**NASA DEVELOP National Program**

**2020 Summer Project Proposal**

**Idaho – Pocatello**

**Mark Twain National Forest Ecological Forecasting**

*Using NASA Earth Observations to Classify Ground Cover Types in the Mark Twain National Forest to Target Restoration and Monitoring Efforts*

**Project Overview**

***Project Synopsis*:** The Mark Twain National Forest (MTNF) in Southern and Eastern Missouri has a complex forest structure, fit with pine, hardwood, and dense understory stands. The contribution of all these forest types is invaluable to the ecology and ecotourism of the area. Native pine stands in the forest are a useful proxy for land managers to identify areas of bare and shallow soil in need of restoration to promote reforestation. Therefore, these pine stands are used as markers to locate and begin to restore these areas. This project will work with land managers in the MTNF to spectrally separate pine stands from hardwood and understory species, urban areas, and exposed ground in the forest using Landsat 5 TM, Landsat 8 OLI, SRTM, and the National Land Cover Database, which will allow land managers to better identify vegetation stands and soil types in and around the MTNF. This will assist land managers in their efforts to identify tree diversity at a species level in the MTNF.

***Community Concern:*** Pine species have been heavily logged since the turn of the century, and restoration efforts are increasing to combat the lack of native species in an otherwise hardwood dominated forest. Land managers at the MTNF use pine stands as markers for shallow or exposed soil in the national forest to help generate maps of areas in need of restoration. Native pines also store carbon and influence groundwater stocks and slope erosion. If these trees are missing within areas of the forest, these factors can run unchecked and targeted restoration will be necessary. These concerns are the chief motivation for delineating between pine stands and other forest types on a landscape level throughout the forest.

***Source of Project Idea:*** In initial contact with the US Forest Service Mark Twain National Forest (USFS MTNF), this project was identified as a priority by Kevin Godsey, a soil scientist working in the MTNF. An increase in observed poor soil quality and an invasion of new species motivated the USFS MTNF to seek new avenues of restoration, and help from DEVELOP was requested by the partners to assist restoration planning.

***National Application Area Addressed:*** Ecological Forecasting

***Study Location:*** Mark Twain National Forest, MO

***Study Period:*** 1986-2020 (October – March); Forecasting to 2040

***Advisor:*** Keith Weber (Idaho State University, GIS TReC)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **USDA, US Forest Service, Mark Twain National Forest** | Kevin Godsey, Soil Scientist; Kyle Steele, Forest Ecologist | End User | No |
| **USDA, US Forest Service, Geospatial Technology and Applications Center** | Nick Klein-Baer, Remote Sensing Analyst | Collaborator | No |

***End-User Overview***

***End User’s Current Decision-Making Process:*** The USFS MTNF has not yet completed a forest-wide inventory of glade ecological sites in the national forest. Management decisions in the forest are determined on a case-by-case basis, taking additional time and resources. Beyond manual field inventories completed by foresters and aerial photography review, no remote sensing of the forest has been attempted.

***End User’s Capacity to Use NASA Earth Observations:***

*USDA, US Forest Service, Mark Twain National Forest* – Employees at this organization are moderately familiar with GIS. This partner uses GIS in a nominal capacity for decision making but has no specific focus on using NASA Earth observations or remote sensing.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

 *USDA, US Forest Service, Geospatial Technology and Applications Center* – Partners at this agency will provide the team with data and geospatial research for the MTNF. This organization focuses on the use of remote sensing to solve spatial problems in the MTNF and has strong experience with NASA Earth Observations. They will use this expertise to provide feedback to the team on methodology and end products.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The Idaho NASA DEVELOP team will meet with partners biweekly to give progress updates and to ask questions about specific project elements. Email communication will be open between the team and partners throughout the term.

