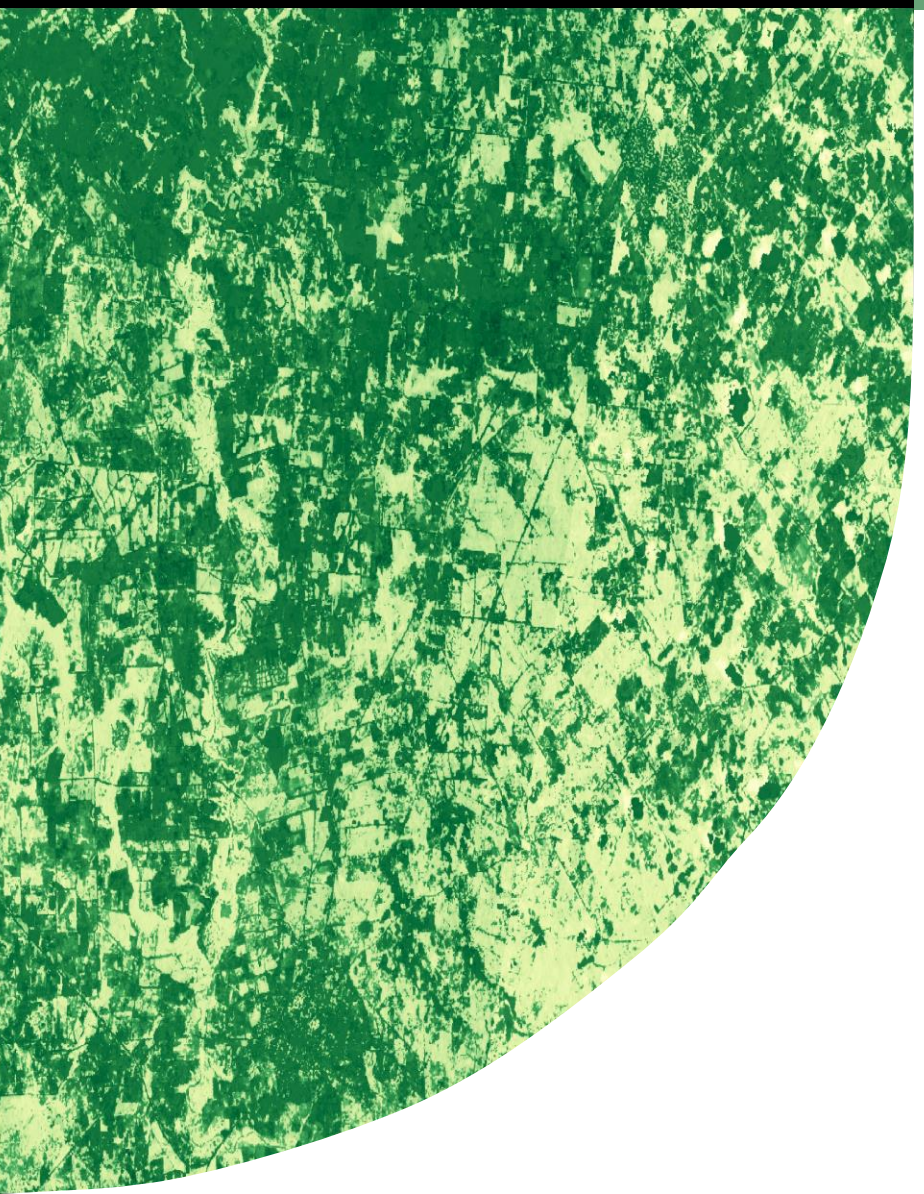
National Aeronautics and Space Administration



Texas & Oklahoma Ecological Conservation

Investigating Vegetation Structure and Diversity in Texas and Oklahoma with Earth Observations to Aid Grassland Bird Conservation

Gayatri Paudel, Cole J.P. Seither, Tessa Forth, & Nana-Esi Irie Hanson (Analytical Mechanics Associates)

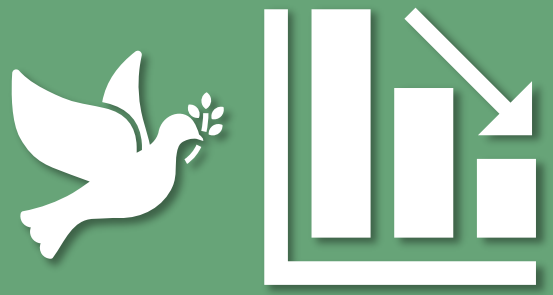
Pop Up Project – Texas Tech University | Summer 2025

Grasslands: Globally Relevant, Locally Threatened

31% of global landmass

Human & climate **stressors**

Habitat **degradation**



Bird species threatened (up to 92% decrease)

Image Credits: PowerPoint, Derek Wiley

Oaks and Prairies Joint Venture (OPJV)

- Promoting native **grassland conservation to protect threatened bird species**

- **Grassland Restoration Incentive Program (GRIP)**
  - Funding & science-based support
  - Grassland treatments

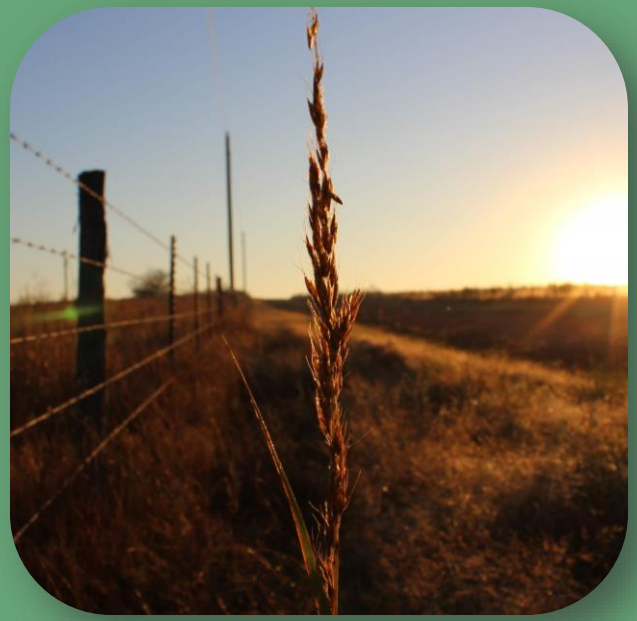


Image Credits: Will Newman, Jim Giocomo

Community Concerns

Grassland Bird Conservation Impacts...

