**NASA DEVELOP National Program**

**2017 Fall Project Proposal**

**Virginia – Wise**

**Yellowstone Ecological Forecasting**

*Utilizing NASA Earth Observations to Identify Spatial and Temporal Patterns of Early Season Invasive Grasses in Yellowstone National Park*

**Project Overview**

***Project Synopsis*:** Cheatgrass (*Bromus tectorum)* is an invasive grass species widely distributed across the western United States. Unseasonable germination and a shallow, nitrogen-fixing, root system allow cheatgrass to outcompete endemic grass and forb species and quickly become dominant in areas of high disturbance. This project will use Landsat data, multi-temporal and multi-spectral indices, field data, and ensemble distribution modeling to map changes in cheatgrass spatial distribution in Yellowstone National Park. Species growth will be forecast until 2045 and periods of extensive growth will be correlated with specific climatic and weather events to support the planning and execution of cheatgrass management within Yellowstone National Park.

***Community Concern:*** The National Park Service’s mission is to preserve the natural resources of the public lands it manages. Recent fires and disturbance due to park expansion and visitor use has rendered Yellowstone National Park highly susceptible to continued cheatgrass invasion as well as increased fire frequency and severity in areas populated by the grass. Highly restricted in its range, Ross’s bentgrass (*Agrostis rossiae*) is extremely rare and only known to grow in the Shoshone Geyser Basin in Yellowstone National Park, however the impending spread of cheatgrass threatens its success. Competition between cheatgrass and endemic species leads to lower biodiversity and possible changes in the ecology of the landscape and fire regime, ultimately affecting wildlife populations dependent upon native flora.

***Source of Project Idea:*** This project originated from a proposal written by Heidi Anderson, Park Botanist and Wetlands Ecologist at Yellowstone National Park.

***National Application Areas Addressed:*** Ecological Forecasting, Climate

***Study Location:*** Yellowstone National Park, WY

***Study Period:*** 1985 – 2017; Forecasting to 2027

***Advisors:*** Dr. Kenton Ross (NASA Langley Research Center), Dr. L. DeWayne Cecil (NOAA National Centers for Environmental Information, Global Science & Technology, Inc.), Robert VanGundy (The University of Virginia’s College at Wise), Dr. Amanda West (Colorado State University)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| National Park Service, Yellowstone National Park | Heidi Anderson, Park Botanist & Wetlands Ecologist | End User | No |

***End User Overview***

***End User’s Current Decision-Making Process:*** Park botanists at Yellowstone National Park currently use extensive field surveys and *in situ* measurements to track the distribution of cheatgrass in efforts to control its spread through hand-pulling and mechanized techniques. These field surveys do not cover the majority of the park, nor are they easily updated on a yearly basis.

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

*National Park Service, Yellowstone National Park* – Botanists at Yellowstone National Park are familiar with NASA Earth observations such as MODIS and Landsat, but do not use them as a part of their daily decision making. This project aims to introduce a tool that park botanists can use to monitor the spread of cheatgrass as well as forecast where it may spread next.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Bi-weekly teleconferences will be held between the team and end users to communicate project progress over the course of the term. The main DEVELOP POC will be the team lead.

***Transition Plan*:** Products created during the project will be presented to the end users via Google Hangout with shared slides and transferred via NASA Large File Transfer or email.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 5 TM** | Greenness, land cover, moisture, surface reflectance | This dataset provides the temporal and spatial resolution required to model the progression of cheatgrass invasion in Yellowstone National Park with images beginning in 1985. |
| **Landsat 8 OLI** | Greenness, land cover, moisture, surface reflectance | This data set provides the temporal and spatial resolution required for modeling current cheatgrass cover in Yellowstone National Park with images beginning in 2013. |
| **Landsat 8 TIRS** | Brightness, temperature | This dataset will be used to differentiate cheatgrass from Ross’s bent grass by examining correlations between surface temperature and soil moisture. |
| **Terra MODIS** | Vegetative phenology | The USFS Forwarn phenology dataset will be used to evaluate vegetation types and distinguish cheatgrass, and possibly Ross’s bentgrass, across the landscape of Yellowstone National Park. |
| **SRTM Version 2** | Aspect, elevation, slope, topographic indices | This dataset will be used to derive topographic indices for modeling species distribution of cheatgrass and Ross’s bentgrass. |

***Ancillary Datasets:***

National Park Service, Yellowstone National Park – Administrative Boundaries – final map creation

National Park Service, Yellowstone National Park – Cheatgrass and Ross’s Bent Grass Field Data – model training and validation

WorldClim – Current and potential future climate conditions – model training

USDA – GSSURGO – Soil data – model training

***Modeling:***

Boosted Regression Trees (BRT) (POC: Amanda West, Colorado State University)

Generalized Linear Model (GLM) (POC: Amanda West, Colorado State University)

Maxent (POC: Amanda West, Colorado State University)

Multivariate Adaptive Regression Splines (MARS) (POC: Amanda West, Colorado State University)

Random Forest (RF) (POC: Amanda West, Colorado State University)

***Software & Scripting:***

Esri ArcGIS – Landsat imagery processing, indices derivation, map production

R Studio – statistical modeling and graphing

Software for Assisted Habitat Modeling (SAHM) – species distribution modeling

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| Cheatgrass Cover Time Series | The time series will be used to identify progression of cheatgrass invasion in Yellowstone National Park since 1985 to provide partners with a baseline to assess the spread of cheatgrass over time. | Field data, MODIS, Landsat 5 and Landsat 8 data will be used to identify parameters such as greenness, land cover, and surface reflectance to create maps displaying cheatgrass progression from 1985 – 2017. | N/A |
| Ross’s Bentgrass Cover Map | Cover maps will identify locations of Ross’s bent grass in the park to provide partners with a baseline to assess the extent of Ross’s bentgrass coverage. | Landsat 5 and 8 datasets will be used to create a map displaying the coverage of Ross’ bentgrass in the park. | N/A |
| Cheatgrass Bioclimatic Forecasting Map | Forecasting future progression of cheatgrass in Yellowstone National Park will assist partners in planning and management efforts to mitigate cheatgrass growth. | Field data and WorldClim data will be used to identify current and potential future climate conditions through model training and validation. | N/A |

***End User Benefit*:** This project will provide the National Park Service with a better understanding of cheatgrass distribution and movement patterns. This will save NPS time and money by allowing park personnel to better focus their efforts when conducting field surveys. Furthermore, the products created will provide the agency with additional means to manage current cheatgrass populations and, potentially, prevent further invasion.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2017 Fall

***Related DEVELOP Work:***

2015 Fall (CO) – Wyoming Ecological Forecasting: Mapping Cheatgrass Distribution and Phenology in a Post-Wildfire Landscape in Wyoming’s Medicine Bow National Forest

2016 Summer (GSFC) – Northern Great Plains Ecological Forecasting: Utilizing NASA Earth Observations to Map Temporal and Spatial Patterns of Annual Bromes for Prairie Management and Invasive Species Control in the Northern Great Plains

**References:**

Ross’s Bentgrass – Yellowstone National Park (U.S. (n.d.)). Retrieved October 19, 2016, from https://www.nps.gov/yell/learn/nature/bentgrass.htm