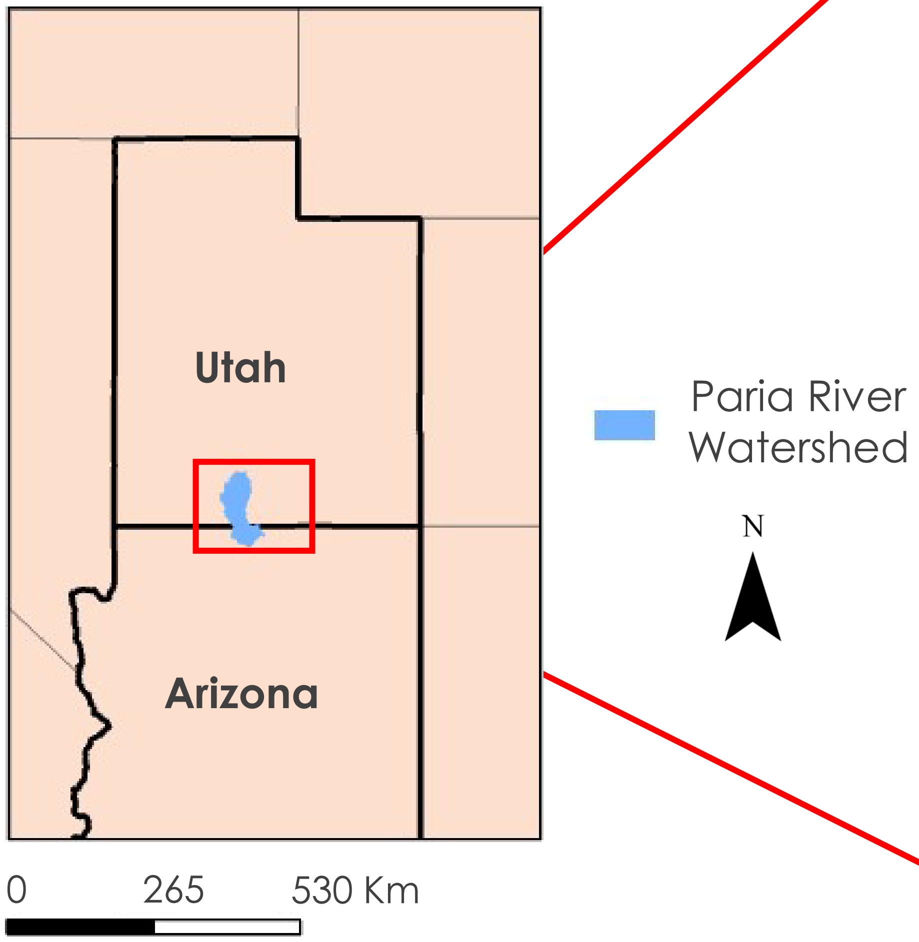
Community Concerns

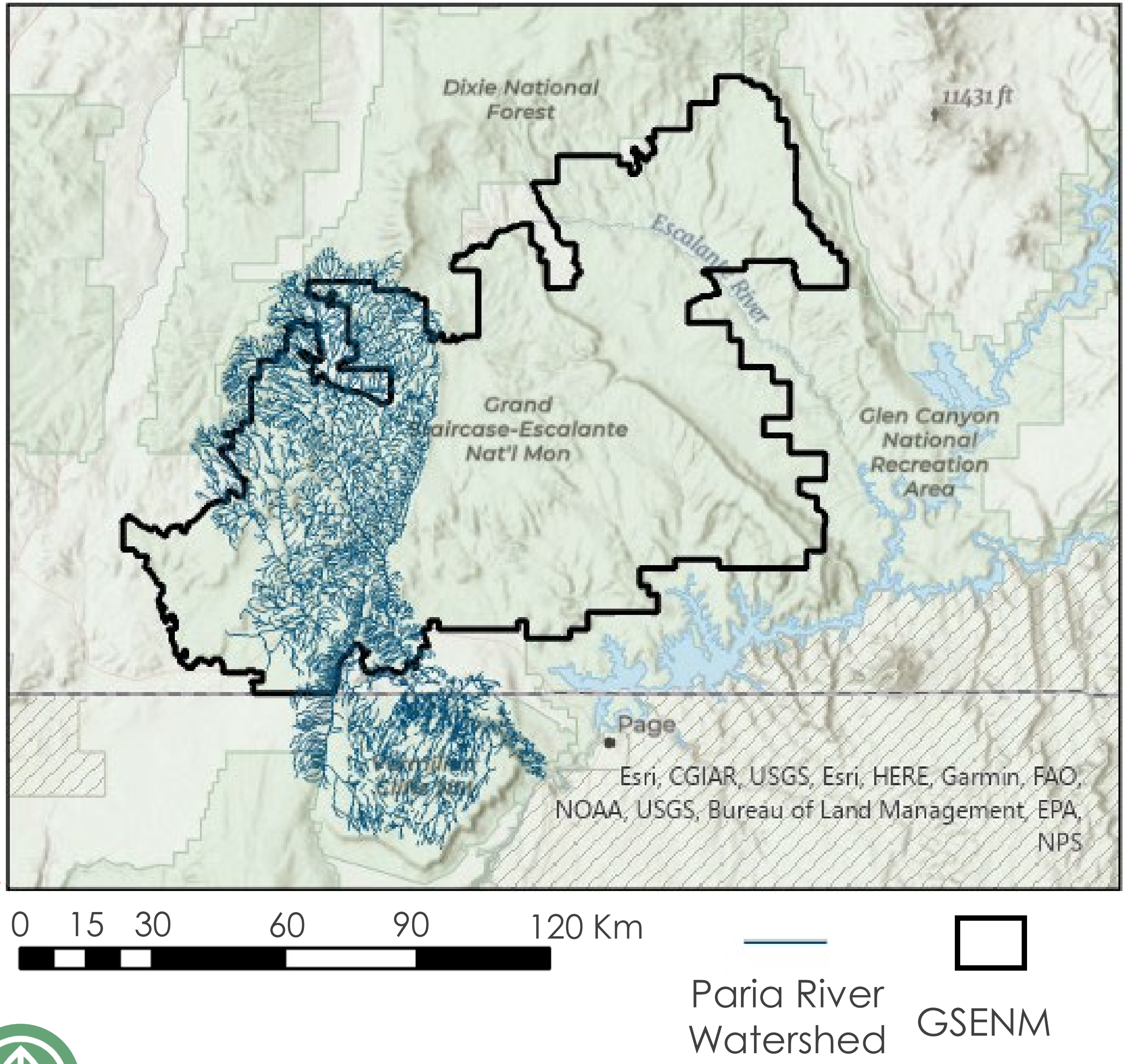


Community Concerns



Study Area


Utah
Arizona
0
265
530 Km
Paria River Watershed
N


Dixie National Forest
11431 ft
Escalante River
Grand Staircase-Escalante Nat'l Mon
Glen Canyon National Recreation Area
Page
Esri, CGIAR, USGS, Esri, HERE, Garmin, FAO, NOAA, USGS, Bureau of Land Management, EPA, NPS
0
15
30
60
90
120 Km
Paria River Watershed
GSENM

