**NASA DEVELOP National Program**

**Summer 2016 Project Proposal**

**University of Georgia**

**Southeast Ecological Forecasting III**

Utilizing NASA Earth Observations and Proximal Remote Sensing for Mapping the Spatio-Temporal Distribution of *Hydrilla verticillata*

**Project Overview**

***Objective:*** To develop a multi-platform approach for mapping the spatial and temporal distribution patterns of *Hydrilla verticillata* (*Hydrilla*) in several water bodies in Georgia and South Carolina.

***Community Concern:*** *Hydrilla,* aninvasive aquatic plant,has become one of the most serious threats to native vegetation and water quality in the southeastern United States. It outcompetes native plants by growing rapidly, forming a surface canopy that blocks the light passing through the water column, intensifying stratification and creating anoxic conditions in deeper areas. It affects the food chain - as aquatic wildlife can die from consuming *Hydrilla* with associated toxic epiphytic cyanobacteria - and is also a concern for the recreation industry, clogging boat motors and becoming a swimming hazard. It can be economically costly as it obstructs water withdrawal for drinking, irrigation, and power generation.

***National Application Areas Addressed:*** Ecological Forecasting, Water Resources

***Study Location:*** Lakes Thurmond, GA/SC and Long Branch, GA

***Study Period:*** 2016; forecast yearly growth cycle

***Advisors:*** Dr. Deepak Mishra (Department of Geography, University of Georgia), Dr. Susan Wilde (Warnell School of Forestry and Natural Resources, University of Georgia)

***Source of Project Idea:*** The project idea originated from a previous partner interaction with Georgia Power. Anthony Dodd, Environmental Specialist from Georgia Power, expressed interest in beginning a DEVELOP project focusing on the spread of *Hydrilla* in Georgia lakes.

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| US Army Corps of Engineers, J. Strom Thurmond Project | Kenneth Boyd, Conservation Biologist | End-User | No |
| Henry County Water Authority, Cubihatchi Outdoor Education | Kenneth Presley, Assistant Reservoir Manager | End-User | No |

***End-User Overview***

***End-User’s Current Decision Making Process:***

Currently, chemicals are used to manage *Hydrilla*, including copper, diguat, endothall, and fluridone. Applying these chemicals can have adverse effects on the lake ecosystem. A lower impact strategy has been to introduce triploid (sterile) Grass Carp *(Ctenopharyngodon idella),* a species of fish which consumes aquatic plant material including *Hydrilla.* Because triploid Grass Carp are sterile, their populations can be controlled after introduction to an ecosystem. Partners currently use traditional monitoring practices involving visual analysis, rake collection, and sonar.

***End-User’s NASA Earth Observations Capacity:***

US Army Corps of Engineers – Mr. Boyd who is a conservation biologist with US Army Corps frequently monitors Lake Thurmond for assessing the spatial extent of *Hydrilla sp.* infestation. The science advisors have introduced the utility of NASA Earth observations in mapping the spatio-temporal distribution of *Hydrilla sp.* in the lake to the US Army Corps staff at Lake Thurmond. They are aware of such mapping activities carried out elsewhere using high resolution satellite data. Therefore, they are eager to work with the DEVELOP team to implement such mapping activities for their lake.

Henry County Water Authority – DEVELOP’s University of Georgia Science Advisors have been assisting the Henry County Water Authority since 2010 when a *Hydrilla sp.* infestation was discovered in two of their newly constructed drinking water reservoirs. They were introduced to NASA Earth observations by way of our science advisors and gained an understanding of their application over the past two terms. They welcome the use of remote sensing tools to help understand the seasonal development and annual variation in invasive species distributions in lake environments.

***Project Communication & Transition Overview***

***In-Term Communication Plan:***

The team will have regular communication with project partners to plan field trips at each of their sites. Additionally, the team will arrange for monthly telecons with their partners. Kenneth Boyd from the US Army Corps of Engineers and Kenneth Presley from the Henry County Water Authority will serve as the main points of contact for each end-user organization.

***Transition Approach:***

Deliverables with be shared with partners through Google Drive and an in-person presentation with one or both of the end-users. The results will be used to inform decisions about invasive aquatic plant management. Specifically, the project will increase their understanding of the seasonal development and annual variation in invasive species distributions in lake environments.

**Letters of Support:**

United States Army Corps of Engineers, Christopher D. Spiller, Natural Resources Manager

Henry County Water Authority, Kenneth Presley, Assistant Reservoir Manager

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI** | *Hydrilla* distribution and vegetation indicies | Landsat 8 OLI will be combined with *in situ* data to estimate *Hydrilla* density and distribution at study lakes. This will provide a mapping protocol and detection tool for monitoring *Hydrilla* that can be used in water quality restoration decision making processes. |
| **DJI Phantom 2 Vision+** | *Hydrilla* distribution | UAS imagery will be georeferenced and mosaicked to analyze *Hydrilla* distribution |

***Ancillary Datasets:***

UGA-owned SVC HR-1024i hyperspectral spectroradiometer - Chlorophyll-a concentration - satellite verification

UGA participant field collection - Total Suspended solids (organic + inorganic) concentration - satellite verification

