**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 Team**

***Project Team:***

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**Project Overview**

***Project Synopsis:*** The gopher frog (*Lithobates capito)* is approaching endangerment with only five breeding locations remaining in the state of Alabama. With this species being native to the Conecuh National Forest, the Gopher Frog Working Group believes that retaining the habitat is crucial to the biodiversity of the ecosystem. This project utilized data from the Landsat and Sentinel missions and the Shuttle Radar Topography Mission (SRTM) to evaluate current and potential breeding regions. Products created gauged the current conditions of the area while forecasting seasonal changes of the habitat. The overall results of this project predicted locations for the future development of gopher frog habitats.

***Abstract:***

The gopher frog (*Lithobates capito*) is an endangered species facing extinction within the next century due to loss and alteration of its habitat. With limited active gopher frog habitats in Alabama, it is crucial to maintain these areas. The Gopher Frog Working Group (GFWG) works to ensure the protection and rehabilitation of gopher frog habitats to protect the survival of the species. The NASA DEVELOP Conecuh National Forest Ecological Forecasting team partnered with the Alabama Department of Conservation and Natural Resources, the United States Forest Service’s Conecuh National Forest, and the Mississippi State University College of Forest Resources, which are all part of the GFWG, to identify potential habitats for the gopher frog in Conecuh National Forest. As the environment fluctuates over time, present and probable breeding wetlands are threatened. The team identified the environmental concerns endangering the breeding habitats utilizing Landsat 5 Thematic Mapper (TM), Landsat 8 Operational Land Imager (OLI), the Shuttle Radar Topography Mission (SRTM), and Sentinel-1 C-band Synthetic Aperture Radar (C-SAR) satellite imagery. The team produced a series of map products to evaluate the status of the current breeding region as well as forecast the future suitability of the habitat. These products enabled the GFWG to determine where to create new breeding habitats in the Conecuh National Forest.

***Keywords:***

remote sensing, Sentinel, Landsat, SRTM, TerrSet, SAR

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

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

***Study Period:*** January 2005 to July 2019

***Community Concerns:***

* Amphibians are most susceptible to environmental changes and are of the highest conservation concern.
* According to the Florida Fish and Wildlife Conservation Commission, the gopher frog will 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, which is primarily wetlands in longleaf pine forests.
* Fire suppression often allows dense shrubs to encroach on gopher frog habitat and corridors, restricting movement to new breeding grounds.
* The loss of amphibians in an area signals the onset of forthcoming ecosystem change, which, in turn, can affect other keystone species and humans alike; for this reason, it is important to restore areas that are experiencing a decline in frog populations.

***Project Objectives:***

* Gauge previous and current changes in wetland and land cover in the Conecuh National Forest
* Predict and analyze seasonal changes in gopher frog habitat
* Determine areas that are optimal for future habitat development

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **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 | 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 of Wildlife Ecology and Management | Collaborator | Yes |

***Decision-Making Practices & Policies:***

The Gopher Frog Working Group (GFWG) consists of multiple stakeholders in the southeastern United States, including our project partners at the Alabama Department of Conservation and Natural Resources (ADCNR) and US Forest Service (USFS). The ADCNR and USFS are familiar with GIS and remote sensing and use NASA Earth observations in-house for habitat management while relying heavily on *in situ* data to manage the state’s fish and wildlife resources. The USFS and ADCNR work in tandem to manage and conserve wildlife in the forest and implement plans to protect the current habitat of the gopher frog and create new habitat. Within Conecuh National Forest, the USFS assists the ADCNR through prescribed burns, which aids gopher frog conservation efforts.

***Project Benefit to End User:***

The end products produced for the project partners can improve the management of the land and provide guidance for the conservation of the gopher frog. The utilization of Earth observations will allow the cost of conservation to decrease, as the current method of gathering data consists of expensive fieldwork. The end products will also allow for the assessment of wetland fluctuation patterns and vegetation density across the forest to better concentrate conservation efforts.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Sentinel-1 C-SAR** | Backscatter values, surface roughness | Sentinel-1 C-band Synthetic Aperture Radar (C-SAR) data were used to map fluctuations in wetland inundation and extent. |
| **Landsat 5 TM** | Surface reflectance | Landsat 5 Thematic Mapper (TM) complemented Landsat 8 Operational Land Imager (OLI) surface reflectance data for the vegetation density analysis. |
| **Landsat 8 OLI** | Surface reflectance | Landsat 8 OLI imagery complemented Sentinel-1 C-SAR data for the wetland inundation time series. Data were also used to map vegetation density using the Enhanced Vegetation Index (EVI). |
| **SRTM** | Slope | SRTM data were used as an input into the TerrSet Habitat and Biodiversity Modeler. |

***Ancillary Datasets:***

* USFS gopher frog *in situ* data – Habitat data, gopher tortoise burrow locations, known gopher frog breeding pond locations, and prescribed fire data were used in the vegetation density analysis
* USGS National Land Cover Database (NLCD) – Land cover used for accuracy assessment in the forecasting maps
* NASA DEVELOP Alabama – Marshall field data collected by the team – Up-to-date locations of gopher frog breeding ponds in Conecuh National Forest to validate wetland maps

***Modeling:***

* Clark Labs TerrSet Habitat and Biodiversity Modeler (HBM) (POC: Leah Parker, The University of Alabama in Huntsville) – Corridor assessment and suitability modeling of the gopher frog habitat
* Fuzzy logic model (POC: Helen Baldwin, NASA SERVIR) – Used to create the Habitat Suitability Map deliverable, which served as an input for the TerrSet Habitat and Biodiversity Modeler

***Software & Scripting:***

* Clark Labs TerrSet – Model a corridor map utilizing the Habitat and Biodiversity Modeler (HBM)
* Esri ArcMap 10.4.1 – Raster manipulation and map creation
* ESA Sentinel Application Platform (SNAP) – Preprocess Sentinel raster imagery

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Wetland Inundation Time Series** | Sentinel-1 C-SAR  Landsat 5 TM  Landsat 8 OLI | This end product will help partners understand the hydrologic variation of the gopher frog breeding ponds and wetland habitat in the Conecuh National Forest. | N/A |
| **Vegetation Density Analysis** | Landsat 8 OLI | This end product assessed the density of the southern pine forest, which will ultimately inform partners’ prescribed burn decision-making practices. | N/A |
| **Habitat Suitability Map** | Sentinel-1 C-SAR  Landsat 5 TM  Landsat 8 OLI  SRTM | Partners can use this map to assess the regions within the forest that are most suitable for the gopher frog. | N/A |

**Project Handoff Package**

***Transition Plan:*** During week ten of the summer 2019 DEVELOP term, the team had a virtual handoff in the style of a webinar with all project partners. The team presented findings, discussed final end products, and sent partners the handoff package through Google Drive. During the presentation, team members went into detail on the methodology and validation of the data and end products and took questions. The team and partners also discussed plans for the second term of this project, which will allow the current Project Lead to provide direction and guidance to the future team.

***Project Continuation Plan:*** The Conecuh National Forest Ecological Forecasting project will continue in the fall 2019 DEVELOP term. Term I of the project provided each end product to project partners during handoff, as specified in the Handoff Package list below. The team from the first term will give the second term team the same materials as the partners with additional notes related to methodologies. The team for the second term will provide improved end products and supplementary materials during handoff.

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***Handoff Package:***

* Wetland Inundation Time Series
* Vegetation Density Analysis
* Habitat Suitability Map
* Presentation
* Technical Paper
* Poster

**References**

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