Ecosystem Services

Recreation & Landscape Identity

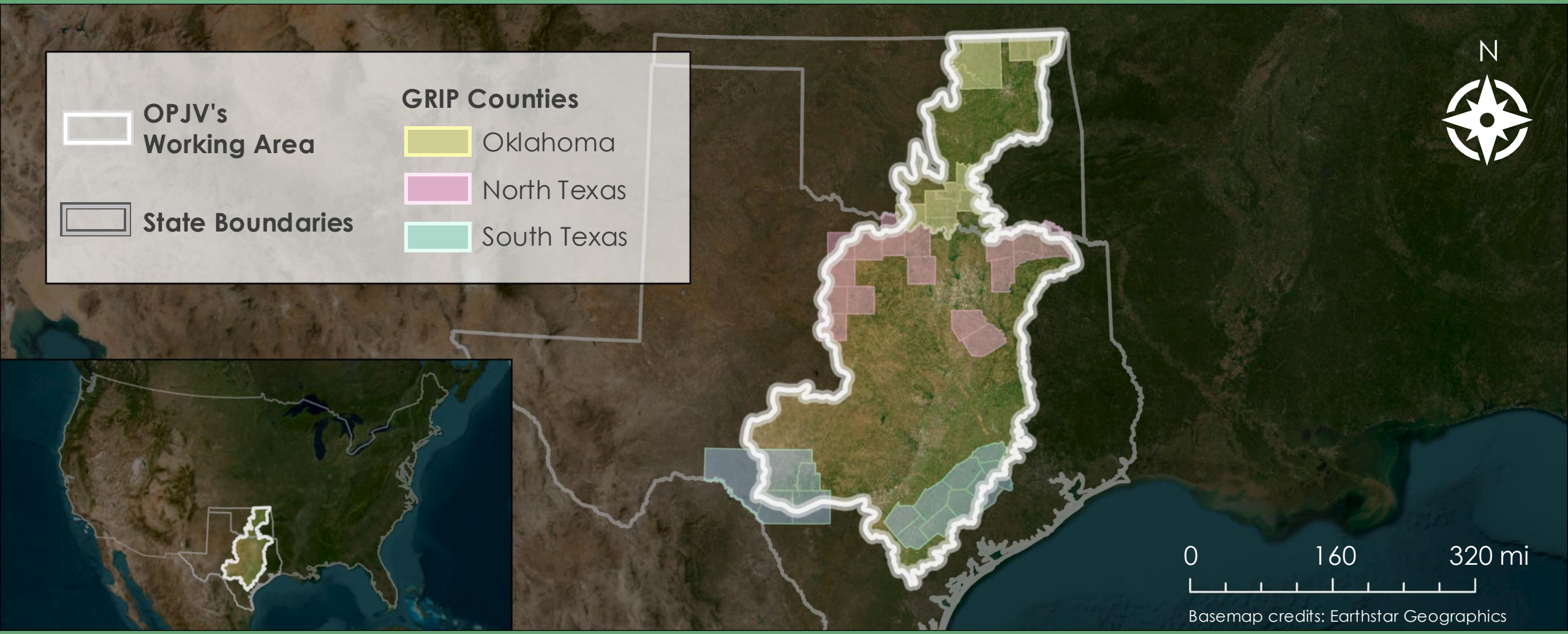
Economy

Image Credits: Jim Giocomo, Derek Wiley, Karen Arnold, Rebekah Rylander

Objectives

1. **Time series maps** of climatic patterns
2. Predictive, scalable **vegetation analysis model**
3. ArcGIS Pro **tutorial** for grassland monitoring

Study Area

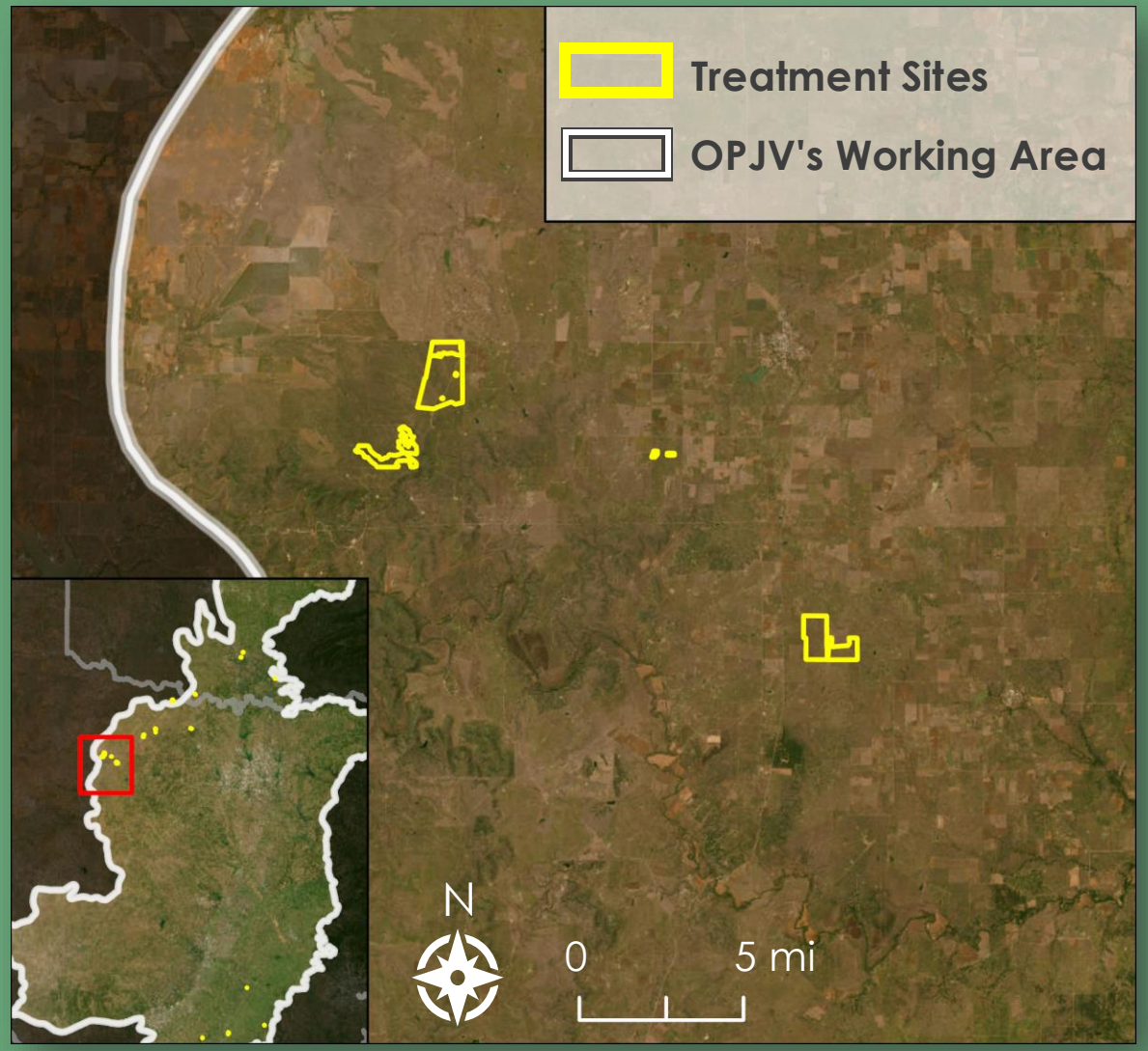

OPJV's
Working Area
State Boundaries
GRIP Counties
Oklahoma
North Texas
South Texas
N
0
160
320 mi
Basemap credits: Earthstar Geographics

