Summer 2023 Project Summary

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

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 the 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 and Russian olive 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 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

Commented [CB1]: You **must include**:
1) What NASA Earth observations were involved
2) The partner organization(s) with whom you partnered
3) Who the decision makers are and what the decision being made is
3) What the problem was
4) What you did in response
5) What the benefits or outcomes are/will be
6) What were your results

Be concise. Give only high-level information. Write in active voice in simple past tense: www.englishpractice.com/improve/active-passive-voice-simple-tense/

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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
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 is 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 each of the species (i.e., the endangered southwestern Willow Flycatcher nests in tamarisk, many species eat the berry of the Russian olive), there is decreased biodiversity in area with invasive species.
- 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(s):

Organization(s)	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 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. 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. While the Bureau of Land Management oversees the monument, the executive branch of the government can make decisions on land management.

Commented [CB3]: Pick key terms that describe your project well – not just a list of the Earth observations you used. These key terms will be used in other deliverables, too.

Commented [LP4R3]: Another good way to think about key terms, is "If someone where to search for my project, what words would they use?" Methods (i.e., NDVI), Study Area (i.e., the Duck River Watershed), or community concerns (i.e., carbon stock loss) are good places to start. These are the same key terms from the Tech Paper.

Commented [CB5]: Change "(s)" for any given section. Example:
⇒ **National Application Area Addressed**: Application Area 1
⇒ **National Application Areas Addressed:** Application Area 1, Application Area 2

Commented [CB6]: **Org Names** – follow proper partner nomenclature and include the full partner org name with any larger/umbrella orgs **first**. Go from broadest to most specific. Please use the official IA partner names found in the Project Proposal.
POC – if there is more than one for an org, just list them in the same box separated by semi-colons (there should be one row per organization). One caveat: you cannot have the same individual listed for multiple organizations. If there are multiple orgs involved, you need to find a different POC for each.
Partner Type – collaborator or end user
Boundary Org – yes or no

Be sure to notify the PC and IA teams of any partner changes during the term!

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Earth Observations & End Products Overview

Earth Observations:

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.
Shuttle Radar Topography Mission (SRTM)	Elevation, slope, aspect	We incorporated these data into our model as topographic predictor variables to create occurrence maps.
LiDAR	Bare Earth, First Return	We incorporated this data to calculate canopy height and incorporate it into our random forest model as a predictor variable

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 Product(s)	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

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Example: Landsat 5 TM, Landsat 7 ETM+, and Landsat 8 OLI should all be in separate rows.

Commented [LP9R8]: Pre-processed datasets (such as NLCD or NAIP) should go in ancillary datasets and not here.

Commented [LP10]: This is the quality you are specifically trying to determine from use of the satellite data. Sometimes there is a band directly for it and other times there are calculations to get to the parameter.

Commented [CB11]: List any non-satellite or airborne datasets you are using for this study, e.g. field surveys, *in situ* measurements, available modeled data (even if it is modeled using satellite data), etc.

For published datasets, list the original source for Creator Organization (i.e. person/organization who actually created the dataset) followed by the formal dataset name. Do not list where the data came from or who provided it, if different from the creator.

Commented [CB12]: This section is for highlighting any model that will be **run by the team** during the term. **For an Eco Forecasting project, this is required!** Some kind of forecasting needs to be taking place. Any model data not being run by the team should be included under ancillary datasets.

The POC for the model needs to be someone the team has contact with that has experience running and troubleshooting the model. The POC doesn't have to be someone affiliated with the group that produced the model.

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		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

Commented [CB15]: The Purdue OWL APA Guide is a great resource for help with writing citations!

Friedman, J. M., Auble, G. T., Shafroth, P. B., Scott, M. L., Merigliano, M. F., Freehling, M. D., & Griffin, E. R. (2005). Dominance of non-native riparian trees in western USA. *Biological Invasions*, *7*(4), 747–751. https://doi.org/10.1007/s10530-004-5849-z

Gregory, S. V., Swanson, F. J., McKee, W. A., & Cummins, K. W. (1991). An Ecosystem Perspective of Riparian Zones. *BioScience*, *41*(8), 540–551. https://doi.org/10.2307/1311607

Lesica, P., & Miles, S. (2001). Natural History and Invasion of Russian Olive Along Eastern Montana Rivers. *Western North American Naturalist*, *61*(1), 1–10.

Nagler, P. L., Nguyen, U., Bateman, H. L., Jarchow, C. J., Glenn, E. P., Waugh, W. J., & van Riper III, C. (2018). Northern tamarisk beetle (Diorhabda carinulata) and tamarisk (Tamarix spp.) interactions in the Colorado River basin. *Restoration Ecology*, *26*(2), 348–359. https://doi.org/10.1111/rec.12575