

National Aeronautics and Space Administration



#### Mark Twain National Forest Ecological Forecasting

Utilizing NASA Earth Observations to Classify Ground Cover Types in the Mark Twain National Forest

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### Road Map





#### Project Partners

- Mark Twain National Forest
  - History
  - Current restoration efforts
  - Community Concerns
  - Study Period
  - Study Objectives
  - Satellites & Sensors
- Methodology
- Results & Conclusions
- Errors & Uncertainties
- Future Work

# **Project Partners**



# USDA, US Forest Service Mark Twain National Forest (MTNF)

#### **USDA, US Forest Service**

#### Geospatial Technology and Applications Center



# **Mark Twain National Forest**



#### ▶ 1.5 million acres

- Diverse landscapes
  - Shortleaf pine-oak woodlands
  - Glades

#### Native species

- 750 native animal species
- 2000+ native plant species





Image Credits: US Forest Service; Nancy Feakes (USFS)

# Mark Twain National Forest - Historical

- Logging & fire suppression
   late 1800s early 1900s
- Only 10% of historic pine-oak woodlands remain today



Image Credits: US Forest Service; W.R. Werner (USFS); Paul D. Kelleter (USFS)

# **Mark Twain National Forest**

- 9 areas, 6 Ranger Districts
- Eleven Point & Poplar Bluff districts
  - Collaborative Forest Landscape Restoration Project (CFLRP, 2012)
- Ava district
  - Glade restoration





# **Community Concerns**





# **Study Period**





Image Credits: Jim Guldin (USFS); USDA-NRCS PLANTS Database

## Objectives





#### Classify

 Create a land cover type analysis of MTNF that can be used to assist with species-level classifications



#### Forecast

 Forecast out to the year 2040 to determine changes in land cover type based on current management practices

### **Satellite and Sensors**





Image Credits: NASA

### **Methods**





# Methodology: Image Processing

National Elevation Data

- Mosaicked DEM
- Calculated slope/aspect

Google Earth Engine

Filtered Landsat images
Applied cloud/snow masks
Calculated derivatives

Clipped & exported

#### ArcGIS Pro

- Mosaicked composite images
- Resampled to DEM's resolution (10m)
- Extracted all layers by mask to unify extents and number of columns/rows

 Greyscale Digital Elevation Model

 False-Color Slope-Aspect Model

Real-Color Landsat 5 Imagery, Winter 2001

False-Color NDVI, Winter 2001

# Methodology: Image Processing

#### Calculated Derivatives

- NDVI
- NDWI
- ► EVI
- Important for Classification
  - Seasonal
  - Differentiates vegetation
  - Isolates waterbodies



# Methodology: Supervised Classification

#### ArcPro Supervised Classification



# **Methodology: Species Modeling**

ArcPro Forest-Based Classification & Regression

















classification

2019 supervised classification



#### Land Cover Change, 1986-2019



10 miles 10 kilometers

> Land Cover Change 1986-2019 in Cassville Ranger District







#### Forecasted Land Cover Change, 2019-2040

Conifer to Deciduous
Meadow to Deciduous
Deciduous to Conifer
Meadow to Conifer
Deciduous to Meadow
Conifer to Meadow



Land Cover Forecast 2019-2040 in Cassville Ranger District

Eleven Point Ranger District:

#### 1986 Land Cover Classification





Eleven Point Ranger District:

#### 2019 Land Cover Classification





Eleven Point Ranger District:

#### 2040 Land Cover Forecast





Ava Ranger District:

#### 1986 Land Cover Classification





Ava Ranger District:

#### 2019 Land Cover Classification





Ava Ranger District:

#### 2040 Land Cover Forecast





**Species Modeling** 

In-Situ data:

Shortleaf Pine & Eastern Red Cedar ground-truthed data





#### Shortleaf Pine Species Modeling

Not present, training

Not present, modeling

Pine present, training

Pine present, modeling







#### Eastern Red Cedar Species Modeling

- C
  - Not present, training
- С

Cedar present, training

Not present, modeling

Cedar present, modeling







10 kilometers









#### Between 1986 and 2019

- Loss of conifer forest and meadow/grasslands
- Increase in hardwood deciduous
- Greatest class conversion was from conifer/grassland to deciduous
- Increase in water cover (2019 record floods)
- > 2040 Forecast
  - Current management practices could promote conifer forest and meadow/grassland revival
- More data is needed for stronger prediction models, especially species-level statistics

# **Errors and Uncertainties**

#### Training & validation data

- In-situ data not usable for species distribution
- Water and developed land cover training points impacted by snow mask

#### Landsat

- Coarse spatial resolution hides detail
- Large study area means we dealt with different swaths
- Low image quality made years ineligible









### **Future Work**





- Incorporate high-resolution aerial imagery into classification (NAIP, DOQ)
- Expand number of classes to be identified
- Incorporate disturbances into forecasting model

Image Credits: US Forest Service; Nancy Feakes (USFS); Jeff Hamm

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