***Transition Plan*:** The Idaho DEVELOP team will hold a virtual handoff at the end of the term. This will include a presentation of findings as well as a handoff of classification maps and a reproducible ArcGIS Model-builder model so that the USFS MTNF can implement this process at a later time if needed. No code will be generated so software release will not be required.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 8 OLI** | Spectral vegetation indices | This satellite will be used to create vegetation indices (NDVI, NDWI, etc.) for the study period to spectrally separate pine stands from other land cover types. |
| **Landsat 5 TM** | Spectral vegetation indices | This satellite will be used to create vegetation indices (NDVI, NDWI, etc.) for the study period to spectrally separate pine stands from other land cover types. |
| **Sentinel-2 MSI** | Spectral vegetation indices | This sensor will be used to generate vegetation indices with a finer spatial resolution (15m) than Landsat. |
| **SRTM** | Topography | SRTM data will be used to generate a DEM of the study area to calculate slope, aspect, etc. |

***Ancillary Datasets:***

* USGS National Land Cover Dataset (NLCD) – Compare tree species types on a fine scale to classifications
* USDA National Agriculture Imagery Program (NAIP) Imagery –Validate imagery selection on a very fine spatial resolution (1m)

***Modeling:***

* Classification Tree Analysis (Keith Weber, ISU GIS TReC) – Used to classify the MTNF into distinct landcover classes
* Land Change Modeler (Keith Weber, ISU GIS TReC) – Used to forecast land cover change of the MTNF out to 2040

***Software & Scripting:***

ESRI ArcGIS Pro – Creation and analysis of vector data

Harris ENVI – Creation of imagery stacks and classifications

IDRISI TerrSet – Land change modeler and Classification Tree Analysis

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Classification and Forecast Map of Landcover Types in MTNF** | This will be used by partners to better establish areas for restoration and further research to discern species-level identification of tree stands, while projecting forest change to 2040. | This will involve Landsat 5 TM, Landsat 8 OLI, SRTM, and Sentinel-2 MSI data being put through a random forest analysis to achieve a high level classification of ground cover types. | I |
| **Tutorial for Classification Workflow** | This will be used to allow partners to recreate this methodology in the future if need be.  | N/A | N/A |

***End-User Benefit*:** A cover type analysis of the forest canopy will allow forest managers to completely map the landcover types of the forest and will eventually assist managers in the creation of species level classifications. This map will then be forecasted out to the year 2040 to see changes in cover type while considering current management practices. This cover map will be integrated with elevation models on-hand so that forest managers can strategize their focus on restoring glade habitat across the 1.5 million acres of public land.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2020 Summer

***Related DEVELOP Work:***

2019 Summer (ID) – Monongahela National Forest Ecological Forecasting: Forecasting Red Spruce

Restoration Using NASA Earth Observations to Support Decision Making in the USFS Monongahela National Forest

2019 Summer (CO) – Moloka’i Water Resources: Employing NASA Earth Observations to Map the Impacts

of the ‘Ohi’a Rust on Forest Health and Coastal Turbidity on Moloka'i, Hawaii

2019 Summer (GSFC) – New York Ecological Forecasting II: Comparing Efficiency of Space-Based Imagery

to AVIRIS Airborne Data for the Identification of Hemlock Forests to Mitigate Invasive Species Expansion

**References:**

Vandendriesche, D., & Haugen, L. (2008). Comparison of FVS projection of oak decline on the Mark Twain

National Forest to actual growth and mortality as measured over three FIA inventory cycles. In *Third Forest Vegetation Simulator Conference* (pp. 68-80). USDA Forest Service. RMRS-P-54. Fort Collins, CO.

Carleer, A., & Wolff, E. (2004). Exploitation of very high resolution satellite data for tree species

identification. *Photogrammetric Engineering & Remote Sensing*, *70*(1), 135-140.

Norris, M. D., Blair, J. M., Johnson, L. C., & McKane, R. B. (2001). Assessing changes in biomass,

productivity, and C and N stores following *Juniperus virginiana* forest expansion into tallgrass prairie. *Canadian Journal of Forest Research*, *31*(11), 1940-1946.