**NASA DEVELOP National Program**

**Fall 2015 Project Proposal**

University of Georgia

**Southeast Ecological Forecasting II**

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

**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 Florida.

**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 though the water column, intensifies stratification and creates anoxic conditions in deeper areas. It affects the food chain, as aquatic wildlife can die from consuming hydrillawith 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 or power generation.

Located in the southwest corner of Georgia along its border with Florida, Lake Seminole is a United States Army Corps of Engineers (USACE) reservoir where there have been attempts to control hydrillafor almost 50 years using a combination of chemical, physical and biological controls. Hydrilla in Lake Seminole has interfered with navigation, degraded water quality and fish and wildlife habitat, diminished recreation area use, increased mosquito populations, blocked hydropower intakes, and decreased adjacent property values. The USACE struggles to produce rapid accurate estimates of invasive plant density to determine which techniques provide the most cost-effective control throughout this large reservoir (37,500 acres) with extensive shoreline (570 km).

In 2013, Georgia Power experienced a rapid hydrillainvasion throughout two large reservoirs on the Chattahoochee River: Lake Harding (5850 acres) and Lake Oliver (2150 acres). During the fall of 2014, Georgia Power discovered hydrillaexpanding into the next reservoir down in the series, Goat Rock Reservoir. They have received countless complaints from their stakeholder user groups including dock owners who are overrun with hydrillaand fisherman who can’t motor through the thick mats. Georgia Power also requires a comprehensive assessment of hydrillaexpansion to optimize their chemical control efforts. The production of accurate timely biomass maps will allow for adaptive plant management.

**Partner Organizations:**

Henry County Water Authority (End-user, POC: Ken Presley, Assistant Reservoir Manager)

J.W. Jones Ecological Research Center (End-user, POC: Dr. Stephen W. Golladay, Associate Scientist)

Georgia Power (End-user/ POC: Anthony Dodd, Environmental Specialist)

DEVELOP’s University of Georgia Science Advisors have been assisting the Henry County Water Authority since 2010 when a hydrillainfestation was discovered in two of their newly constructed drinking water reservoirs. Henry County needs a rapid, accurate assessment of the total acreage of hydrillafor effective management in order to stock sterile Grass Carp at the appropriate density for controlling the invasive vegetation without negatively affecting the fishery.

Contact has been made with all of the listed partners. They welcome the use of remote sensing tools to help understand the seasonal development and annual variation in invasive species distributions in lake environments. Partners are interested in enhancing water management plans as well as assessing future biological invasions. They have offered to provide years of field verified vegetation maps, a 10-year water quality dataset, and access and logistical support for additional field validation the DEVELOP team may like to complete over the course of the project.

**Letters of Support:** J.W. Jones Ecological Research Center, Dr. Stephen W. Golladay, Associate Scientist.

**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 analysis.

In order for current control methods to be effectively implemented, these organizations need a rapid accurate assessment of hydrilla biomass over the growing season. Additionally, they need to have time-series evaluations of the efficacy of their chemical and biological control actions to optimize and adaptively manage this invasive species.

**Earth Observations:**

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| --- | --- | --- |
| **Platform** | **Sensor** | **Geophysical Parameter** |
| **Landsat 8** | OLI | hydrilladistribution and vegetation indices |
| **UAS** | RGB Camera | hydrilladistribution |

**NASA Earth Observations to be Highlighted:**

The team will use NASA's Landsat 8 Operational Land Imager (OLI) datasets to estimate hydrilla density and distribution in the three select sites. Landsat 8, being a relatively new sensor, has not been used to monitor hydrillain Georgia-Florida waters. The team will apply field-based and unmanned aerial system (UAS)-based models to Landsat 8 OLI data in order to map the spatio-temporal distribution of hydrilla. The proposed work is innovative, because it will allow the use of NASA Landsat 8 data to study the spread of the aquatic invasive plants in GA and FL inland waters. The results will be an efficient and non-destructive mapping protocol in the form of a detection tool for monitoring the hydrilla distribution to be used in water quality restoration decision making.