Study Area: Treatment Sites

Prescribed Fire

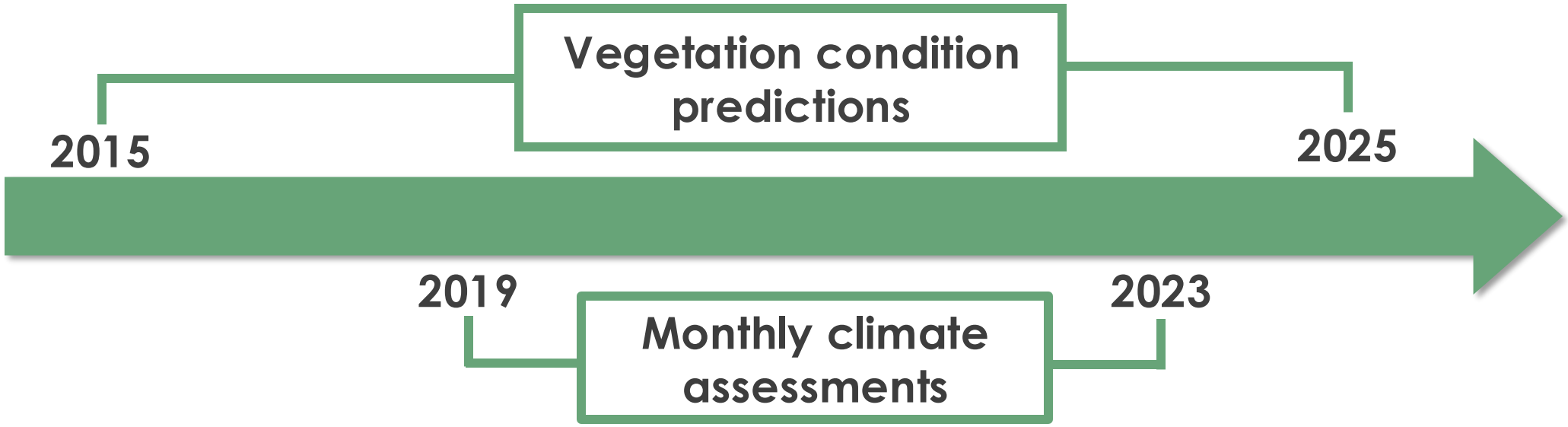
Brush Management

- Site sizes vary
- Treatment years: 2015 – Present



Basemap credits: Earthstar Geographics

Study Period



Broadly applicable impact assessment

Independently replicable for future years

Earth Observations

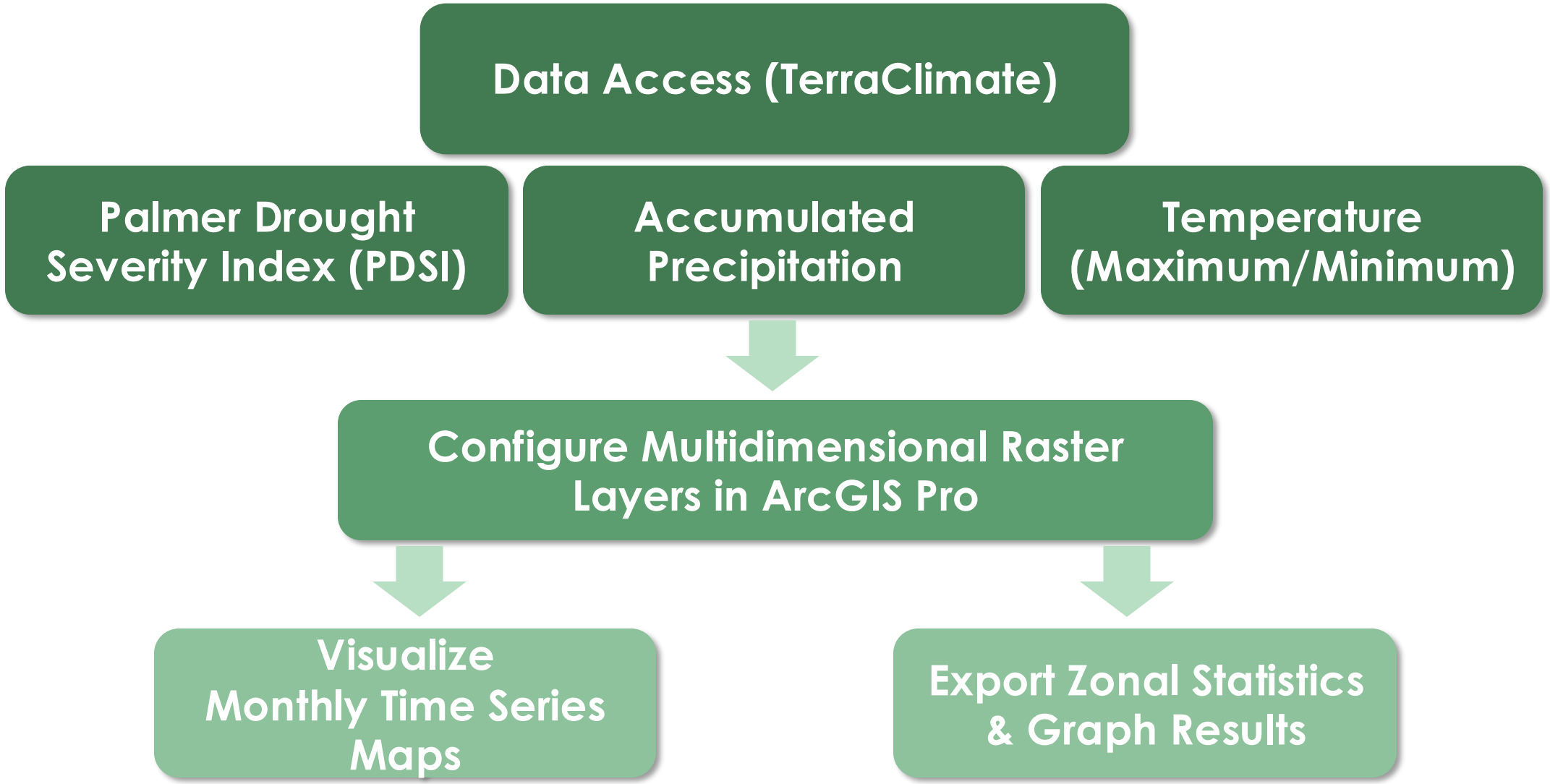
Landsat 8
Operational Land Imagery

Endeavour
Shuttle Radar
Topography Mission

