**NASA DEVELOP National Program**

**2019 Summer Project Proposal**

**Alabama – Marshall**

**Conecuh National Forest Ecological Forecasting**

*Evaluating Current and Potential Habitats for the Endangered Gopher Frog by Assessing Wetland Environments and Land Cover Trends in Conecuh National Forest*

**Project Overview**

***Project Synopsis*:** Many animal species are facing endangerment, and among them is the gopher frog (*Lithobates capito*), which is native to the Conecuh National Forest in Alabama. With only five breeding wetlands across the state, it is imperative to the Gopher Frog Working Group (GFWG) that this species habitat remains intact. This project uses Landsat 5 TM, Landsat 8 OLI, SRTM, Sentinel-1 C-SAR, and Sentinel-2 MSI to assess environmental concerns relating to the current and potential breeding habitats of the gopher frog. A Wetland Inundation Time Series, Vegetation Density Analysis, and Software for Assisted Habitat Modeling analysis will evaluate the status of the frog’s present-day habitat, while. Ultimately, these results will determine where to create new habitat and reintroduce the species in Alabama’s forests.

***Community Concern:*** Amphibians are most susceptible to environmental changes and many are species of highest conservation concern. According to the Florida Fish and Wildlife Conservation Commission, the gopher frogwill likely be extinct within 100 years without human intervention. The single greatest threat to the gopher frog is the loss or modification of its habitat that is marked by its sandy soils, open longleaf pine forests, and wetlands. Fire suppression often allows dense shrubs to encroach on gopher frog habitat and corridors, restricting their movement to new breeding grounds, while wetland degradation has limited potential breeding locations throughout the southeastern region of the U.S. In Alabama, there are five known breeding populations two of which inhabit two ponds in Conecuh National Forest. The loss of amphibians in an area signal the onset of forthcoming ecosystem change, which can, in turn, affect other keystone species and humans alike; for this reason, it so important to restore areas that are experiencing a decline in frog populations.

***Source of Project Idea:*** The Alabama Department of Conservation and Natural Resources (ADCNR) approached the Alabama – Marshall node with this project idea. Representatives from the department met with node leadership and presented a list of research questions they would like answered. From there, node leadership developed a list of goals for the project with science advisors.

***National Application Area Addressed:*** Ecological Forecasting

***Study Location:*** Conecuh National Forest, AL

***Study Period:*** January 2005 – July 2019; Forecasting to 2035

***Advisors:*** Dr. Jeffrey Luvall (NASA Marshall Space Flight Center), Dr. Robert Griffin (University of Alabama in Huntsville)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Alabama Department of Conservation and Natural Resources** | Mercedes Bartkovich, Division of Wildlife and Freshwater Fisheries Nongame Wildlife Biologist;  Eric Soehren, State Lands Division Nongame Biologist; Ericha Shelton-Nix, Division of Wildlife and Freshwater Fisheries Nongame Wildlife Biologist | End User | Yes |
| **USDA, US Forest Service, Conecuh National Forest** | Derek Colbert, District Wildlife Biologist | End User | Yes |
| **Mississippi State University, College of Forest Resources** | Scott Rush, Assistant Professor/ Wildlife Ecology and Management | Collaborator | Yes |

***End-User Overview***

***End User’s Current Decision-Making Process:***Staff of the ADCNR and the Conecuh National Forest are a part of the GFWG that encompasses multiple stakeholders across the southeastern United States who are concerned with the conservation of the species. The ADCNR is responsible for managing the states fish and wildlife resources through scientific research and initiatives. Currently, the ADCNR is strategically planning for improved habitat monitoring and wetland creation in an effort to conserve the endangered gopher frog.

The Conecuh National Forest is responsible for caring for the land and wildlife within the 84,000 acre Conecuh National Forest along the Alabama and Florida state line. The ADCRN and Conecuh National Forest work alongside other partners to monitor the breeding population in Conecuh National Forest by collecting *in situ* data, including burrow habitat, breeding locations, and egg count. To assist in these efforts, the US Forest Service in Conecuh National Forest oversees the prescribed burns of the forest understory. This processes require excess time and physical labor, as well as costly excursions and data collection methods, as the areas can be remote.

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

*Alabama Department of Conservation and Natural Resources* – The ADCNR is familiar with satellite-derived products as they use them to assess land cover, but the department does not process NASA Earth observations in-house. The department does not frequently use remotely sensed data when identifying suitable habitat, rather they rely on *in situ* measurements. To build capacity within the organization, members within the ADCNR are interested in expanding their use of remotely sensed products in habitat assessments. The division often works with geospatial data and has the capacity to introduce new techniques into their current management decisions.

