**Paria River Ecological Conservation**

*Mapping Russian Olive and Tamarisk to Inform Invasive Species Management Along the Paria River, Utah & Arizona*

**Project Team**

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**Project Overview**

***Project Synopsis:***

Since their introduction in the early 1900s, invasive tamarisk and Russian olive plants have dominated riparian areas throughout the American Southwest by rapidly spreading and competing with native vegetation for habitat and water resources. As of now, there have been limited efforts to monitor these invasive species throughout the Paria River watershed in southern Utah and northern Arizona. Using NASA remote sensing data and field survey data from our partners, we monitored the growing season phenology and aimed to model the spatial distribution of these invasive species throughout the watershed.

***Abstract:***

Invasive species within desert riparian environments significantly affect ecosystem function by overtaking native species and altering their fluvial geomorphology. The Paria River, a sediment-heavy river and watershed, flows through the Grand Staircase-Escalante National Monument (GSENM) before its confluence with the Colorado River. Due to its heavy sediment load, it provides an important habitat for various species of native fish and amphibians. Grand Staircase Escalante Partners (GSEP) noticed an increased presence of invasive tamarisk (*Tamarix ramosissima*) and Russian olive (*Elaeagnus augustifolia)* plants along the Paria River watershed, and the extent of both species is largely unknown. Using field survey data from the Grand Staircase Escalante Partners and remote sensing data from Landsat 8 Operational Land Imager (OLI), Landsat 9 OLI-2, Shuttle Radar Topography Mission (SRTM), and Light Detection and Ranging (LiDAR), we performed a Random Forest classification model to identify the presence of these invasive species. We used Tasseled Cap indices to create a time series phenology for 2022, which helped us identify our predictor variables for the random forest classification model. We found that the limited Russian olive cover reflected in the field survey data, and the low spectral and height differentiation from other species, resulted in a classification model not strong enough to make a reliable prediction map. The tamarisk data, however, was abundant enough to produce a marginally reliable prediction map of presence in the watershed. Our results and tamarisk prediction map will help our partners at GSEP make informed decisions about future funding and management efforts.

***Key Terms:***

invasive species, Russian olive, tamarisk, remote sensing, Random Forest, Tasseled Cap

***National Application Area Addressed:*** Ecological Conservation

***Study Location:*** Paria River, UT & AZ

***Study Period:*** January 2022 to December 2022

***Community Concerns:***

* Due to the Paria River’s presence in an otherwise dry environment, riparian ecosystems have increased biodiversity in comparison to the rest of the surrounding landscape, and they are particularly susceptible to invasive species.
* Both Russian olive and tamarisk form dense monocultures that choke native woody vegetation, such as cottonwoods and willows. Tamarisk also has the unique ability to secrete large amounts of salt, creating a saltier soil that is unfit for native species, thus altering the shoreline vegetation make-up.
* Invasive species within desert riparian environments significantly affect ecosystem function by altering fluvial geomorphology. Tamarisk and Russian olive constrict the natural meander and sedimentation processes of the river, leading to a narrowed, incised channel that provides poor habitat for fish and other aquatic life.
* Native species that rely on flora must compete for their own resources to an increasingly limited extent. While certain fauna can make use of the invasive species (i.e., the endangered southwestern Willow Flycatcher nests in tamarisk, many species eat the berry of the Russian olive, etc.), there is decreased biodiversity in areas where invasive species are present.
* Invasive species removal and native species restoration projects require collaboration with other agencies and multiple sources of grant funding, which involves knowing the approximate extent of each species.

***Project Objectives:***

* Conduct time series phenology analysis of the invasive Russian olive and tamarisk in comparison with native cottonwood and willow species​
* Analyze the spatial occurrence of Russian olive and tamarisk in the Paria River watershed ​

**Partner Overview**

***Partner Organization:***

|  |  |  |
| --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** |
| **Grand Staircase Escalante Partners** | Kevin Berend, Conservation Programs Manager | End User |

***Decision-Making Practices & Policies:***

GSENM was established in 1996, and managed by the Bureau of Land Management. It encompasses the majority of the Paria River watershed, as well as the Escalante River. GSEP was established in 2004 and is a non-profit that is dedicated to protecting and preserving the monument, which it accomplishes through its fundraising, outreach events, and partnerships with government agencies and other conservation organizations. GSEP uses in-situ field data to map their invasive species. A prior invasive species removal project along the Escalante River involved millions of dollars of funding and tens of thousands of hours of staff and crew time, and was a collaborative effort between multiple agencies, non-profits, and individuals.

**Earth Observations & End Products Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI** | Raw band values, Tasseled Cap indices (Brightness, Greenness, Wetness) | We used spectral bands for the derivation of vegetation indices, calculated through a weighted sum of the raw band values. These indices acted as spectral and temporal predictor variables in the random forest model to create occurrence maps. |
| **Landsat 9 OLI-2** | Raw band values, Tasseled Cap indices (Brightness, Greenness, Wetness) | We used spectral bands for the derivation of vegetation indices, calculated through a weighted sum of the raw band values. These indices were incorporated into our random forest model as spectral and temporal predictor variables to create occurrence maps. |
| **SRTM** | Elevation, slope, aspect | We incorporated these data into our model as topographic predictor variables to create occurrence maps. |

***Ancillary Datasets:***

* GSEP in-situ data – Percent biotic/abiotic cover data of 10-meter plots, used to create a point layer of all plots that included an attribute table of percent coverage of the vegetation
* GSEP shapefile of the Paria River watershed – Delineates the entire study area, used to clip layers to the watershed
* Utah Geospatial Resource Center Quality Level 2 LiDAR data of Kane County – First-return and bare-earth tiles, used to derive canopy height

***Modeling:***

* Random Forest Model (POC: Dr. Anthony Vorster, Natural Resource Ecology Laboratory) – Predict the presence and absence of Russian olive and tamarisk, as well as rank the variables’ importance as predictors

***Software & Scripting:***

* ArcGIS Pro 3.1 – Initial data processing, LiDAR mosaics, map production
* Google Earth Engine – Satellite imagery processing, vegetation indices derivation
* R 4.3.1 – Data organization, Random Forest model

***End Products:***

|  |  |  |
| --- | --- | --- |
| **End Products** | **Earth Observations Used**  | **Partner Benefit & Use** |
| **Time Series Phenology Analysis**  | Landsat 8 OLI, Landsat 9 OLI-2 | This analysis will allow GSEP to analyze the time series phenology among the two native species groups (cottonwoods and willows) and two invasive species (Russian olive and tamarisk).  |
| **Canopy Height Analysis**  | LiDAR | These plots show the canopy height of differing species along the Paria River watershed, which allows GSEP to view the height ranges among known field data plots, divided by percent cover.  |
| **Tamarisk Occurrence Map** | Landsat 8 OLI, Landsat 9 OLI-2, SRTM | This tool will allow GSEP to visualize the predicted tamarisk occurrences along the entire Paria River watershed, and to gain a better understanding of the extent.  |

***Product Benefit to End User:***

Plots that demonstrate the phenological and canopy height differences between the species provide specialized information about the ecology of the under-surveyed reaches of the Paria River watershed. Knowing the approximate extent of invasive species along the Paria River watershed will allow the GSEP to identify and prioritize treatment areas, and to help gauge the level of effort required for a treatment similar to the one previously conducted along the Escalante River. This data will also support grant and funding applications for the GSEP and facilitate coordination with other partners such as the Bureau of Land Management.

**References**

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