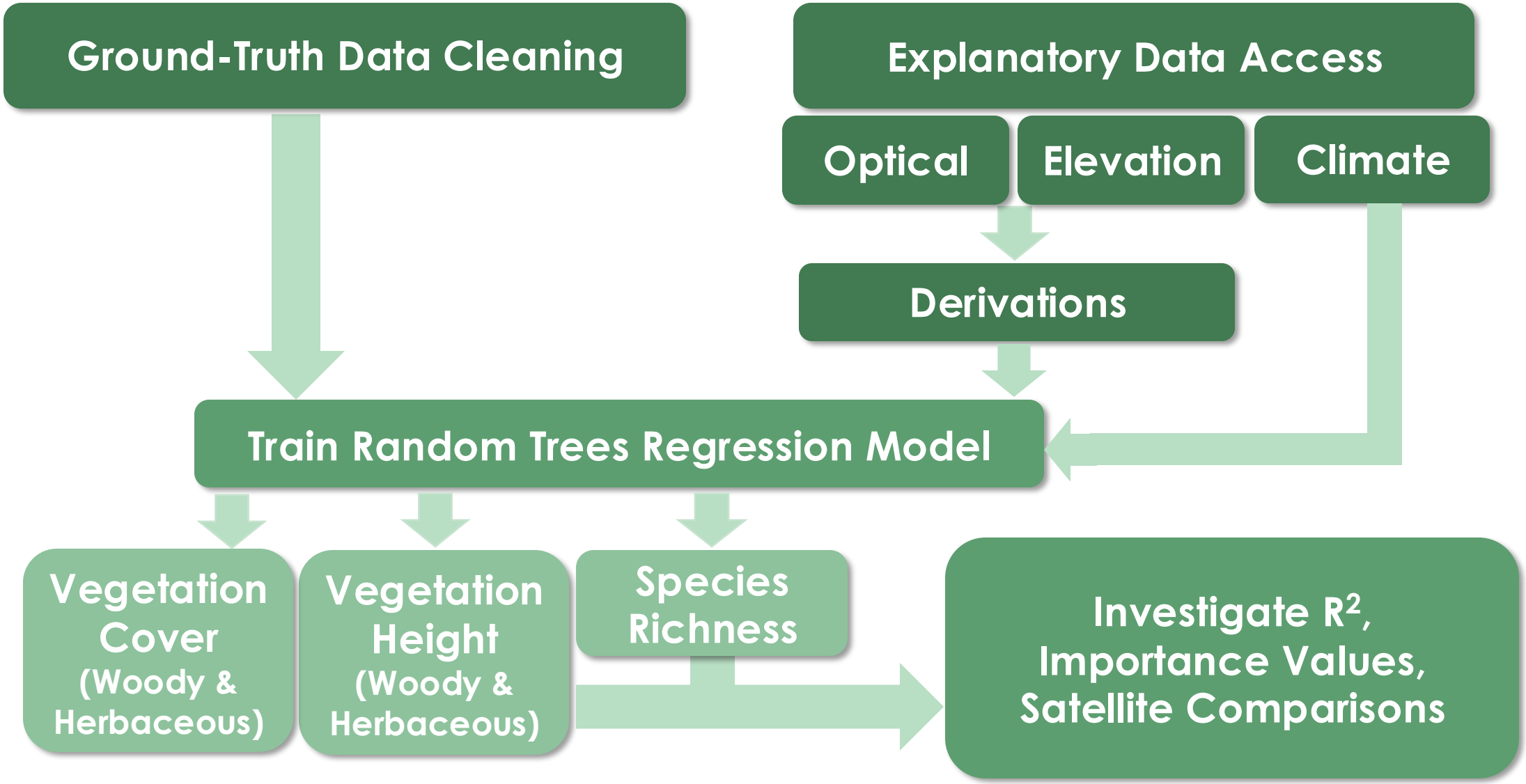
Sentinel-1
C-SAR

Image Credits: NASA's Marshall Space Flight Center, Rama

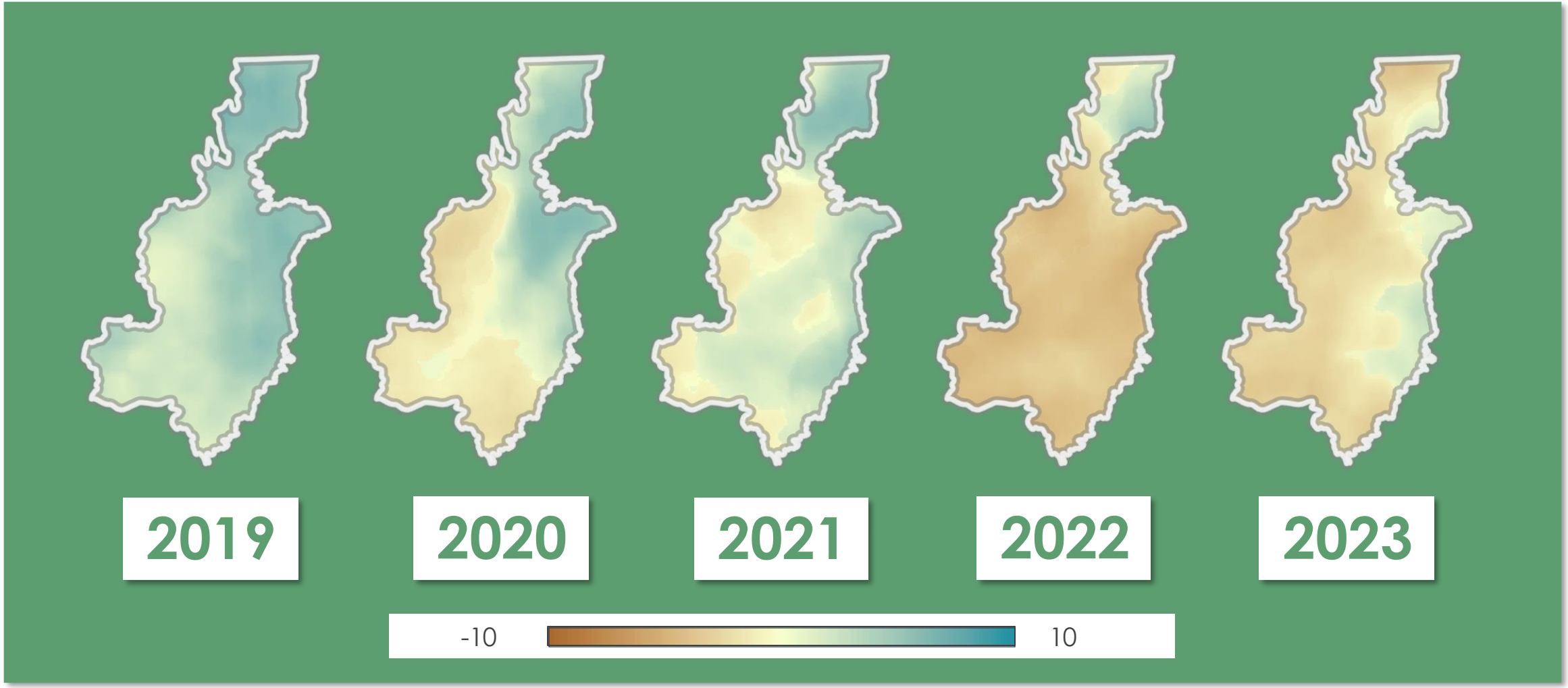
Methods: Climatic Time Series



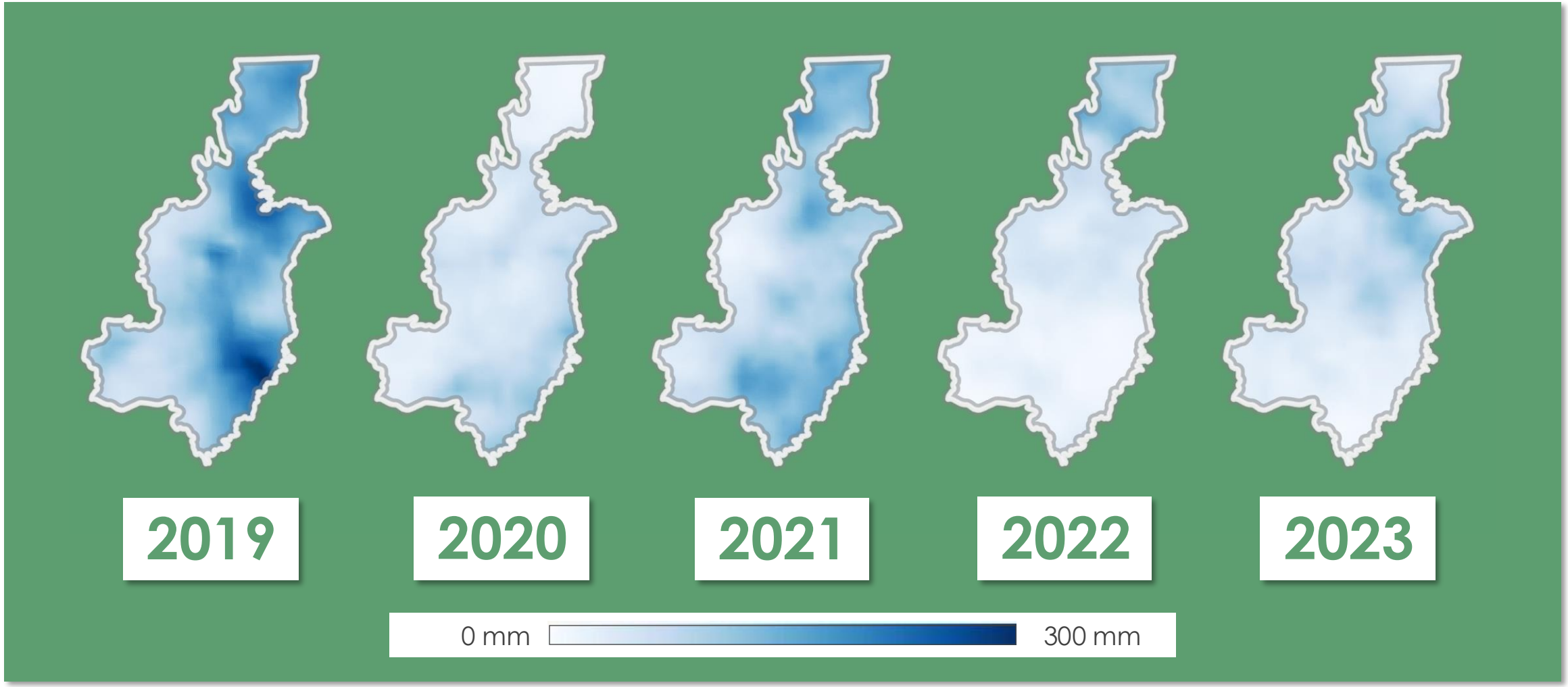
Methods: Grassland Prediction Model



Time Series: Palmer Drought Severity Index (June, Yearly)

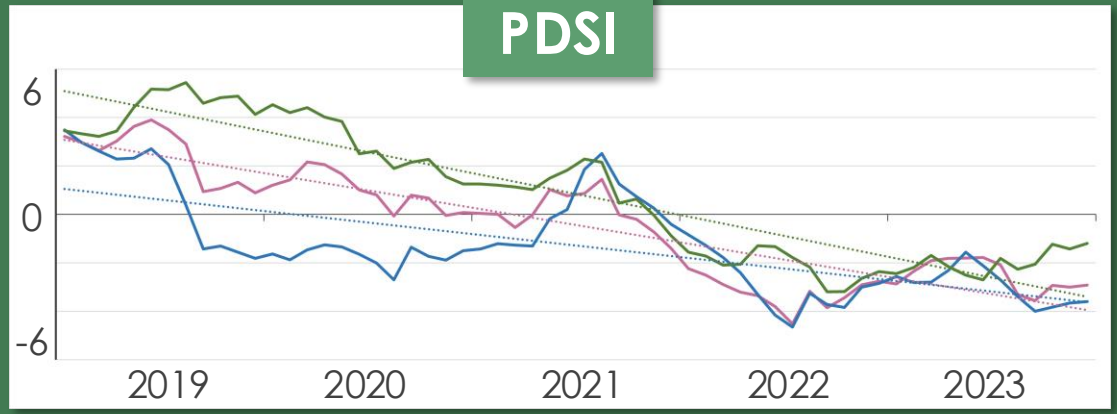


Time Series: Accumulated Precipitation (June, Yearly)

