**NASA DEVELOP National Program**

Marshall Space Flight Center

**Fall 2014**

**Cumberland Plateau Ecological Forecasting**

*Utilizing NASA Earth Observations to Map and Model the Spread of Invasive Asiatic Bush Honeysuckle on the Cumberland Plateau*

**Team Lead:** Brandie Stringer, brandie.stringer@gmail.com

**Team Members:**

Michael Logsdon

Daryl Ann Winstead

**Advisors & Mentors:**

Dr. Jeffrey Luvall (NASA, Global Hydrology and Climatology Center)

**Applied Sciences National Applications Addressed:**

Ecological Forecasting

**Study Area:** Cumberland Plateau: Alabama, Tennessee, Kentucky

**Study Period:** November 2001 – January 2014

**Partners/Collaborators**

USDA Forest Service Southern Research Station: Dr. Callie Schweitzer

Land Trust of North Alabama: Marie Bostick

**80-100 Word Blurb**

The Cumberland Plateau is home to the greatest diversity of species in the southeastern United States. Many areas within this region are protected. Some of these areas are currently being surveyed to determine invasive plant coverage; however, a large portion of the region is privately owned and inaccessible to the U.S. Department of Agriculture Forest Service Southern Research Station (USDAFS SRS) for surveys. This study employed a methodology to determine hot spots for invasive bush honeysuckle using satellite imagery. The results of this study will help land managers decide how and where to focus timely management efforts.

**Community Concerns**

* Invasive terrestrial plant groups such as Asiatic bush honeysuckle (invasive, shrubby species of the *Lonicera* genus) are capable of radically altering a habitat or ecosystem.
* Asiatic bush honeysuckle is negatively impacting the Cumberland Plateau, putting its recreational purposes and diverse ecology in danger.
* Asiatic bush honeysuckle has spread rapidly throughout the Cumberland Plateau, averaging complete coverage of 0.1-0.4 hectare per year in several areas. This has raised regional concerns and has helped land managers to develop an initiative to identify problematic areas for management.

**Current Management Practices & Policies**

Mechanical and chemical methods are the primary means of controlling exotic bush honeysuckles. Currently, the U.S. Department of Agriculture Forest Service Southern Research Station (USDAFS SRS) is using ground-surveying methods that are both time- and manpower-intensive to determine coverage of the invasive Asiatic bush honeysuckle on the Cumberland Plateau. The station is currently not using remote sensing for surveying. Because Asiatic bush honeysuckle plants typically expand their leaves in early spring and retain them longer in the fall than most plants, remote sensing imagery collected during November through January can be used for determining the location and for forecasting the future spread of the plant group in the surrounding area.

**Abstract**

Invasive terrestrial plant groups, such as Asiatic bush honeysuckle, are capable of altering a habitat or ecosystem to such an extent that the inherent functions of the system are radically changed. These plants can change the structure of the soil, create erosion problems, and alter the availability of resources, such as water. These changes can have cascading effects felt throughout the entire ecosystem. Asiatic bush honeysuckle has spread rapidly throughout the Cumberland Plateau, averaging complete coverage of 0.1-0.4 hectares per year in several areas. Maps of this invasive shrub group are required to identify problematic areas in order to prioritize sites for management. The goal of this project was to map the location, density, and probability of movement for Asiatic bush honeysuckle throughout the Cumberland Plateau. Ground-survey data were collected by the United States Department of Agriculture Forest Service Southern Research Station (USDAFS SRS). The data were then used to build a Geographic Information Systems (GIS) database, where imagery were incorporated from Landsat 7 Enhanced Thematic Mapper Plus (ETM+), Landsat 8 Operational Land Imager (OLI), and Terra Moderate Resolution Imaging Spectroradiometer (MODIS) Leaf Area Index (LAI) and Fraction of Photosynthetically Active Radiation (FPAR). Using the Normalized Difference Vegetation Index (NDVI) and the Reaction-Diffusion (R-D) model of the species, a spread and habitat suitability model was constructed. Relative density and spread maps for Asiatic bush honeysuckle were derived, predicting the spread rate and allowing prioritization of area management for current and future needs.

**Decision Support Tools**

* Asiatic Bush Honeysuckle Relative Density Maps - derived by correlating vegetation indices with relative density of bush honeysuckle at sampling plots, these maps will help land managers prioritize their management focus
* Asiatic Bush Honeysuckle Spread Maps - based on Reaction-Diffusion (R-D) model spread rate and suitable habitats for invasion, these maps will also aid land managers in prioritizing their management focus

**Benefit to End-User:**

* Identification of problematic areas
* Prioritization of management
* Time and manpower conservation using satellite imagery for methodology

**Earth Observations & Parameters**

Landsat 7, Enhanced Thematic Mapper Plus (ETM+) – Spectral vegetation indices

Landsat 8, Operational Land Imager (OLI) – Spectral vegetation indices

Terra, Moderate Resolution Imaging Spectroradiometer (MODIS) – Leaf Area Index (LAI) and Fraction of Photosynthetically Active Radiation (FPAR)

**Future Applicable NASA Missions**

Ecosystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS)

– Plant evapotranspiration

Global Ecosystem Dynamics Investigation Lidar (GEDI) – Forest Canopy Structure Hyperspectral Infrared Imager (HyspIRI) – Change in vegetation

**Models Utilized**

Reaction Diffusion (R-D) Model of invasive species spread

Habitat suitability model

**Ancillary Datasets Utilized**

U.S. Department of Agriculture Forest Service Southern Research Station (USDAFS SRS) – understory and overstory data

**Software Utilized**

ArcGIS 10.2.1 - Raster manipulation / analysis, image enhancement, and map creation using imagery from Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and Terra / Aqua MODIS

ENVI 5.0 - Raster manipulation / analysis, and image enhancement of data from Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and Terra / Aqua MODIS