**NASA DEVELOP National Program**

**2018 Spring Project Proposal**

**Colorado – Fort Collins**

**Minnesota & Texas Agriculture**

*Employing NASA Earth Observations to Model Current and Historic Distribution of Crop Wild Relatives, in Support of USDA ARS Genetic Resource Conservation Efforts*

**Project Overview**

***Project Synopsis*:** This project will use Landsat 4 & 5 TM, Landsat 8 OLI, Terra MODIS, Sentinel-2, and the SRTM version 3 to provide partners at the United States Department of Agriculture’s (USDA) Agricultural Research Service (ARS) with distribution maps for northern wild rice (*Zizania palustris L.)* and Texas wild rice (*Zizania texana*) populations. Utilizing a multitude of modeling approaches, this project will identify potential suitable habitat for focal species. The USDA ARS is responsible for conserving species genetic diversity, but this organization lacks insight as to the geographic distribution of zizania populations. Partners at USDA ARS will apply the end products produced through this project to more effectively enable strategic ecological planning, as well as apply more targeted field collections for species conservation.

***Community Concern:*** The USDA ARS National Plant Germplasm System (NPGS) is tasked with collecting, preserving, and making available for research an array of crucial species as a means to conserve genetic diversity and to bolster both national and global food security as well as rural economic productivity. Currently, there is limited geographic information for crop wild relatives’ species distribution. Identifying historic and current crop wild relatives’ distributions by utilizing species distribution models fit with data captured by NASA Earth observations and can provide resource managers with additional information to pursue more targeted and effective species conservation strategies.

***Source of Project Idea:*** Dr. Colin Khoury was introduced to the DEVELOP National Program through a joint training opportunity with DEVELOP, USGS, and USDA. Recognizing that the geospatial capacity necessary to complete a portion of one his current USDA projects was not currently available in his laboratory, Dr. Colin Khoury approached DEVELOP CO staff to learn more about the application of NASA Earth observations and to discuss project feasibility.

***National Application Area Addressed:*** Agriculture

***Study Location:*** MN, TX

***Study Period:*** 1984 – 2017

***Advisors:*** Dr. Paul Evangelista (Colorado State University, Natural Resource Ecology Laboratory), Dr. Amanda West (Colorado State University, Natural Resource Ecology Laboratory), Nicholas Young (Colorado State University, Natural Resource Ecology Laboratory), Tony Vorster (Colorado State University, Natural Resource Ecology Laboratory), and Brian Woodward (Colorado State University, Natural Resource Ecology Laboratory)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **USDA, Agricultural Research Service , National Plant Germplasm System** | Dr. Colin Khoury, Research Associate; Dr. Stephanie Greene, Supervisory Plant Physiologist | End User | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***The USDA ARS NPGS is responsible for collecting and conserving genetic diversity of useful flora, and making that information available for research. Currently USDA ARS NPGS has occurrence data for focal species in both Minnesota and Texas. Further knowledge of historic and current distribution of suitable habit of northern wild rice and Texas wild rice will supply the agency with more informed conservation information, as well as potentially replicable methodologies for future work.

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

*USDA, Agricultural Research Service, National Plant Germplasm System* – This federal organization encompasses a broad array of academic researchers and policy makers tasked with searching for solutions to agricultural problems that affect Americans every day. Our specific point of contact does not have experience using NASA Earth observations in research. This project will build capacity for the partner, as well as the USDA organization as a whole by showcasing the use and application of NASA Earth observations.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will communicate with partners at USDA on a biweekly basis. Since the partners of this project are based locally in Fort Collins, in-person meetings will be simple to plan and carry out. The Center Lead and Team Lead of this project will be the primary points of contact with both partner organizations.

***Transition Plan*:** At the end of the term, the team will host a seminar to disseminate project results and hand off decision support tools. A short training workshop on the use of the data and tutorial will follow the seminar.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Terra MODIS** | Normalized differencevegetation index (NDVI),Enhanced vegetationindex (EVI), Land Cover tasseled cap brightness, greenness, wetness | This dataset provides the needed forenvironmental predictive variables which will be utilized for an exploratory analysis to evaluate changes in greenness over time and employed via aspecies distribution modeling approach toinvestigate crop wild relative’s presence. |
| **Landsat 4 TM** | Surface reflectance, normalized difference vegetation index, normalized difference moisture index, tasseled cap brightness, greenness, and wetness | This dataset provides the temporal (16 days) and spatial (30 m) resolution needed for environmental predictive variables employed via a species distribution modeling approach investigating crop wild relative’s presence. |
| **Landsat 5 TM** | Surface reflectance, normalized difference vegetation index, normalized difference moisture index, tasseled cap brightness, greenness, and wetness | This dataset provides the temporal (16 days) and spatial (30 m) resolution needed for environmental predictive variables employed via a species distribution modeling approach investigating crop wild relative’s presence. |
| **Landsat 8 OLI** | Surface reflectance, normalized difference vegetation index, normalized difference moisture index, tasseled cap brightness, greenness, and wetness | This dataset provides the temporal (16 days) and spatial (30 m) resolution needed for environmental predictive variables employed via a species distribution modeling approach investigating crop wild relative presence. |
| **Sentinel-2 MSI** | 13 spectral bands including Near Infrared and Narrow Near Infrared  | This dataset provides the spatial (10-60 m) resolution needed for environmental predictive variables employed via a species distribution modeling approach investigating crop wild relatives presence. |
| **SRTM** | Elevation, slope, aspect,compound topographicindex | This dataset will be used to derive topographic indices to be used as predictors that could represent important characteristics of crop wild relative presence. |