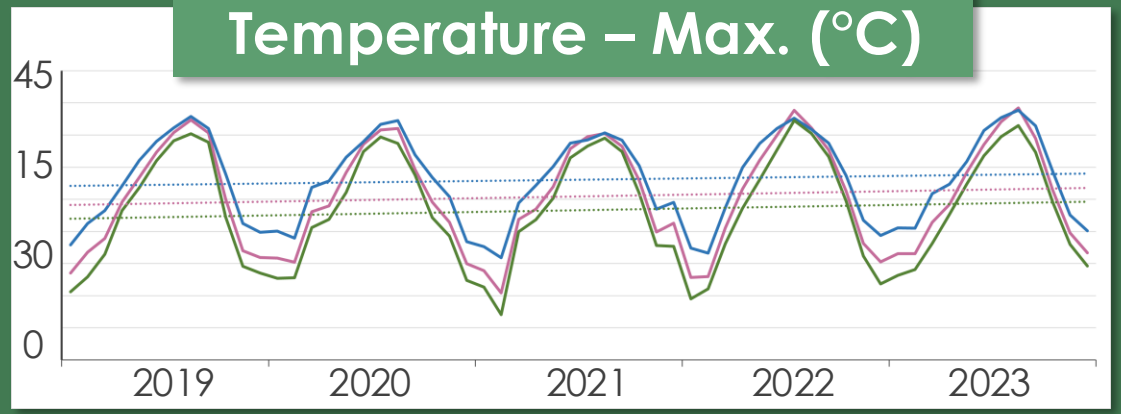


Time Series: Regional Profiles

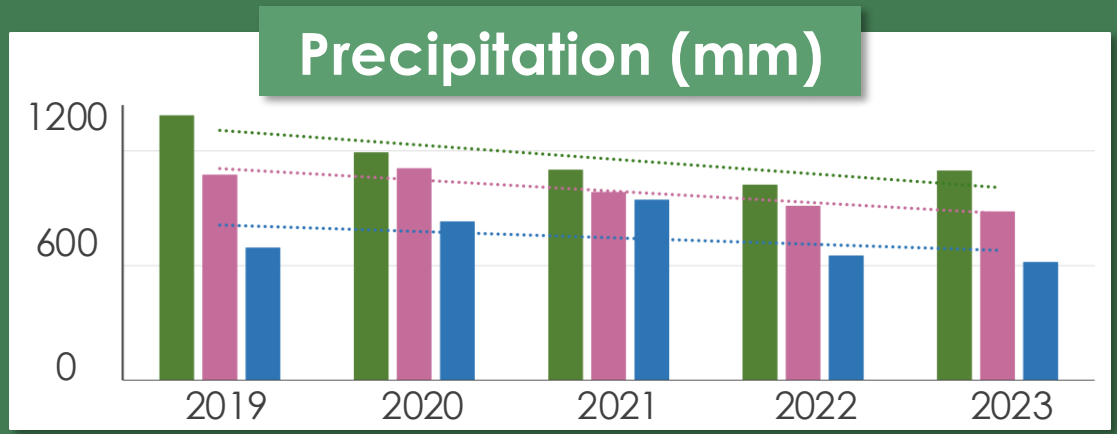
PDSI



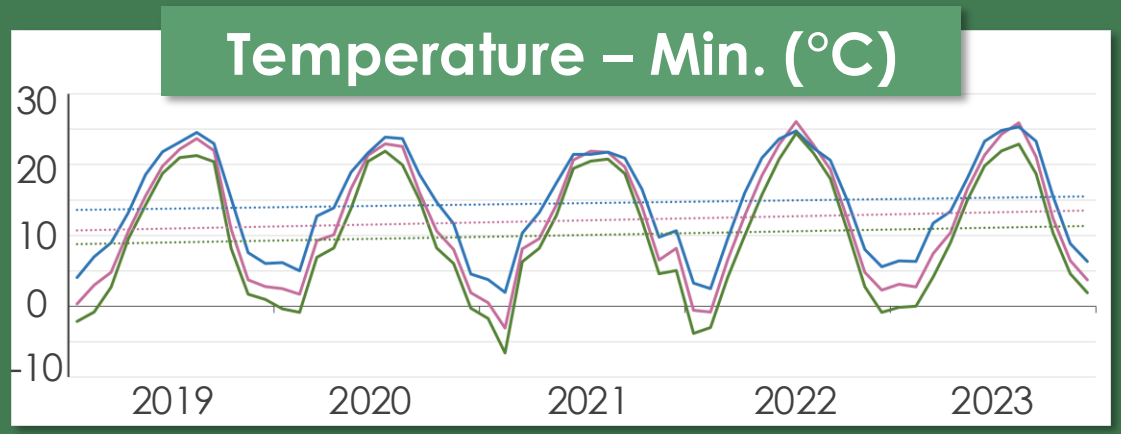
Temperature – Max. (°C)



Precipitation (mm)



Temperature – Min. (°C)



Oklahoma North Texas South Texas

Random Forest Regression Model Performance

Dependent Variable	Maximum R^2 Value	Normalized Root Mean Square Error *(n=27)*
Woody Cover	0.774	0.108
Herbaceous Cover	0.673	0.143
Woody Height	0.756	0.097
Herbaceous Height	0.648	0.119
Species Richness	0.676	0.088