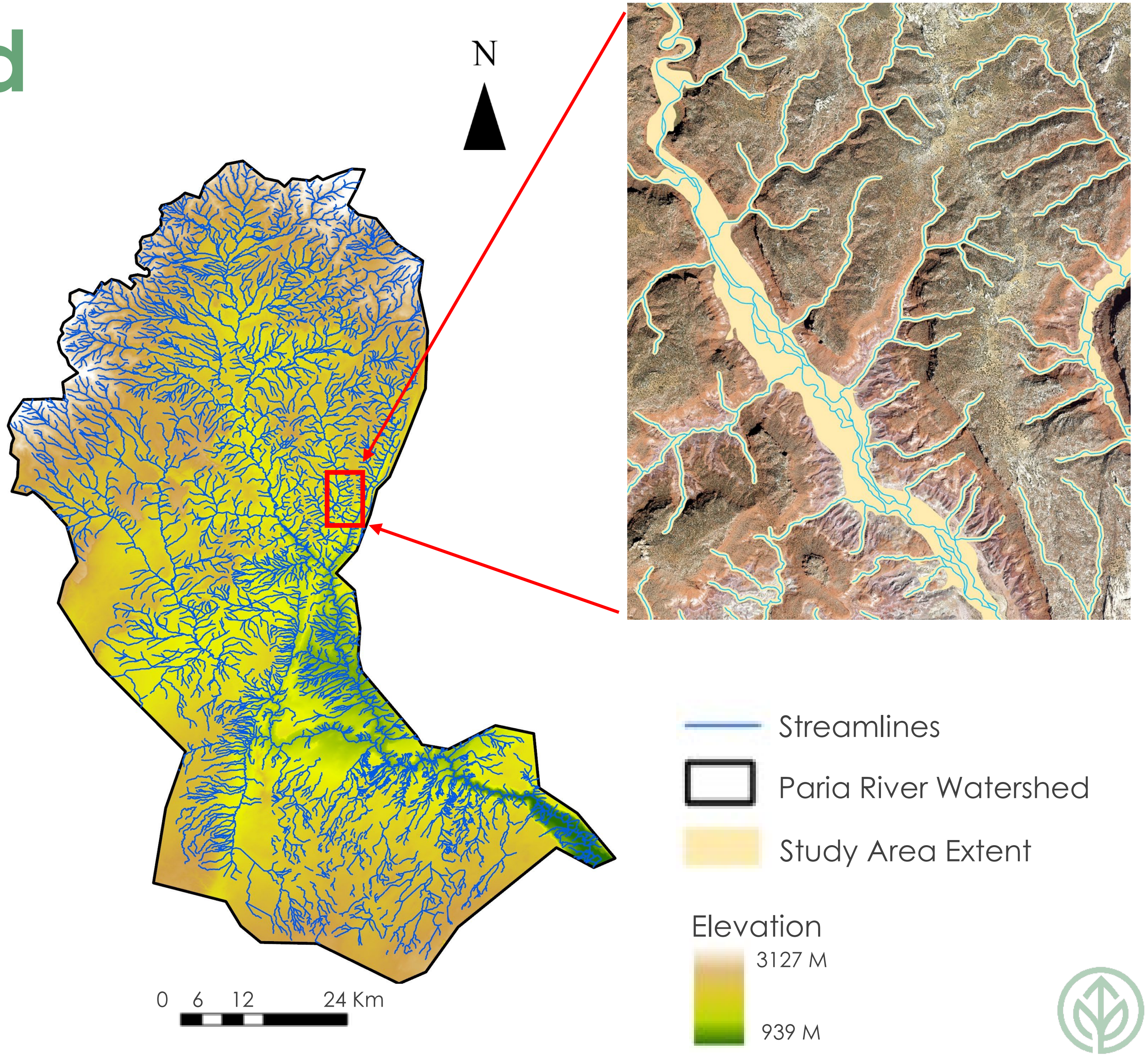
Study Area & Period

Area:

- Paria River watershed in Southern Utah
  - Main stem
  - Tributaries

Period:

- January – December 2022



Partner

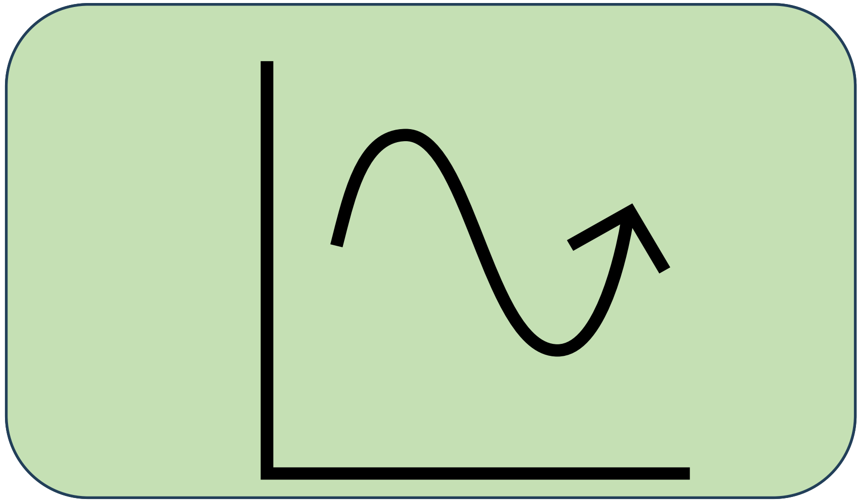

Grand Staircase Escalante Partners
Image Credits: Truman Anarella & Annie Kowalski

