Utilizing NASA Earth Observations to Evaluate the Distribution of Russian Olive and its Impact on Evapotranspiration in the Upper Colorado River Basin

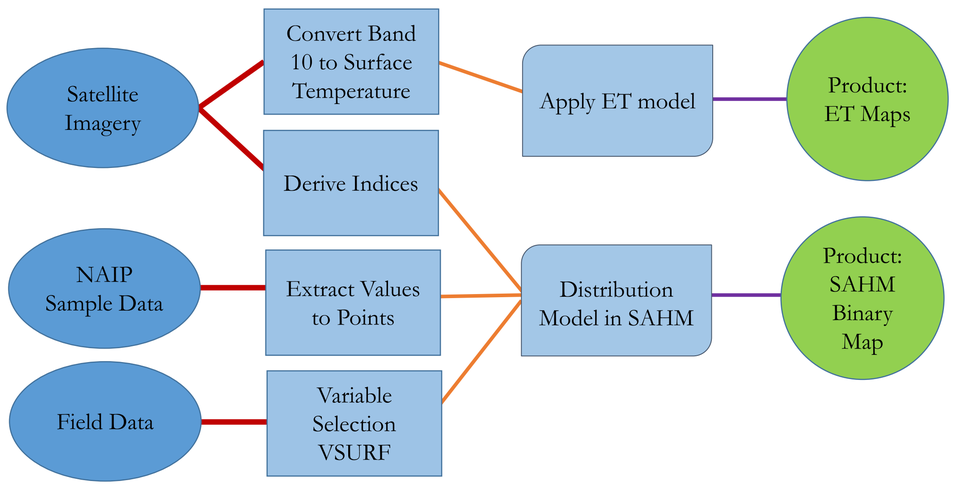
Abstract

Riparian plant communities are vital to water quality, erosion control, biodiversity, and functionality of river ecosystems. The invasion of nonnative Russian olive (*Elaeagnus angustifolia* L.) poses a risk to these fragile ecosystems, as it outcompetes native riparian species such as cottonwoods (*Populus* spp.) and willows (*Salix* spp.) in semiarid environments throughout the western United States. Russian olive is well-established in the Colorado River Basin, which supplies water to 40 million people. Studies show that Russian olive alters riparian evapotranspiration rates, streamflow, and sediment regimes. Quantifying the effect of this species on the Colorado River Basin is vital for managing water quality and quantity. In this study, the team 1) mapped the distribution of Russian olive in the San Juan River (a tributary of the Colorado River) using Landsat 5 Thematic Mapper (TM),, Landsat 8 Operational Land Imager (OLI), and Sentinel-2 MultiSpectral Instrument (MSI) imagery, 2) compared the accuracy of Landsat 5 and 8 presence maps to those of Sentinel-2, and 3) determined relative evapotranspiration (ET) rates for Russian olive. We identified predictor variables and utilized Software for Assisted Habitat Modeling (SAHM) to generate multiple classification algorithms, including Boosted Regression Trees (BRT), General Linear Model (GLM), Multivariate Adaptive Regression Splines (MARS), and Random Forest (RF). These algorithms were used to produce presence maps and evaluate modeling approaches. The Walton Family Foundation will use our products to assess previous restoration efforts of Russian olive and to prioritize future management plans and restoration efforts.

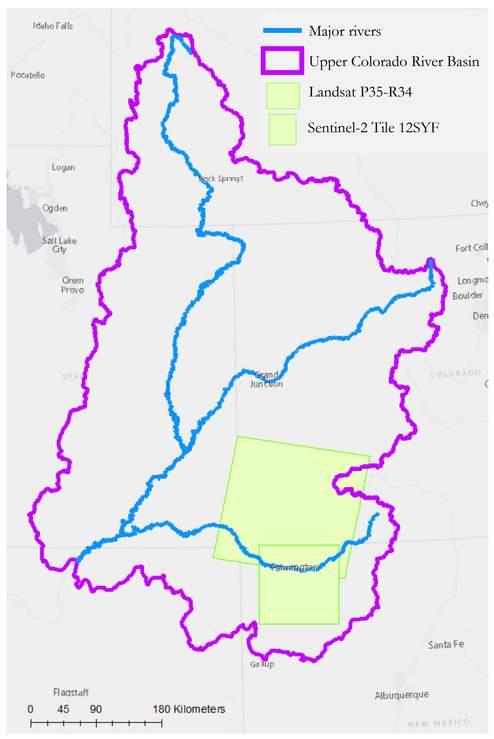
Objectives

- **Create** a digital sampling methodology to collect Russian olive presence data using high resolution orthoimagery (NAIP)
- **Predict** Russian olive distribution along the Upper Colorado River Basin (UCRB) in 2006 and 2016 using Landsat 5, Landsat 8 and Sentinel-2 imagery and the U.S. Geological Survey's Software for Assisted Habitat Modelling (SAHM)
- **Compare** Russian olive distribution between 2006 and 2016, and between Landsat 8 and Sentinel-2 imagery
- **Create** a methodology and a map of predicted evapotranspiration for riparian zones in the study area
- **Assess** how the predicted evapotranspiration in areas of high Russian olive cover compares to areas of no observed Russian olive presence