Strongest Predictors

Sentinel SAR VV

Sentinel SAR VH

Landsat 8 Green

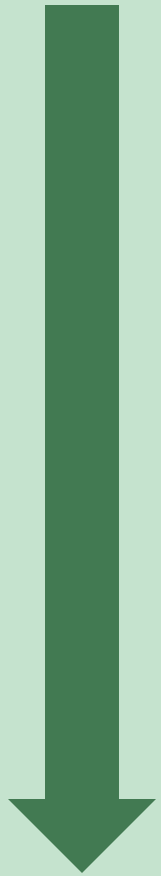
Landsat 8 Near IR

Landsat 8 Red

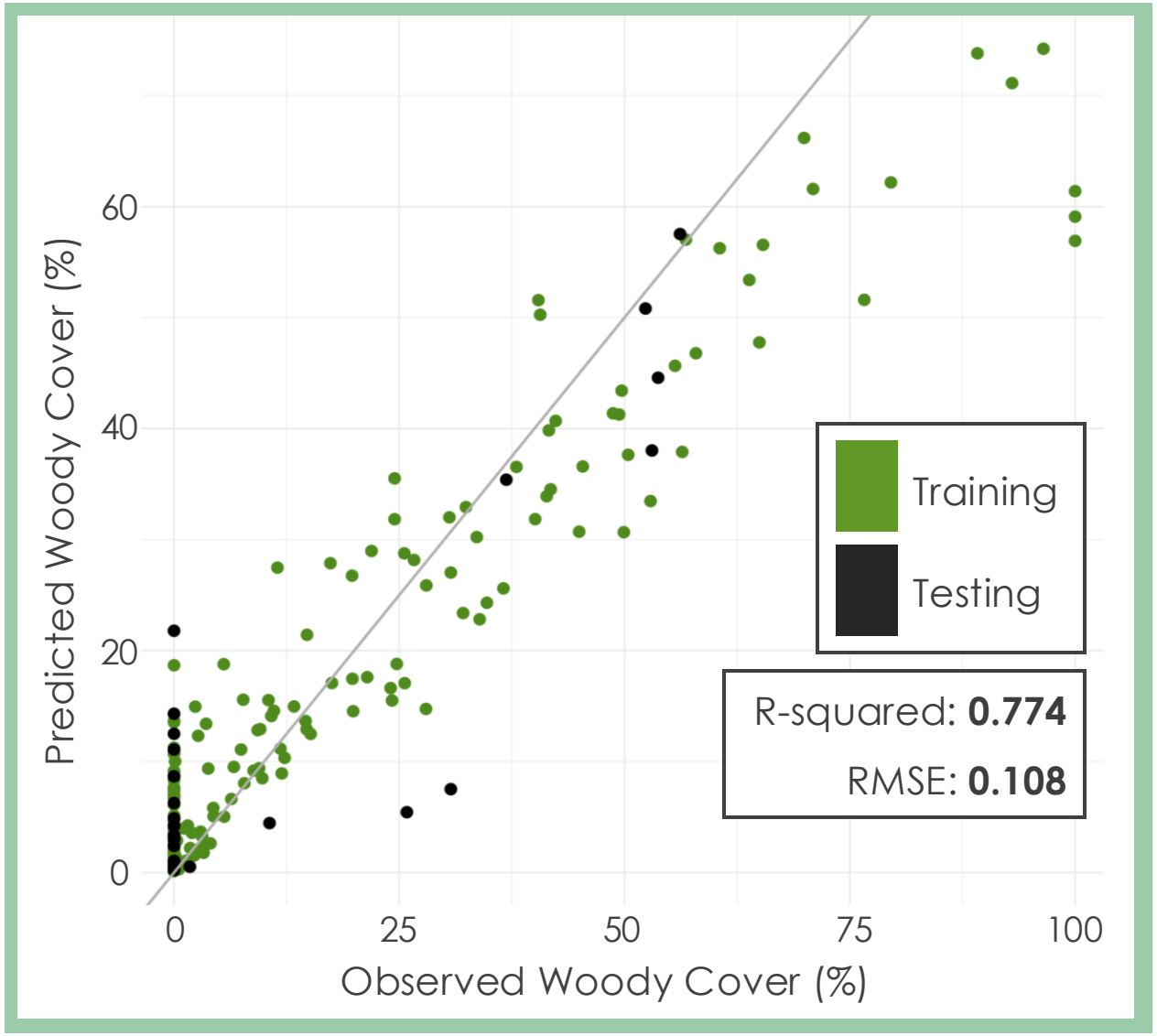
Normalized Burn Ratio

Landsat 8 Ultra Blue

SRTM Elevation

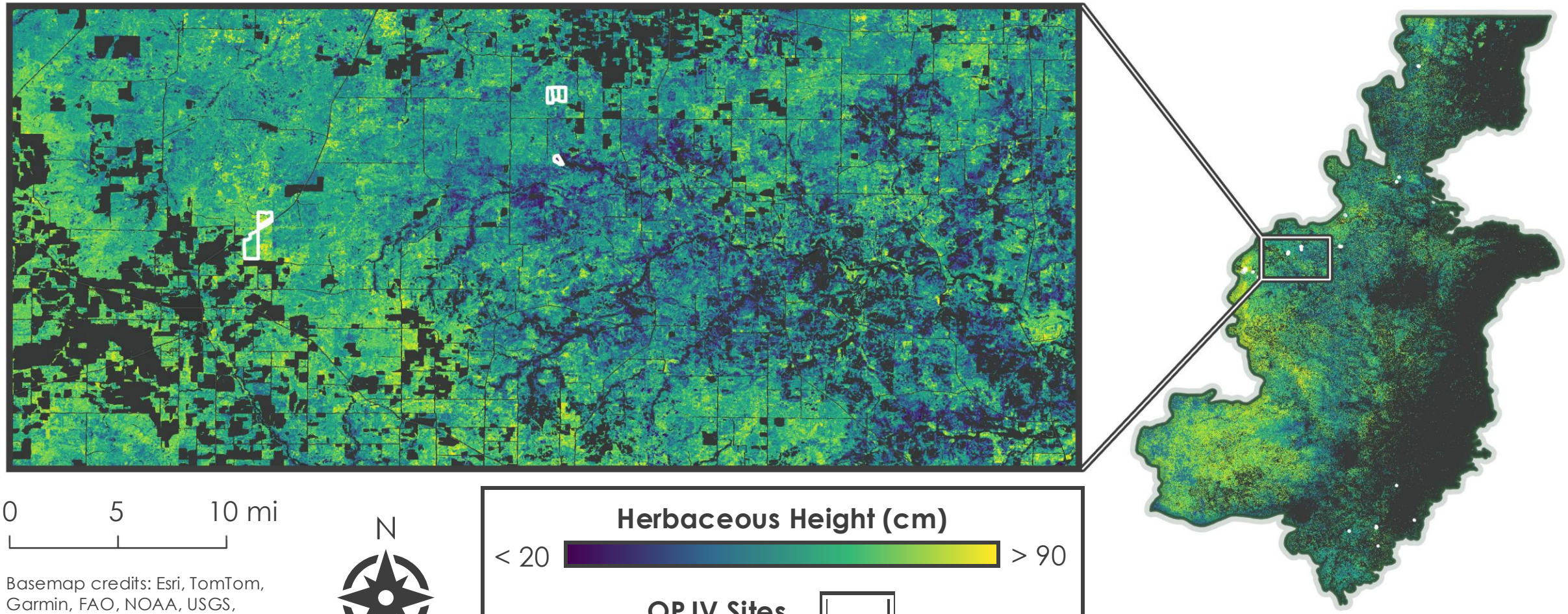


Assessing Model Performance



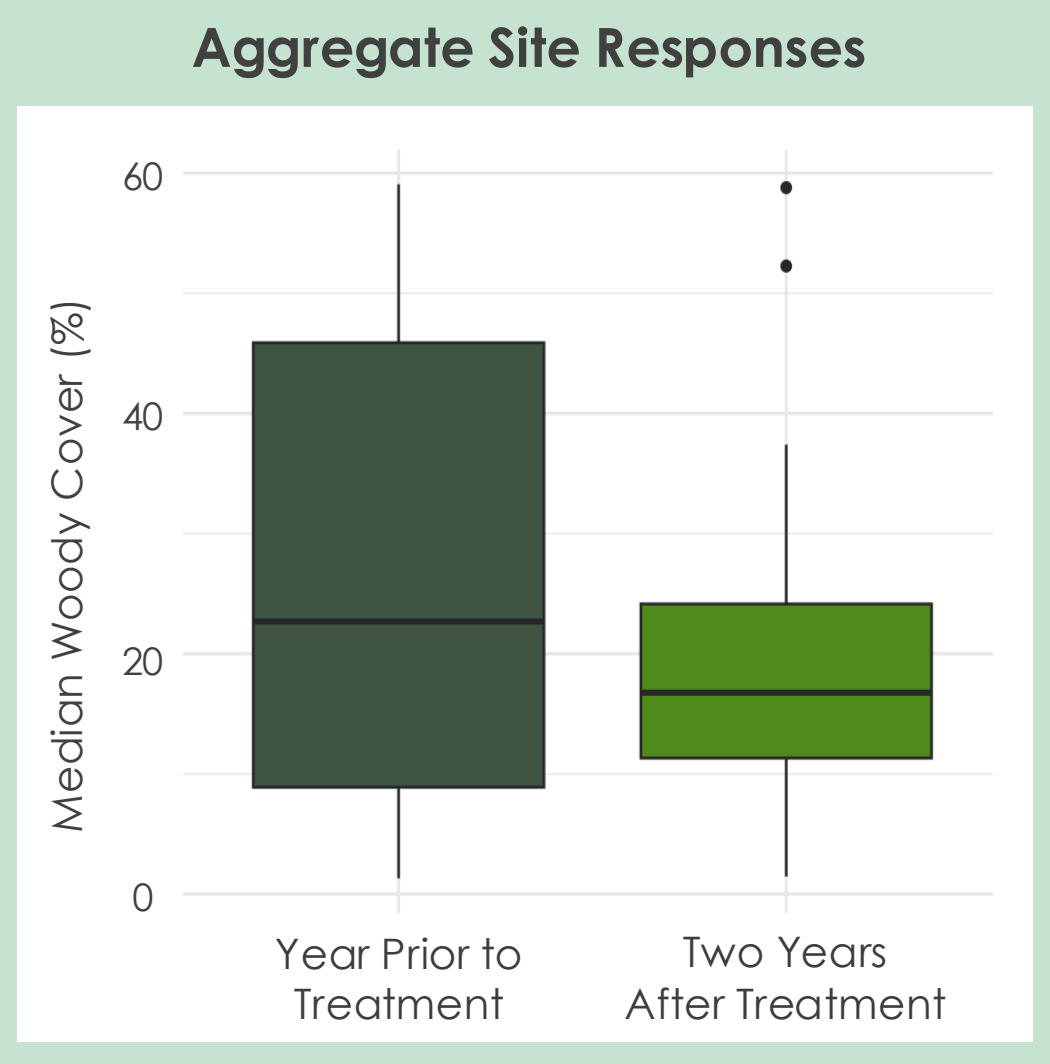
- Testing points follow the **same trend** as training points
- **Overestimation** when observed woody cover is low
- **Underestimation** when observed woody cover is high
- Potential influences by ground samples with no woody cover

Predicted Mean Herbaceous Height (2024)