Partner Goals

- Plan for coordination for watershed management
- Clarify the extent of species to determine necessary resources
- Identify and prioritize treatment areas
- Support grant/funding applications

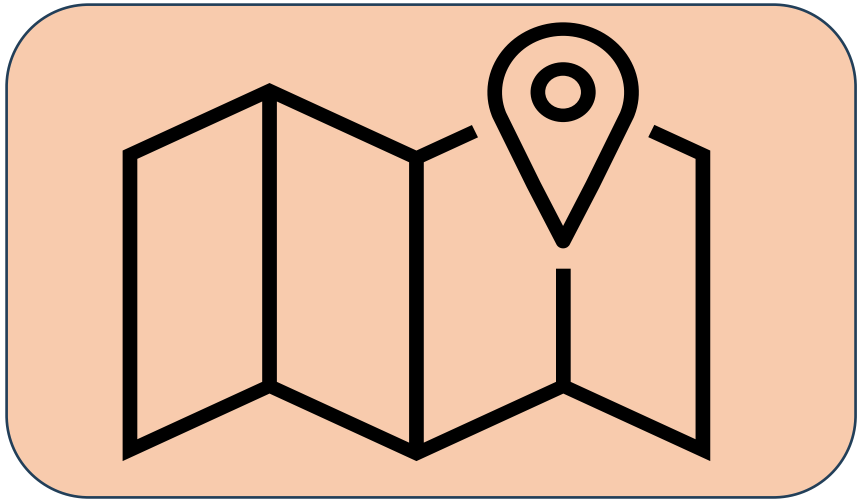
Image Credit: Truman Anarella

Objectives



Time series phenology analysis of the invasive Russian olive and tamarisk in comparison with native cottonwood and willow species

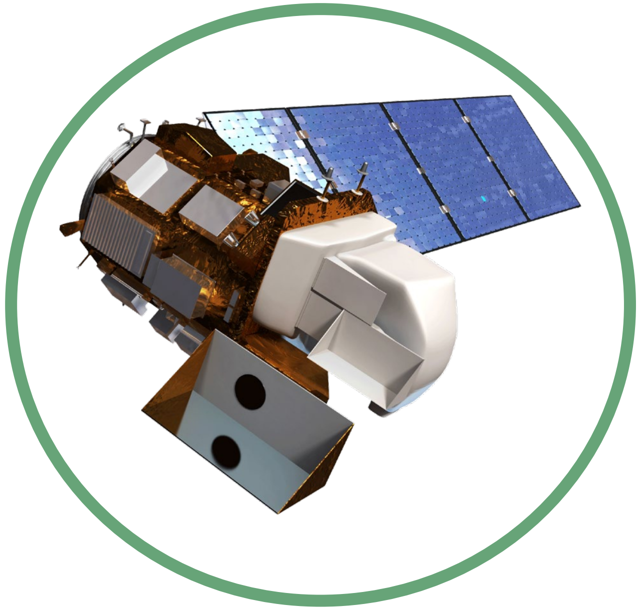
1



Analyze the spatial occurrence of Russian olive and tamarisk in the Paria River watershed

2

Satellites and Sensors



Landsat 8 OLI
Optical Imagery

Landsat 9 OLI-2
Optical Imagery

Shuttle Radar
Topography Mission
(SRTM)

Image Credit: NASA

Methods Overview

Data Processing

ArcGIS

Data Inputs:

- ➢ LiDAR
- ➢ Field Data

Outputs:

- Canopy Height
- Species Percent Cover

GEE

Data Inputs:

- ➢ Landsat 8/9 Bands
- ➢ SRTM DEM

Outputs:

- Tasseled Cap
  - Brightness
  - Greenness
  - Wetness
- Topography

Data Analysis

R

Data Inputs:

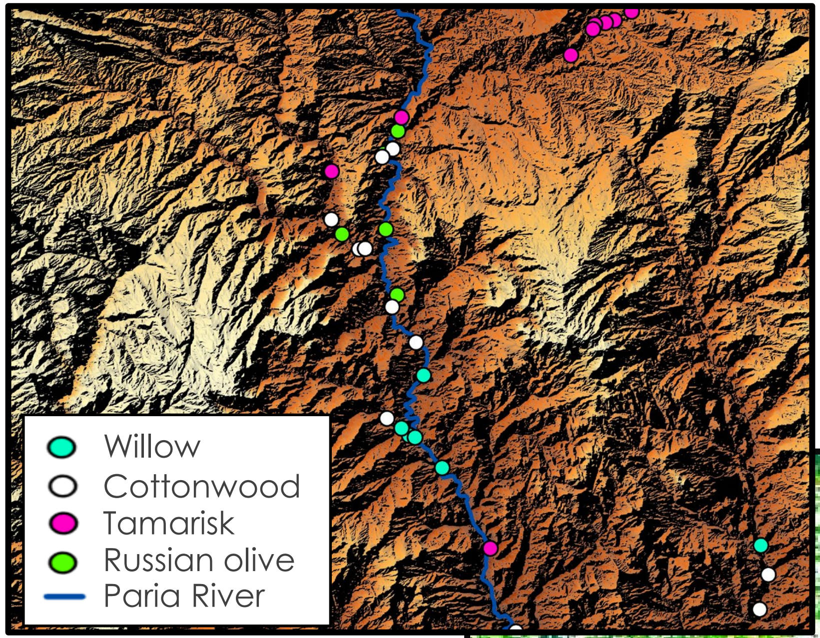
- ➢ Predictor Variables
- ➢ Tamarisk and Russian Olive Cover

Outputs:

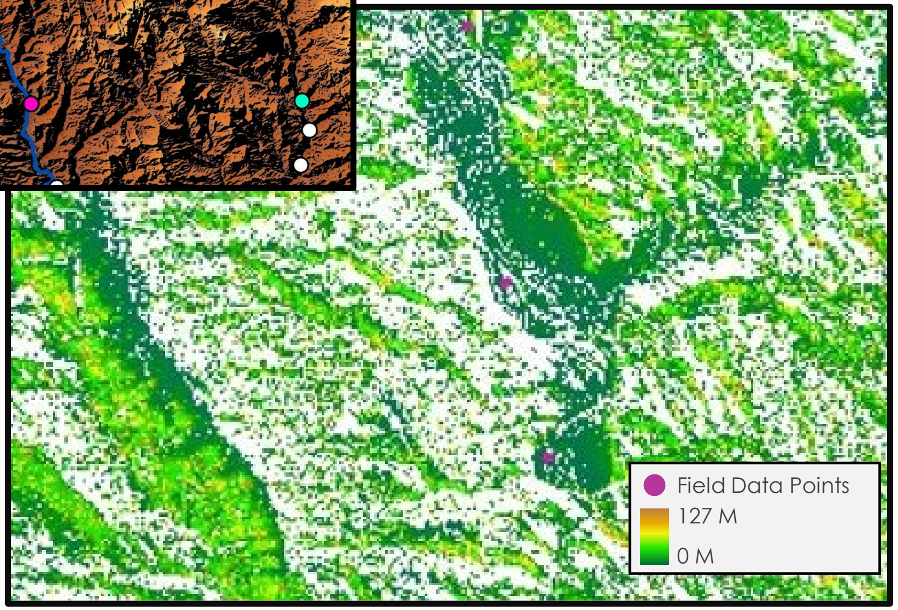
- Phenology time series
- Predictor variable importance plots
- Invasive species prediction maps

Data Processing (ArcGIS)

Created study area shapefile using Valley Bottom Extraction Tool (VBET) and mapped field data plots



Calculated canopy height from LiDAR bare earth & first return tiles

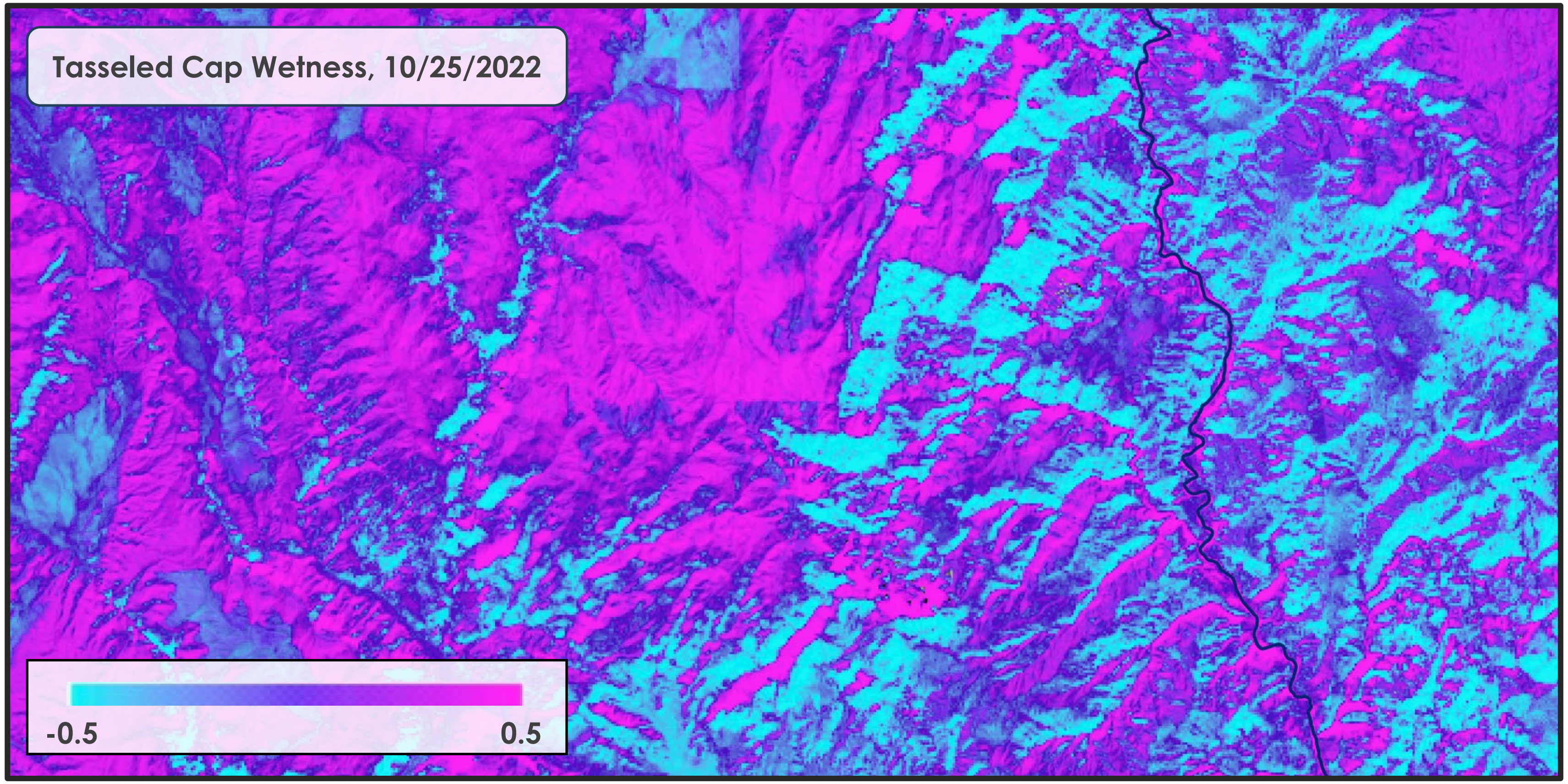


Data Processing (GEE)