*USDA, US Forest Service, Conecuh National Forest* – The US Forest Service, Conecuh National Forest, is familiar with GIS and remote sensing techniques but does not currently use NASA Earth observations in habitat management. The national forest is interested in expanding their use of remote sensing techniques especially as it applies to assessing habitat and the impact of prescribed burning practices. The results from this project would expand their capacity to use satellite data in the future and assess its management of Conecuh National Forest.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*Mississippi State University, College of Forest Resources* – The University’s College of Forest Resources will provide scientific advising and knowledge concerning gopher frog habitat. As a member of the GFWG, the University contributes additional insight regarding gopher frog habitat and will provide guidance during the term. The organization is interested in replicating the methodologies and processes of this project in Mississippi and along the Florida panhandle.

***Dissemination by Boundary Organizations*:**

*Alabama Departmet of Conservation and Natural Resources* – As part of the GWFG, the department will disseminate results of this project throughout their network, educating conservationists and the public alike about the work they are doing to protect endangered species in the state of Alabama. It will share the methodologies and findings with similar organizations concerned about the gopher frog throughout the southeastern region of the US.

*USDA, US Forest Service, Conecuh National Forest* – As part of the GFWG, the US Forest Service at Conecuh National Forest will disseminate results of this project throughout their network in the southeastern region of the US. The methodologies and findings from this report will be shared with branches of the US Forest Service in Mississippi and Florida.

*Mississippi State University, College of Forest Resources*– As part of the GFWG, the Mississippi State University, College of Forest Resources will disseminate results of this project to other researchers in their network. This includes both other universities and other members of the working group.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The Center Lead will schedule a conference call for the first week of the term for participants and partners to introduce themselves and determine if there are any adjustments that need to be made to the proposed end products. The Project Lead will be the main point of contact for the partners throughout the term and will update them weekly via email as well as organizing meetings once every one to two weeks.

***Transition Plan*:** At the end of the term, end products and results will be disseminated to the project partners and explained through a web conference. During this meeting, the team will give a presentation of the results and field any questions that the partners may have. This will be followed by a tutorial explaining how to use the end products.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Sentinel-1 C-SAR** | backscatter values, surface roughness | Sentinel-1 C-SAR data will be used to map fluctuations in wetland inundation and extent. |
| **Sentinel-2 MSI** | surface reflectance | Sentinel-2 MSI will complement Landsat surface reflectance in the vegetation density analysis. The analysis will be used as an input to the Software for Assisted Habitat Modeling (SAHM). |
| **Landsat 5 TM** | surface reflectance | Landsat 5 TM will complement Sentinel-2 MSI and Landsat 8 OLI surface reflectance for the vegetation density analysis. The analysis will be used as an input to SAHM. |
| **Landsat 8 OLI** | surface reflectance | Landsat 8 OLI will complement Sentinel-1 C-SAR for the wetland inundation time series. It will also be used to map vegetation density using the Enhanced Vegetation Index (EVI). |
| **SRTM** | slope | SRTM will be used as an input to SAHM and the TerrSet Land Change Modeler. |

***Ancillary Datasets:***

USFS *in situ* data – gopher frog habitat data, gopher tortoise burrow location, known gopher frog breeding pond locations, prescribed fire data to be used in the vegetation density analysis and SAHM analysis

USGS National Land Cover Database (NLCD) – land cover to be used for accuracy assessment in the forecasting maps

USDA Web Soil Survey – soil measurements to be used in the habitat suitability model

US Census TIGER/Line Shapefile Primary Roads – a road layer will be used in the forecasting model

***Modeling:***

Software for Assisted Habitat Modeling (POC: Timothy Mayer, NASA SERVIR)

TerrSet Land Change Modeler (POC: Leah Parker, University of Alabama in Huntsville)