Methodology



Study Area

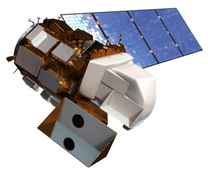


Earth Observations

Sentinel-2 MSI

Landsat 5 TM

Landsat 8 OLI

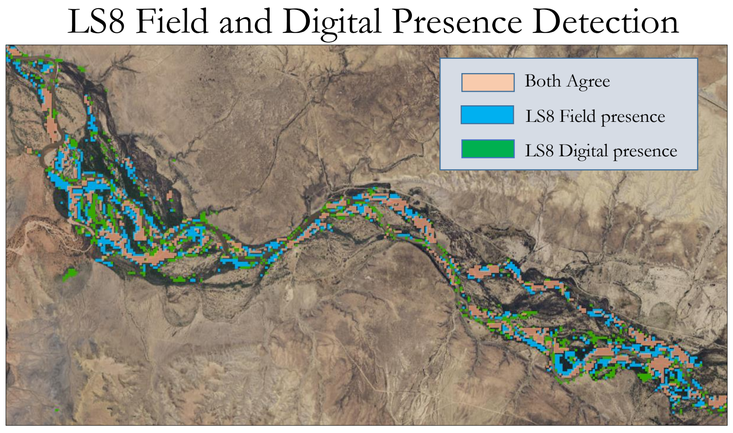


Results

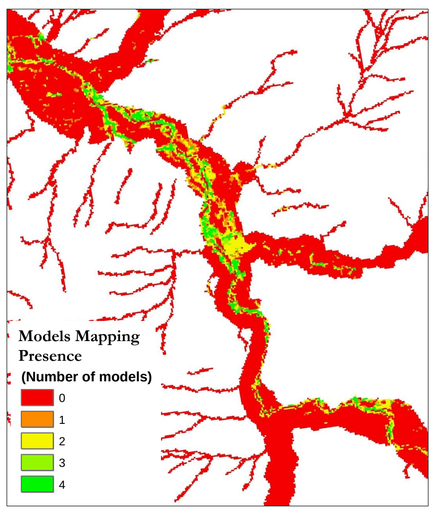
Area Calculations

	Percentage of VBET Predicted as RO	
Data Set	**Digital**	**Field**
LS5	3.30	63.75
LS8	1.06	1.46
LS8_subset	1.42	
Sentinel	1.26	

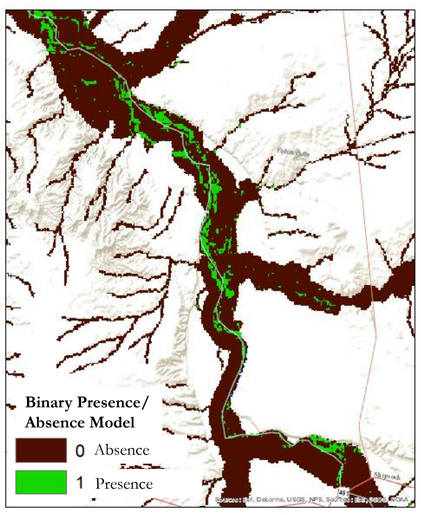
LS8 Field and Digital Presence Detection



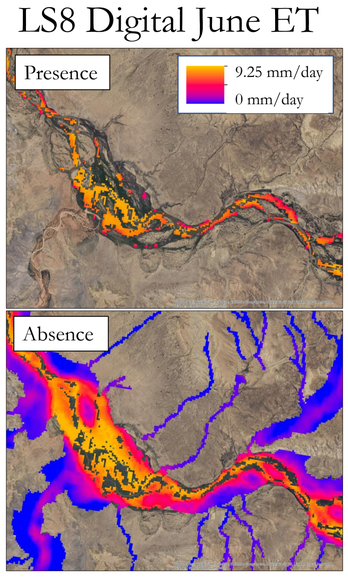
LS8 Model Ensemble



LS8 Digital Presence



LS8 Digital June ET



Conclusions

- Models weere fit using datasets generated from digitally sampled NAIP imagery and previously sampled field data points in order to compare models produced with each sampling method.
- Russian olive is well-suited for mapping with remotely sensed imagery due to its unique spectral signature.
- Models fit with digital points had higher performance metrics than did models fit with field points, but field data is imperative for validation.
- Evapotranspiration rates were higher in areas mapped as Russian olive presence than areas mapped as Russian olive absence within the VBET delineation.
- Our evapotranspiration methodology can be applied to other invasive species and across time series.
- Our presence maps can aid land managers in restoration and monitoring efforts.
- ET calculations can inform restoration decision making and prioritization.

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Project Partners

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Water Resources II
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