Landsat 8 & 9 images

Clipped and masked

Calculated Tasseled Cap Indices

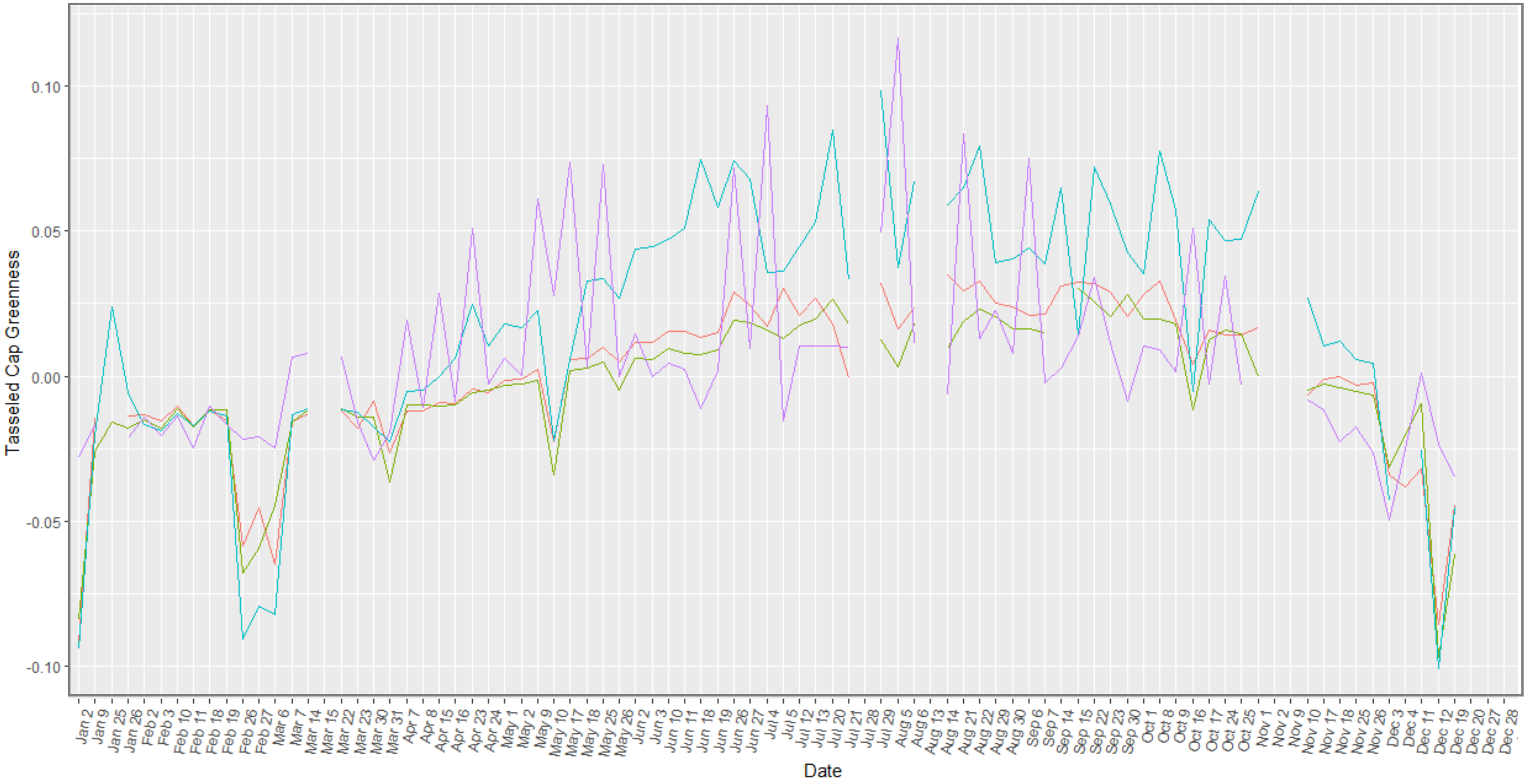


Exported tasseled cap and raw bands as model predictors

Data Analysis (R)

Phenological Time Series

2022 Tasseled Cap Greenness

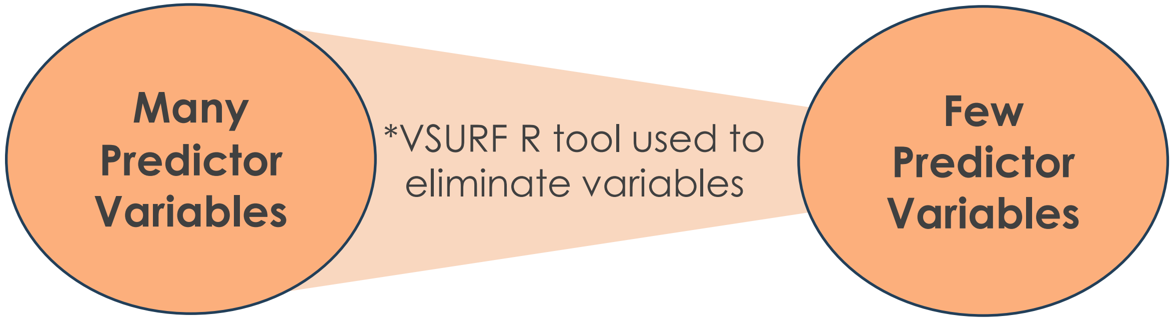


Species

- Russian Olive
- Tamarisk
- Cottonwood
- Willow

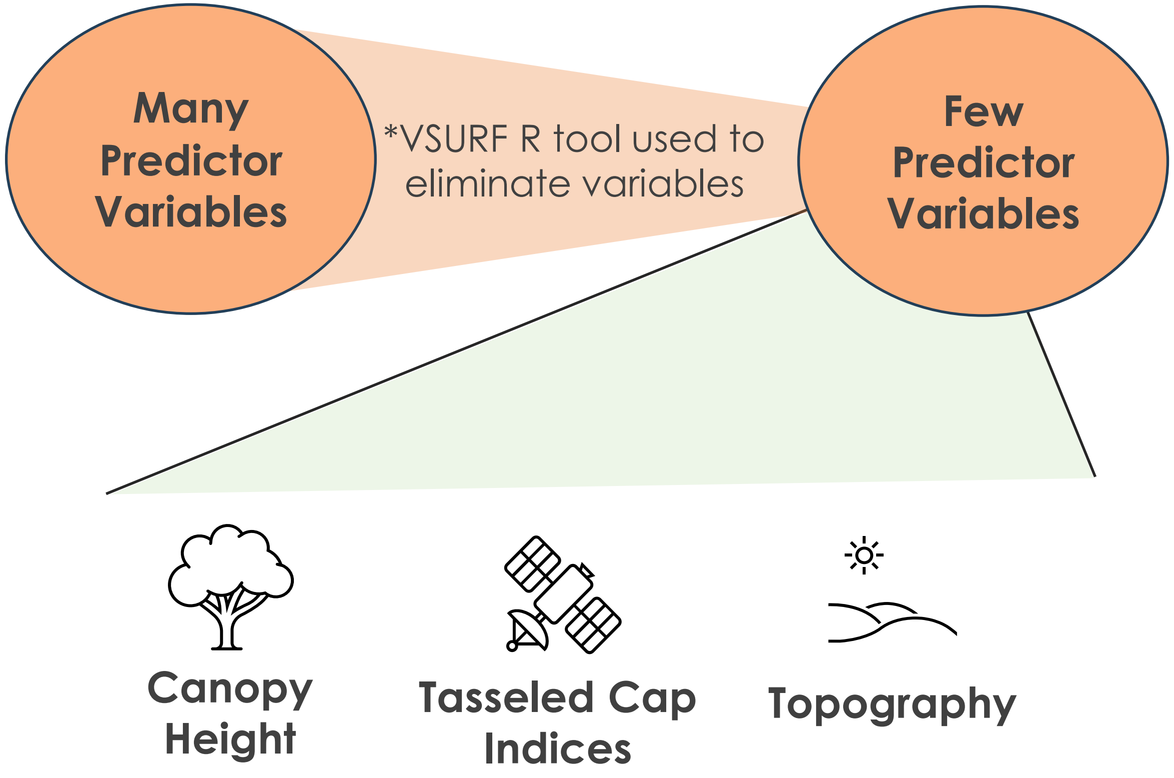
Data Analysis (R)