***Ancillary Datasets:***

USDA presence field measurements – Generate species distribution models

Global Biodiversity Information Facility Occurrence data for crop wild relatives – Generate species distribution models

USGS Biodiversity Information Serving Our Nation Occurrence data for crop wild relatives – Generate species distribution models

USGS National Land Cover Database (NLCD) – Environmental Predictor Variables Data

North American Land Data Assimilation System (NLDAS-2) Mosaic Precipitation, Soils, Surface Water – Environmental Predictor Variables Data

***Modeling:***

Random Forest (POC: Dr. Amanda West, Colorado State University, Natural Resource Ecology Laboratory)

MaxEnt (POC: Dr. Amanda West, Colorado State University, Natural Resource Ecology Laboratory)

Boosted Regression Tree (POC: Dr. Amanda West, Natural Resource Ecology Laboratory)

Generalized Linear Model (POC: Dr. Amanda West, Natural Resource Ecology Laboratory)

Multivariate Adaptive Regression Splines (POC: Dr. Amanda West, Natural Resource Ecology Laboratory)

***Software & Scripting:***

Esri ArcGIS – Image processing, data analysis, map creation, end product generation

Software for Assisted Habitat Modeling (SAHM) – Creation of habitat models

R – Index calculation

Google Earth Engine API – Large scale image analysis

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **2017 Great Lakes Region Northern Wild Rice Distribution Map** | Maps will be used to evaluate the distribution for northern wild rice in the Great Lakes region and guide future monitoring and conservation efforts.  | Random Forest, MaxEnt, Multivariate Adaptive Regression Splines, Generalized Linear Model, and Boosted Regression Tree models will be trained with field survey data and indices created from SRTM, Terra MODIS, and Landsat to create potential distribution maps of northern wild rice.  | N/A |
| **Historic Great Lakes Region Northern Wild Rice Distribution Map**  | Maps will be used to evaluate the historic distribution for northern wild rice in the Great Lakes region.  | Random Forest, MaxEnt, Multivariate Adaptive Regression Splines, Generalized Linear Model, and Boosted Regression Tree models will be trained with field survey data and indices created from SRTM, Terra MODIS, and Landsat to create potential distribution maps of northern wild rice.  | N/A |
| **2017 Texas Wild Rice Distribution Map** | Maps will be used to evaluate the current distribution for Texas wild rice as well as compare to the Minnesota study area to test modeling methodology within a new geographic location. | Random Forest, MaxEnt, Multivariate Adaptive Regression Splines, Generalized Linear Model, and Boosted Regression Tree models will be trained with field survey data and indices created from SRTM, Terra MODIS, and Landsat to create potential distribution maps of Texas wild rice. | N/A |
| **Historic Texas Wild Rice Distribution Map**  | Maps will be used to evaluate the historic distribution for Texas wild rice as well as compare to the Minnesota study area to test modeling methodology within a new geographic location. | Random Forest, MaxEnt, Multivariate Adaptive Regression Splines, Generalized Linear Model, and Boosted Regression Tree models will be trained with field survey data and indices created from SRTM, Terra MODIS, and Landsat to create potential distribution maps of Texas wild rice. | N/A |
| **Distribution Modeling and Mapping Tutorial**  | The tutorial will enable end users to replicate this study in future years and for additional crop wild relatives. | The tutorial will cover data collection and processing, fitting statistical models to the data, and interpretation of model output. | N/A |

***End-User Benefit*:** This project will save the USDA time and money by further refining monitoring and field survey collection efforts. The project also enables future analysis across larger scales and new species and study sites that would not be possible without full utilization of NASA Earth observations. End products will be integrated in the USDA decision making and conservation processes.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2018 Spring

***Related DEVELOP Work:***

Spring 2014 (CO) – Colorado Agriculture: Reconstructing Forest Harvest History Using Landsat Imagery for Enhanced Land Management

Summer 2015 (CO) – Colorado Agriculture II: Reconstructing Forest Harvest History in Northern Colorado and Southern Wyoming Using the Landsat Time Series

Summer 2017 (CO) – Alaska Climate FC: Utilizing NASA Earth Observations to Model Potential Suitable Habitat of Invasive Species Threatening Alaskan Wetlands