***Software & Scripting:***

TerrSet – predict future habitat and land cover change

ArcGIS – raster manipulation and map creation

R – statistical analyses and raster processing

ESA Sentinel Application Platform (SNAP) – preprocess Sentinel raster imagery

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Wetland Inundation Time Series** | This product will map the yearly and seasonal fluctuations of wetland inundation. Using this product, the partner will better understand the hydrologic variation of the gopher frogs breeding ponds and wetland habitat which will in turn assist the partners’ conservation efforts. | Using backscatter from Sentinel-1 C-SAR surface reflectance from Landsat 5 TM and Landsat 8 OLI, this product will assess fluctuations in the wetland water levels from 2005 to July 2019. | N/A |
| **Vegetation Density Analysis** | The partners will use this product to assess the density of the southern pine forests in the region. The USFS oversees the prescribed burns of the understory and are looking for a way to assess vegetation density remotely to better allocate their resources. | Using reflectance from Landsat 8 OLI and Sentinel-2 MSI, the team will complete an EVI analysis to assess the vegetation density of the forests, as well as analyze the current burn regimes. | N/A |
| **Conecuh National Forest Land Cover Forecast Maps** | This product will provide the partner with predictive maps of land cover change at 3 year intervals throughout the National Forest from 2020 to 2035. This product will help the partner assess its current land management practices and the future of the gopher frog’s habitat. | Using the Wetland Inundation Time Series end product, SRTM, Landsat derived land cover, and road data, this product will use the TerrSet Land Change Modeler to forecast land cover in 2035. | N/A |
| **SAHM Analysis** | This product will identify where possible gopher frog presence is in southern Alabama. The partners will use this information to focus their efforts and survey ponds with a higher likelihood of having species present. In addition, by understanding where the frog is presently, the partners can act to conserve land which may be susceptible to conversion. | This product will combine Landsat 8 OLI, SRTM, the vegetation density analysis, and ancillary datasets into SAHM. The team will analyze the statistics outputted by SAHM in order to determine the likelihood of species presence throughout the forest. | N/A |

***End-User Benefit*:** The end products will assist the ADCNR in monitoring gopher frog habitat management and restoration efforts, while also identifying potential areas for wetland creation. The use of NASA Earth observations will supplement ground verification done by the department and improve the spatial extent of its data collection. The partner will use these products to justify wetland creation and resource allocation.

**Project Timeline & Previous Related Work**

***Project Timeline:*** Terms: 2019 Summer to 2019 Fall

***Multi-Term Objectives:***

* **Term 1 (Proposed Term):** 2019 Summer (MSFC) – Southern Alabama Ecological Forecasting
  + The team will assess the current habitat of the gopher frog and lay the groundwork for a habitat creation and corridor assessment. The team will produce a wetland inundation time series and a vegetation density analysis to help the partners better assess the current habitat of the gopher frog in southern Alabama. These results will also help the partners evaluate their current methods and make changes in the immediate future. The forecasted land cover assessment will highlight areas of current and potentially future concern and will be the bulk of the inputs for the second term.
* **Term 2:** 2019 Fall (MSFC) – Southern Alabama Ecological Forecasting II
  + Using the forecasted land cover, SAHM analysis, and wetland inundation and forest density maps, the second term will expand on the work of the first term and input the findings into Circuitscape and the Linkage Mapper. Using these models, the second term will be able to create a wetland creation assessment and a corridor assessment, which will aid the partners as they work to connect the various breeding grounds of the gopher frog and determine the best locations to reintroduce the species.

***Related DEVELOP Work:***

2019 Spring (GA) – Talamanca-Osa Ecological Forecasting: Determining Habitat Suitability to Establish a Jaguar Corridor between the Talamanca Mountains and the Osa Peninsula in Costa Rica

2018 Fall (JPL) – Alaska Ecological Forecasting: Automated Wetland Hydroperiod Mapping by Integrating Optical Satellite Imagery and Synthetic Aperture Radar

2018 Fall (CO) – Wisconsin Agriculture & Food Security: Employing NASA Earth Observations to Model Distributions of Crop Wild Relatives, in Support of USDA ARS Genetic Resource Conservation Efforts

2018 Summer (VA) – Monitoring and Predicting the Spread of Roseau Cane Die-offs Connected to the Invasive Mealy Bug (*Nipponaclerda biwakoensis*) and Other Contributing Factors in the Mississippi River Delta Using NASA Earth Observations

2015 Summer (SSC) – Utilizing NASA Earth Observations to Locate Potential Habitat for the Dusky Gopher Frog

**Notes & References:**

***Notes*:** The partners came to the Alabama – Marshall node with a list of research goals: 1) Identify potential habitat, 2) Study the hydrology (yearly and seasonal trends) of the breeding ponds, 3) Assess the current management practices (prescribed burns of the understory), 4) Identify locations for wetland creation, and 5) Determine the best places to reintroduce the gopher frog.   
  
Our partners at the ADCNR, Mississippi State University, and USFS are all a part of the Gopher Frog Working Group (GFWG). The GFWG encompasses state and local agencies, universities, and non-profit organizations who work together to secure funding and support for gopher frog conservation efforts. The ADCNR and USFS are the decision-makers for management in Alabama as the gopher frog habitats are on land managed by those agencies.

***References:***

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