Random Forest Modeling



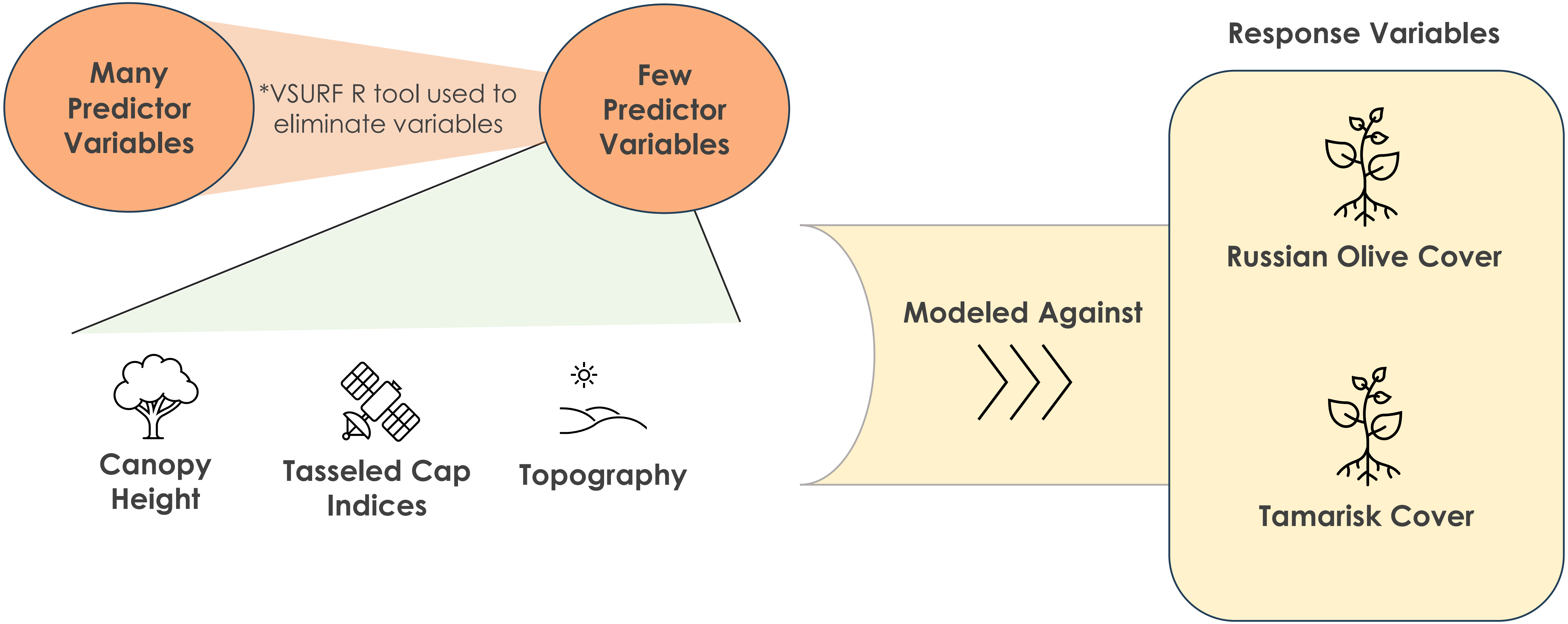
Data Analysis (R)

Random Forest Modeling



Data Analysis (R)