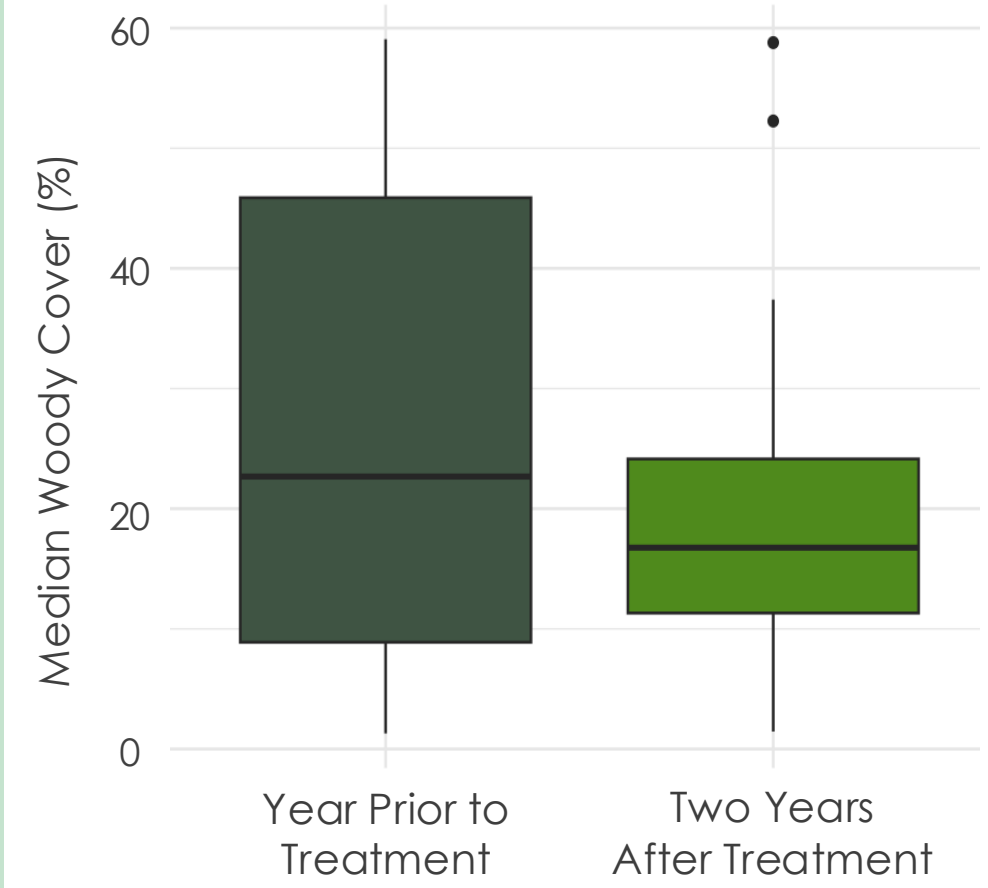
Basemap credits: Esri, TomTom, Garmin, FAO, NOAA, USGS, OpenStreetMap

