**NASA DEVELOP National Program**

NASA Marshall Space Flight Center

**Spring 2016**

**Short Title: Alabama Ecological Forecasting**

**Subtitle:** Assessing Southern Pine Beetle Epidemics in the Bankhead Forest of Alabama Using NASA Earth Observations

**VPS Title:** Here, There, and Everywhere: Assessing Southern Pine Beetle Outbreak Risk in Alabama

**Project Team & Partners**

**Project Team:**

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**Advisors & Mentors:**

Dr. Jeffrey Luvall (NASA at the National Space Science Technology Center)

Dr. Robert Griffin (University of Alabama in Huntsville)

**Partner Organizations:**

USDA Forest Service (end-user), POC: Dave Casey, Dr. John Nowak, Dr. Chris Asaro

**Project Details**

**Applied Sciences National Applications Addressed:** Ecological Forecasting

**Study Area:** Alabama

**Study Period:** May 1995 - Dec 2030

**Earth Observations & Parameters:**

SRTM-v2, C-band – Digital Elevation Models (DEM)

Landsat 5, TM – land cover

Landsat 8, OLI – land cover

TRMM, TMI – precipitation

GPM, iMERGE – precipitation

**Ancillary Datasets Utilized:**

* National Agriculture Imagery Program (NAIP) – land cover
* LANDFIRE data – land cover
* FORWARN Forest NDVI change – change in vegetation health
* NOAA Climate Data Record – climate data
* Southern Pine Beetle Information System – in situ data

**Models Utilized:**

* Princeton University Maximum Entropy Distribution Model (MaxEnt)
* DEVELOP Landsat pre-processing to TOA Dnppy model

**Software Utilized:**

ArcGIS - raster manipulation/analysis, image enhancement & map creation of Landsat TM, ETM+, OLI,
 Aqua/Terra MODIS

R - Regression analysis, execution of MaxEnt, and land cover delineation

**Project Overview**

**80-100 Word Objectives Overview:**

The Southern Pine Beetle (SPB), *Dendroctonus frontalis*, is an opportunistic species that attacks stressed trees that have been weakened by drought, storm damage, or fire. Outbreaks of SPB typically have a six to twelve year interval, are estimated to destroy about 60,000 pine trees per year in Alabama, and cause about $800,000 in damages annually. This project identified areas in Alabama, with a focus in the Bankhead National Forest, that have been infested with the SPB by creating a Historical Pine Beetle Coverage Map. A Pine Beetle Prediction Map was also created to evaluate where mitigation efforts should be focused.

**Abstract:**

The Southern Pine Beetle (SPB), *Dendroctonus frontalis*, is an opportunistic species that attacks stressed trees weakened by drought, storm damage, or fire. In 2000, about 18,600 acres of pine forest were damaged throughout the Bankhead National Forest due to SPB. The United States Forest Service (USFS) currently uses expensive manned aerial surveys, such as aerial photography and LiDAR, as well as MODIS ForWarn and Forest Disturbance Monitor data to help with mitigation efforts. This project used remotely sensed data to identify infected areas throughout Alabama and determine outbreak patterns. Aqua/Terra MODIS were used to derive a Normalized Difference Vegetation Index (NDVI) to show the health of the pine trees and a Normalized Moisture Difference Index (NMDI) to show the surrounding drought conditions. The Tropical Rainfall Measuring Mission (TRMM) and the Global Precipitation Measurement (GPM) were both used to analyze precipitation within the study area. SRTM-v2 Digital Elevation Models (DEMs) were used to understand how elevation and slope affects SPB susceptibility. Presence SPB data and various environmental variables were analyzed by the Princeton Maximum Entropy model (MaxEnt) to assess areas susceptible to a SPB outbreak .Additionally, this project determined where mitigation efforts should be focused by creating a Historical Pine Beetle Coverage Map and a Pine Beetle Prediction Map. The USFS used these methodologies and maps to reduce costs and time associated with SPB suppression in Bankhead National Forest.

**Community Concerns:**

* SPB is one of the most destructive pine pests in the Southeastern United States causing hundreds of thousands of dollars in damage to pine trees each year.
* Trees killed by SPB can increase the risk or severity of forest fires by increasing the fuel load available to burn.
* Damages caused by the SPB may result in limited diversity in surrounding plants and harm other animals’ habitats, such as the near-threatened Red-cockaded Woodpecker.

**Current Management Practices & Policies**:

Currently, the United States Forest Service (USFS) uses expensive manned aerial surveys, such as aerial photography and LiDAR, as well as MODIS ForWarn and Forest Disturbance Monitor data. With the aerial data, field surveys must also be used since the species of beetle must be positively identified before conservation efforts can be implemented. For each species of beetle, specific management control and recommendations are needed as the beetles attack different pine trees at varying health and stress levels. During the winter months, suppression techniques include the removal of infested trees by salvage, piling and burning, or chemical control.

**Decision Support Tools & Benefits:**

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| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Historical Pine Beetle Coverage Map | Landsat 5 TM, Landsat 8 OLI, SRTM v-2 | Determine infected areas and how they have changed to help in prioritizing suppression |
| Pine Beetle Prediction Map | Landsat 5 TM, Landsat 8 OLI, TRMM TMI, GPM iMERGE, SRTM v-2 | Determine where the efforts should be focused for future conservation |
| Near Real-Time Pine Beetle Susceptibility Model | Landsat 8 OLI, GPM iMERGE, SRTM v-2 | Determines which areas are susceptible to a SPB outbreak in near real-time |

**Project Imagery**

**[Insert image here]**

**Caption:** [Insert Caption Here. Max of 25 words.] Image Credit: [Insert project short title] Team.

**Image:** File Name (Please submit your image as a separate .jpeg as well as inserting it in this document)

**Software Release Requirements**

What category do the tools your project is creating fall within? Category II