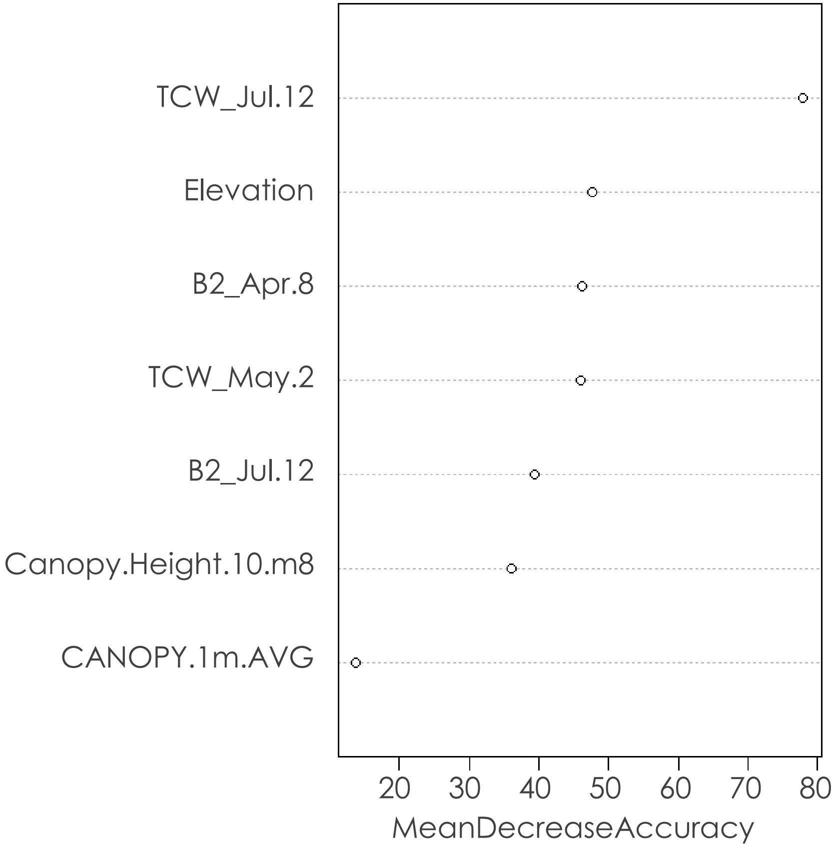
Random Forest Modeling

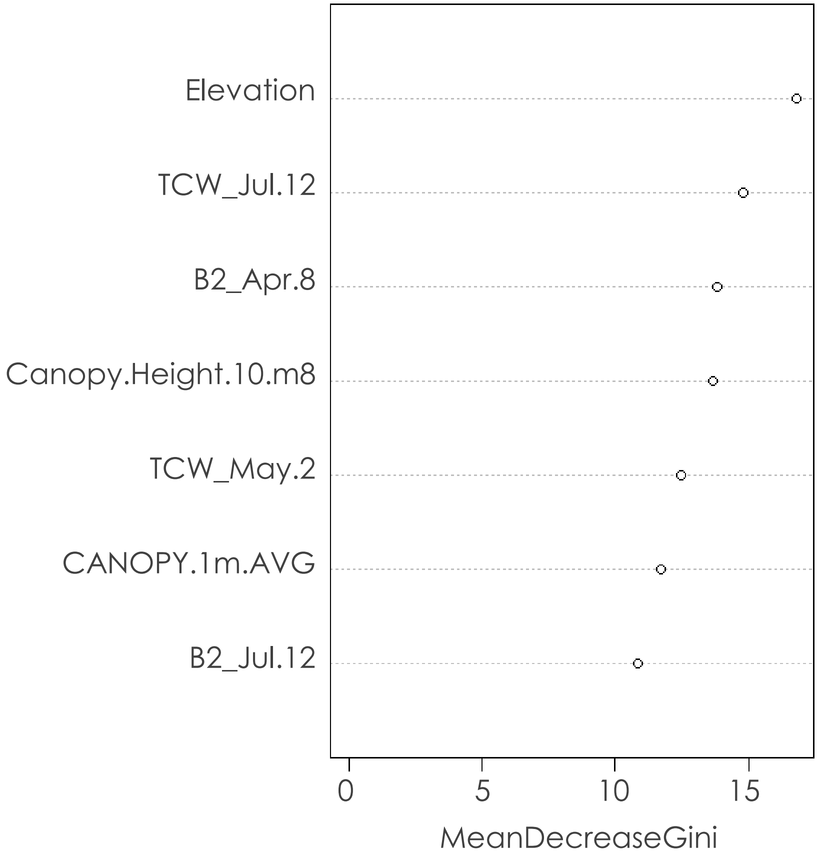


Model Performance

Russian olive

```
Confusion matrix:
      FALSE TRUE class.error
FALSE   209   13  0.05855856
TRUE     44   16  0.73333333
OOB estimate of  error rate: 20.21%
```