**Ancillary Datasets:**

Field data will be used for model calibration, tuning, and validation and it is a crucial part of the project.

* Unmanned aerial system, DJI Phantom 2 Vision +
* Hyperspectral digital camera Basler acA1300, University of Georgia
* Ocean optics non-imaging hyperspectral radiometer, University of Georgia
* Hydrillalocations, density per area, and plant height data
* Lake depth shapefiles for Lakes Thurmond and Seminole, Army Corps of Engineers
* Bathymetric maps, CIBiobase
* Topographic maps for Lakes Harking, Goat Rock, Oliver and Thurmond, University of Georgia

**Models:**

* Radiative Transfer Models (Benthic Mapping) (POC: Deepak Mishra, UGA)
* Green NDVI (POC: Deepak Mishra, UGA)
* HYDRIL Dioecious hyrilla model (POC: Elly P.H. Best and William A. Boyd, U.S. Army Corps of Engineers)

**Decision Support Tools & Analyses:**

|  |  |  |
| --- | --- | --- |
| **Proposed End Products** | **Decision Impacting** | **Current Partner Tool/Method** |
| Landsat 8 Benthic Model for *Hydrilla sp.* Mapping | Detecting and predicting *Hydrilla sp.* to support pre-emptive, planning efforts | Field sampling |
| Hydrilla Distribution Maps | Where lake managers target mitigation efforts | Field sampling |
| Hydrilla Forecast model | How frequently and where to monitor for potential infestation | Field sampling |

*Landsat 8 Benthic Model for Hydrilla Mapping* – The data from different platforms will be compared to develop a scaled-up benthic mapping model using spectral matching techniques. The Landsat 8-based benthic model will also be used to correct the residual atmospheric noise in the data after the FLAASH correction. A benthic mapping radiative transfer model developed by Mishra et al. (2005 and 2006) will be used to extract the bottom reflectance (i.e., hydrilla reflectance) from Landsat 8 data resulting in a density/detection tool for hydrillain inland waters. This tool will help lake managers to understand the factors that support the development of hydrilla*.*

*Hydrilla Distribution Maps* – Landsat 8 based map products will be generated detailing density and spatio-temporal variations of hydrilla. Maps will be analyzed to study the phenology involving hydrillainitiation, growth, and senescence. These maps will inform manager’s decisions on where to target their control methods in Georgia and Florida waters.

*Hydrilla Forecast Model* – Potential hydrillainfestation in a water body primarily depends on four factors, depth, light, sediment, and history. Hydrilla can grow optimally in <15’ of water so bathymetry can predict potential biomass. Light availability will also affect growth potential; this includes surface irradiation (based on climate, longitude), water clarity and percent transmittance, which can be altered by turbidity and tannins. The soil nutrient levels (N, P) and sediment composition (high organic sediments>clay>sandy soils) also serve to predict optimal expansion for hydrilla. Finally the history of occurrence, or fall maximum biomass would correlate with the distribution of tubers and turions present in the sediment and capable of re-sprouting the following year. All four factors, depth, light, nutrients, and history will be analyzed for different study sites to develop a basic HydrillaForecast Model.

**Project Details:**

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

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

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

**Participants Requested:** 5

**Project Timeline:** 3 Terms: 2015 Spring to 2015 Fall

**Study Location:** Georgia and Florida

**Period being Studied:** 2014 (Terms 1 and 2) and 2000 to 2014 (Term 3)

**Previous 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

**Multi-Term Objectives:**

* **Term 1** – *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 hydrillabenthic model
* **Term 2 (Proposed Term)** – 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 HydrillaForecast Model
* **Term 3** – 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 and its linkage to climate change throughout the southeastern United States; coordinate with project partners to understand the biophysical forcing controlling the hydrilladistribution; Outreach and product dissemination

**Software & Scripting Utilized:**

* ENVI FLAASH – Atmospheric correction of Landsat 8 data
* ArcGIS – Map creation
* Matlab and Excel – Model calibration and validation