Woody Cover Responses Vary by Spatial Scale

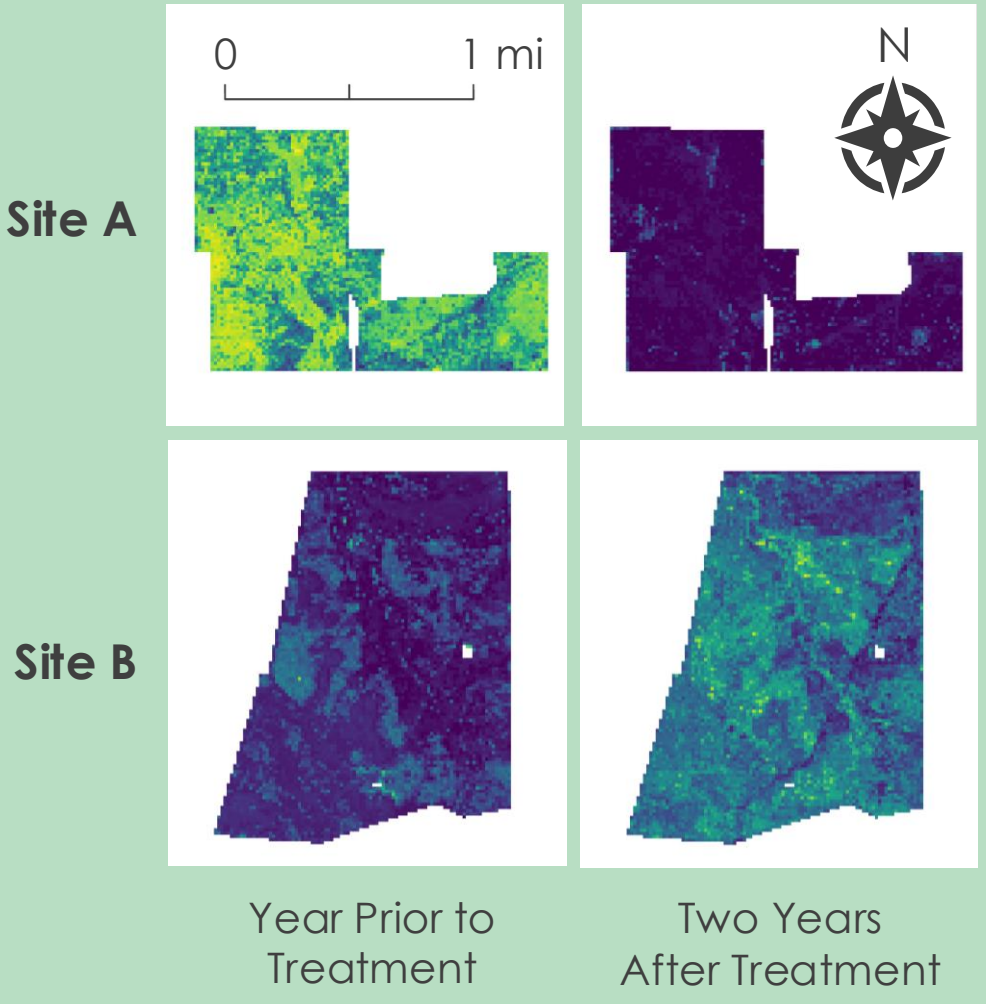


Woody Cover Responses Vary by Spatial Scale

Aggregate Site Responses

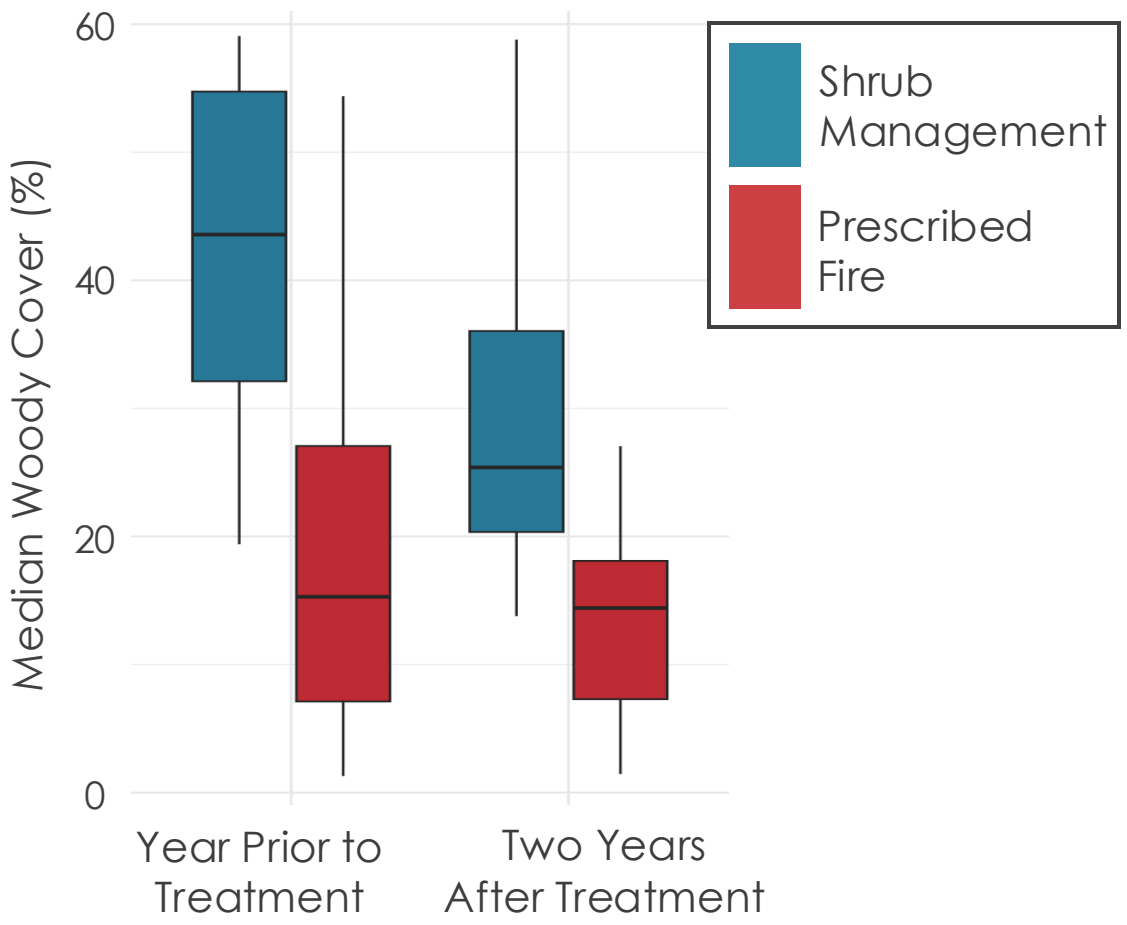


Site-Specific Change Dynamics



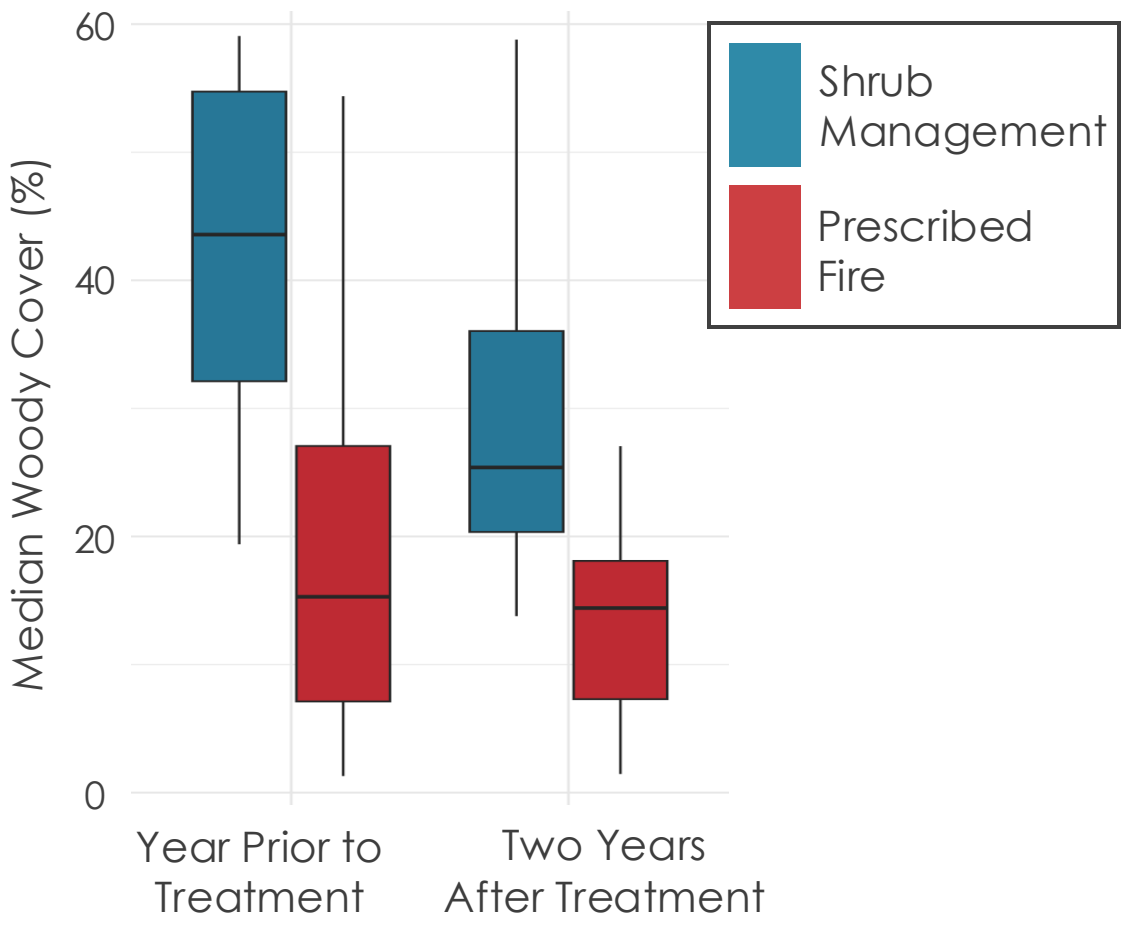
Woody Cover Responses Vary by Treatment

Aggregate Site Responses by Treatment

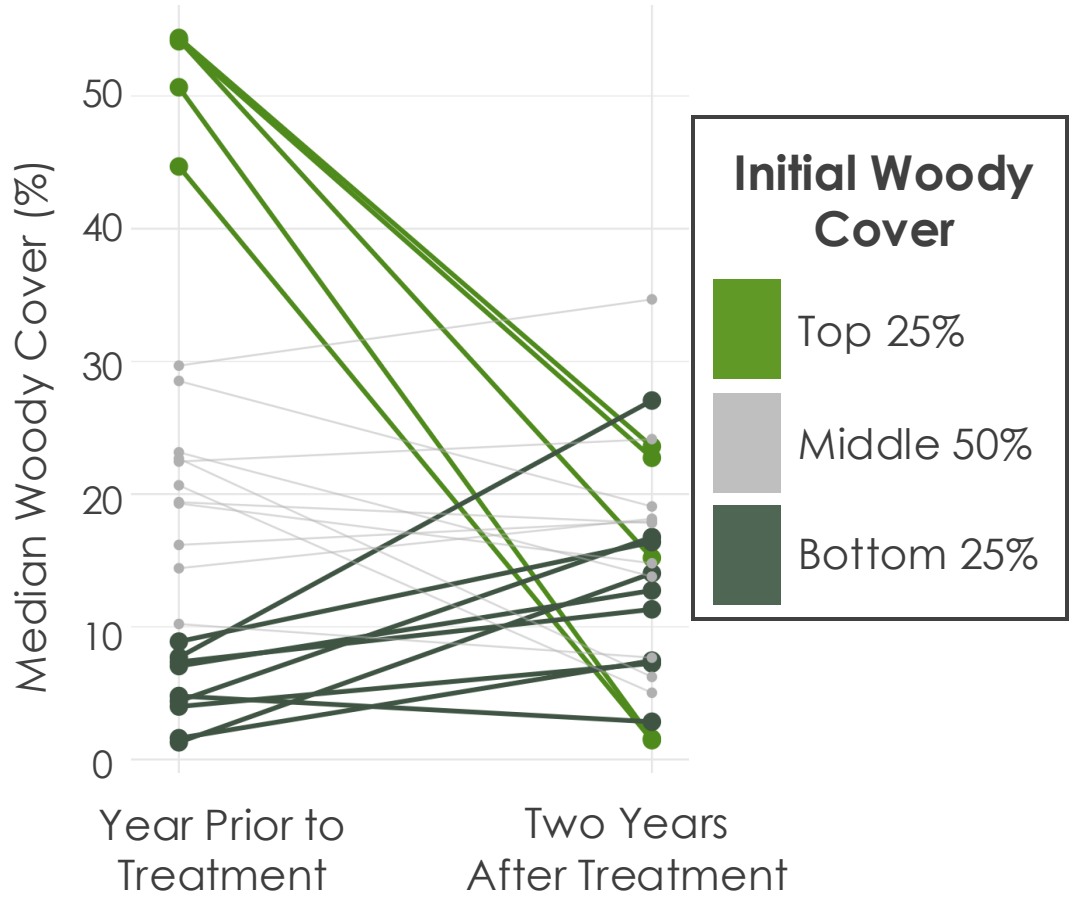


Woody Cover Responses Vary by Treatment

Aggregate Site Responses by Treatment



Response to Prescribed Burning: Variation by Initial Conditions



Errors & Uncertainties

- Site-level climatic statistics are **based on centroid points**.
- Challenging to distinguish restoration impacts by **treatments vs. other factors**.
- One Sentinel-1 C-SAR band, *angle*, produced **artifacts in plant height predictions**.
- **Additional explanatory data** may improve model performance.

Partner Implementation

Internal Decision-Making | **Restoration Monitoring** | **Funding Pursuits**

- Considerations:
  - Honed **regional models**
  - **More inputs** for ground truth data and explanatory variables
  - **Linking ground sampling and remote sensing methods**: aligning transects with Landsat pixels
  - **Google Earth Engine** to make data acquisition more efficient, automated, and less resource-intensive

Conclusions

Earth observations can effectively predict grassland vegetation characteristics

Most confident model predictions: **Landsat 8 + vegetation indices + SRTM elevation and topography + Sentinel-1 SAR**

Monthly climate analysis is useful for **contextualizing vegetation change dynamics**

Feasible for OPJV to adopt these methods to perform **independent analysis moving forward**

Acknowledgements

- **DEVELOP Lead**
  - Jane Zugarek (JPL – California)
- **Science Advisor**
  - Dr. Carlos Portillo-Quintero (Texas Tech University)
- **OPJV Partners**
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  - Derek Wiley (Texas Parks & Wildlife Department)
  - Robert Perez (American Bird Conservancy)

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