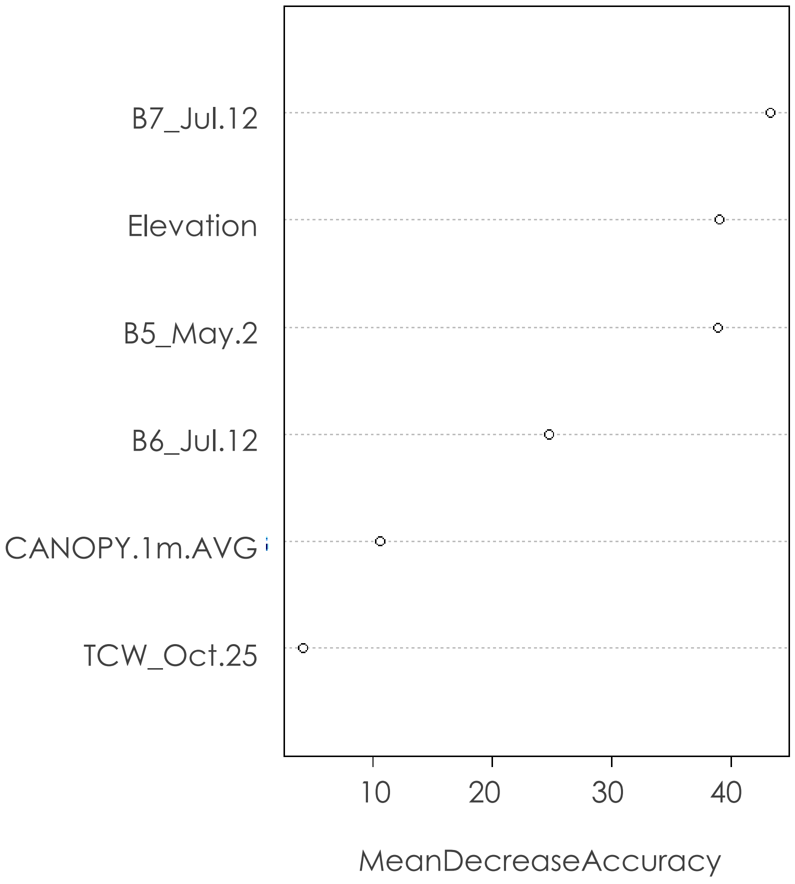


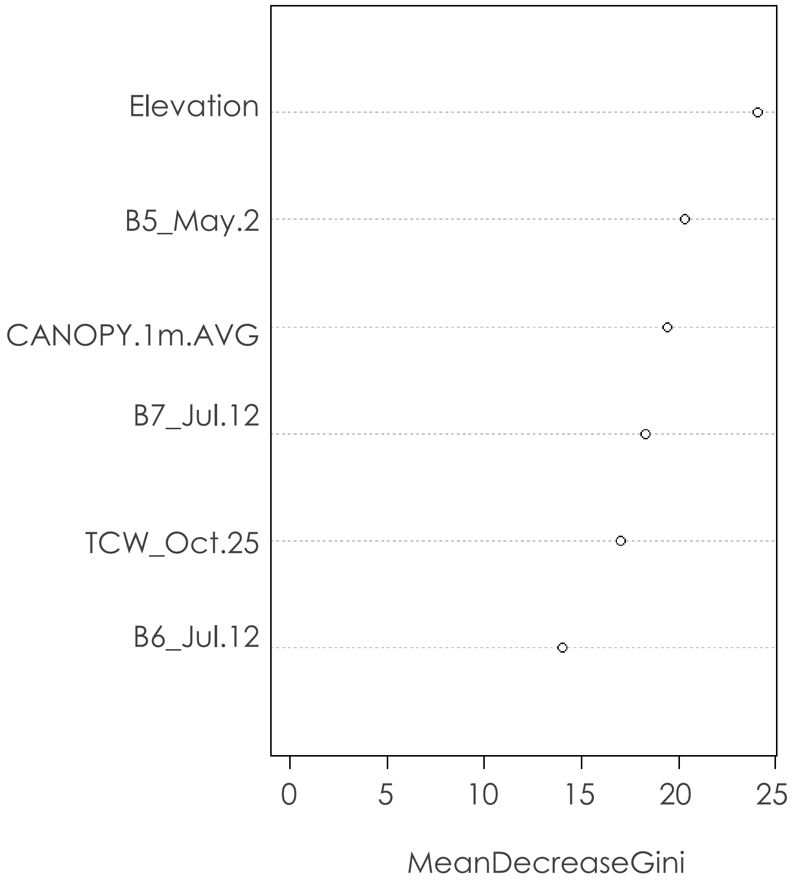


Model Performance

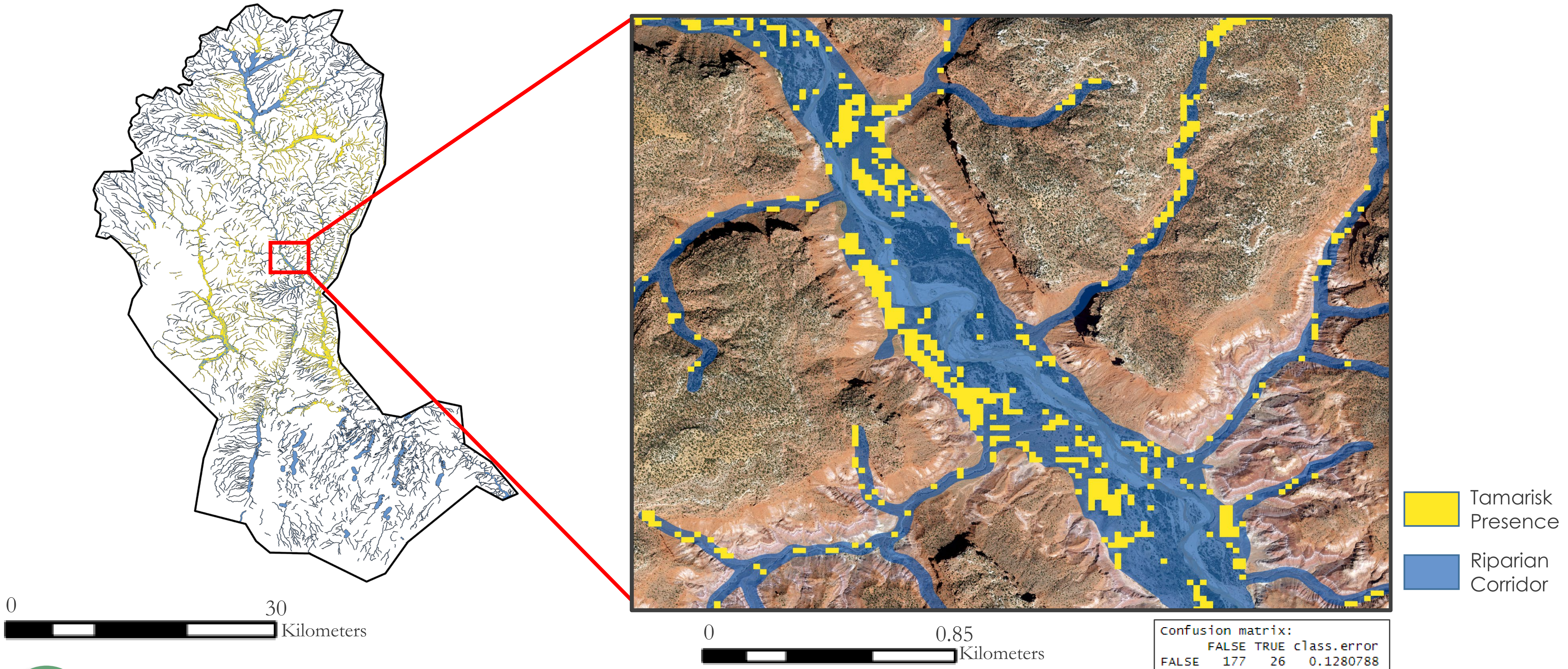
Tamarisk

```
Confusion matrix:
      FALSE TRUE class.error
FALSE   177   26   0.1280788
TRUE     50   29   0.6329114
OOB estimate of  error rate: 26.95%
```





Results (Tamarisk Prediction Map)



Confusion matrix:

	FALSE	TRUE	class.error
FALSE	177	26	0.1280788
TRUE	50	29	0.6329114

Caveats and Takeaways

1. Spectral and phenological similarities between species make remote sensing analyses challenging

2. Low abundance of invasive species, or sparse field data, makes detecting occurrence difficult

3. Landsat and LiDAR together demonstrate promise for mapping invasive species

4. Although the model only predicts with 35% accuracy, it predicts widespread Tamarisk occurrence throughout the entire watershed

Future Work

1. Collecting more invasive species cover data through ocular sampling or field collection to train the model would increase its predictive capability

2. Collecting data from 30-meter plots (as opposed to 10-meter) would match the available satellite imagery and may improve the model

3. A two-step model could help the model better handle the zero-inflated data

Acknowledgements

A special thank you to our Science Advisors, Mentors, and Fellow for their direction and support:

- Dr. Paul Evangelista, Colorado State University, Natural Resource Ecology Laboratory (Science Advisor)
- Dr. Catherine Jarnevich, USGS, Fort Collins Science Center (Science Advisor)
- Dr. Anthony Vorster, Colorado State University, Natural Resource Ecology Laboratory (Science Advisor)
- Peder Engelstad, Colorado State University, Natural Resource Ecology Laboratory (Science Advisor)
- Sarah Hettema, NASA DEVELOP (Fellow)

We would also like to thank our project partner and collaborator:

- Kevin Berend, Grand Staircase Escalante Partners

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Questions?