UGA participant field collection - Turbidity - satellite verification

UGA-owned Secchi Disk - depth of *Hydrilla* - satellite verification

UGA-owned SVC HR-1024i hyperspectral spectroradiometer - Above water radiance – satellite verification, help identify presence of *Hydrilla*

UGA-owned SVC HR-1024i hyperspectral spectroradiometer - Above water Irradiance - satellite verification, help identify presence of *Hydrilla*

UGA-owned SVC HR-1024i hyperspectral spectroradiometer - Above water reflectance - satellite verification, help identify presence of *Hhydrilla*

UGA-owned SVC HR-1024i hyperspectral spectroradiometer - Underwater/above canopy radiance – satellite verification, help identify presence of *Hydrilla*

UGA-owned SVC HR-1024i hyperspectral spectroradiometer - Underwater/above canopy irradiance – satellite verification, help identify presence of *Hydrilla*

UGA-owned SVC HR-1024i hyperspectral spectroradiometer - Underwater/above canopy reflectance - satellite verification, help identify presence of *Hydrilla*

UGA-owned Secchi Disk - Vertical diffuse attenuation coefficients - satellite verification

UGA participant field collection - *Hydrilla* biomass and stem height - quantify physical characteristics of *Hydrilla*

UGA participant field collection - GPS locations - satellite verification and precise location data

UGA participant field collection - Photographs - VPS and documentation

***Models:***

The benthic Habitat Radiative Transfer Model (POC: Deepak Mishra, University of Georgia)

SAV light requirement model (POC: Deepak Mishra, University of Georgia; Richard A. Batiuk, US EPA, Chesapeake Bay Program Office, Annapolis, Maryland)

**Decision Support Tool & End-Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| Landsat 8 Benthic Model for *Hydrilla* sp. Mapping | Detecting the spatial distribution of *Hydrilla* sp. to support pre-emptive, planning efforts | Landsat 8 CDR products; Vertical diffuse attenuation coefficients; GPS locations, Photographs; Chlorophyll-a concentration; Total Suspended Solids (organic + inorganic) concentration; Turbidity; Secchi Disk depth | N/A |
| *Hydrilla* Distribution Maps | Lake managers can use these map products to target mitigation and restoration efforts | Landsat 8; Above Water Irradiance, reflectance; Underwater/above canopy radiance, irradiance, reflectance; Maps will be analyzed to study the phenology involving *Hydrilla sp.* initiation, growth, and senescence. | N/A |
| *Hydrilla* Biomass Forecast Model | Biomass forecast model can be used by the end-users to approximate the standing biomass of *Hydrilla* in their lakes from satellite data and forecast their growth cycle for the year | Landsat 8; Above Water Irradiance, reflectance; Underwater/above canopy radiance, irradiance, reflectance; Vertical diffuse attenuation coefficients; *Hydrilla* biomass and stem height | N/A |

***End-User Benefit:***

The modeling and mapping activities proposed by the DEVELOP team will produce accurate spatial extent maps of *Hydrilla* distribution in the Lakes Thurmond and Long Branch. The maps will help the end-users to target their restoration efforts (removal or chemical applications) to those infested areas. This will enable them to conduct economically and environmentally effective invasive plant management with less time and labor. The forecast model will provide insight into the growth and development of standing biomass for the season, which will help them better prepare for mitigation efforts.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 3 Terms: 2015 Summer (Start) to 2016 Summer (Completion)

***Multi-Term Objectives:***

* **Term 1:** 2015 Summer (UGA) – Southeast Ecological Forecasting I
  + *In situ* sampling and proximal remote sensing data collection; atmospheric correction of Landsat 8 data and reflectance extraction; development and calibration of Landsat 8-based *Hydrilla* benthic model
* **Term 2:** 2015 Fall (UGA) – Southeast Ecological Forecasting II
  + Additional field data collection and Landsat 8-based benthic model validation; application of the model to generate *Hydrilla* distribution maps for the study sites; model tuning if necessary; development and testing of a basic *Hydrilla* Forecast Model
* **Term 3 (Proposed Term):** 2016 Summer (UGA) – Southeast Ecological Forecasting III
  + Prediction and forecast model operation - apply model to a wider study area over multiple years and analyze the spatio-temporal spread of the aquatic invasive plant throughout the southeastern United States; apply field-based and unmanned aerial system (UAS)-based methods to Landsat 8 OLI data in order to map the spatio-temporal distribution of *Hydrilla sp*.; develop metrics for minimum light requirement for *Hydrilla* development in the two study sites; coordinate with project partners to understand the biophysical forcing controlling the *Hydrilla* distribution; outreach and product dissemination

***Related DEVELOP Work:***

Fall 2014 (UGA) - Georgia Water Resources: Developing a Cyanobacteria Detection Tool for Georgia Inland Waters Using NASA Landsat 8 OLI Data for Water Quality Protection and Restoration

**Project Needs/Requests**

***Participants Requested:*** 4-5

***Software & Scripting:***

ENVI FLAASH – Atmospheric correction of Landsat 8 data

ArcGIS – Map creation

Matlab – Model calibration and validation