**NASA DEVELOP National Program**



 NASA John C. Stennis Space Center)

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Mississippi Ecological Forecasting

Utilizing NASA Earth Observations to Locate Potential Habitat for the Dusky Gopher Frog

 **Technical Report**

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# I. Abstract

[Placeholder - do not put anything here until the final draft submission. The abstract in the project summary is where the working draft of the abstract should “live”]

**Keywords**

Remote Sensing, Ecological Forecasting, Precipitation, Longleaf Pine Forest, Landsat 8, Dusky Gopher Frog

# II. Introduction

Listed as one of the top 100 endangered species in the world, the dusky gopher frog (DGF), *Lithobates sevosus*, is the most endangered species of frog in North America. Currently, this species is found to inhabit and breed in only two, genetically isolated ponds in Harrison County, Mississippi, meaning the population of DGF in Mississippi has little genetic mixing with other organisms within the same species. Mississippi has been a known habitat for DGFs since the 1920s. Historically, the DGF inhabited the Gulf Coastal Plain in Southwest Alabama, Southern Mississippi, and Southeast Louisiana from east of the Mississippi River Delta to Mobile Bay. The reduction of long leaf pine forests, coupled with the highly specific habitat requirements of *Lithobates sevosus*, makes it especially challenging to federal land wildlife managers to maintain existing populations and increase the number of viable populations through reintroduction and/or establishment of new populations.

# Background Information:

The dusky gopher frog was listed as an endangered species under the Endangered Species Act of 1973 on December 4, 2001 and received a priority number of 6 out of 12 which indicated a high degree of threat (USFWS 2014). Historically, records show existence of the DGF in Southwest Alabama, Southern Mississippi and Southeast Louisiana from East of the Mississippi River to the West of Mobile Bay. Currently only four populations of the species are known and are located in Southern Mississippi (USFWS 2014). Glen’s Pond was originally the only known breeding location for the DGF. Currently Glen’s Pond, two other naturally-occurring ponds and a fourth pond which was established as a recovery plan using translocation experiments are the only known ponds with DGFs (USFWS 2014).

In an effort to save the DGF from extinction, the US Fish and Wildlife Service (USFWS) has initiated a recovery plan. The recovery plan has designated approximately 6,477 acres throughout Southwest Alabama and Southeast Louisiana as critical habitat for the dusky gopher frog (USFWS 2014). The strategy for the DGF consists of monitoring the current known ponds with DGFs; maintaining and enhancing existing populations on public and private land; identifying and securing additional dusky gopher frog populations and habitat; establishing new populations through translocation or reintroductions(USFWS 2014). In 2012 the DGFs priority number was changed to 5 because of taxonomic change but the high degree of threat and low potential for the recovery of the frog has not changed (USFWS 2014).

The dusky gopher frog habitat includes upland sandy and sandy loam habitat. Historically, longleaf pine forests and wetland breeding sites within the forest were the optimal habitat (USFWS 2014). The DGF will only inhabit and breed in ephemeral wetland ponds that are geographically isolated from other water bodies, making rainfall the only source of water for these ponds. These need to be located on the topographic high of low lying areas. Ponds must also be hard bottomed, drain almost completely during the non-breeding season, have emergent and submergent vegetation present for egg attachment, and have open canopy cover which is essential for tadpole development. DGFs were historically known to live in abandoned gopher tortoise burrows however a decline in gopher tortoises has resulted in the DGF living in stump holes or small mammal burrows within the forest (USFWS 2014). Since *Lithobates sevosus* has extremely specific habitat requirements, it makes recovery plans for the DGF enormously challenging.

Project Objectives:

This project covers methodologies developed at John C. Stennis Space Center during the summer 2015 DEVELOP Mississippi Ecological Forecasting project by using NASA Earth Observations to locate potential breeding sites suitable for the endangered dusky gopher frog. The project will focus on Southern Mississippi in Hancock, Harrison and Jackson counties. These sites will incorporate canopy cover, proximity to roadways, proximity to developed land, and proximity to other bodies of water, identification of small pond water bodies, emergent vegetation, submerged vegetation and appropriate pond hydrology. This data will be utilized by end-users in current decision practices to decide where to relocate and reintroduce ponds for the dusky gopher frog in order to aid in monitoring, protection and restoration of the critically endangered species.

Study Area:

The focus for the project consists of the following three Mississippi counties and one Louisiana Parish: Hancock county (533 sq mi), Harrison county (976 sq mi), Jackson county (1,043 sq mi), and St. Tammany Parish (854 sq mi). These three counties are located south of Hattiesburg, Mississippi and all border the Gulf of Mexico. St. Tammany Parish is located north of New Orleans, and borders west Hancock county, Mississippi. The total combined areas of the three counties and parish is approximately 3,406 square miles, with a total population of about 613,000 according to the 2013 census. St. Tammany has a population of approximately 242,000, Hancock 44,000, Harrison 188,000 and Jackson 140,000.

Study Period: This project will utilize NASA Earth Observations and ancillary data collected from 2005 until present, in order to locate potential breeding sites suitable for the endangered dusky gopher frog. This study period includes data for areas that were impacted by hurricanes, such as Hurricane Katrina and Rita in summer of 2005, Hurricane Gustav in August of 2008, and Hurricane Isaac in August of 2012.



**Study Area**

 **St. Tammany Parish**

 **Hancock County**

 **Harrison County**

 **Jackson County**

National Application(s) Addressed: This project applies to the application area of ecological forecasting. The project and information provided by this project will augment current decision making practices of end-users regarding where relocation and reintroduction ponds for the dusky gopher frog should be established.

Project Partners: Our partners include the Nature Conservancy and US Fish and Wildlife Service (USFWS). On September 10, 2014, the USFWS released a draft recovery plan for *Lithobates sevosus* to the public. The goals for recovery were creating a GIS database for the species and using remote sensing to locate preexisting and potential gopher frog ponds, which has not previously been done by these organizations. The project results and methodologies will provide supplemental information to the current decision making practices regarding where relocation and reintroduction ponds for the dusky gopher frog should be established in order to aid in monitoring, protection, and restoration of this critically endangered species.

# III. Methodology

**Data Acquisition**

1. Land Cover

The USGS 2011 National Landcover Database (NLCD), USGS Landfire and USGS National Gap Analysis Program (GAP) was acquired for the conterminous area of the United States at 30 meter ground resolution. The USGS Landfire data was acquired for 2001 and 2012 for comparison. Shapefiles of each county/parish were used to clip the NLCD to the study areas. The shapefiles were downloaded through ESRI’s template data. Data was extracted from Coastal Change Analysis Program (CCAP) Regional Land Cover (NOAA CSC) at 30 meter resolution, these files were downloaded through ESRI’s template data.

1. Elevation

A 30 meter resolution USGS 2011 National Elevation Dataset (NED) was acquired for the study area. 30 meter resolution Digital Elevation Model (DEM) data files from webGIS were acquired for St. Tammany Parish, Jackson County, Harrison County and Hancock County.

1. Precipitation

Precipitation data at 4 km resolution was extracted from Parameter-Elevation Relationships on Independent Slopes Model (PRISM).

1. Soil Data

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) website was used to download data for soil texture types. Soil Information for Environmental Modeling and Ecosystem Management multi-layer soil characteristics dataset based on the USDA State Soil Geographic Database (STATSGO) was used to download data for the study area at 30m.

1. Multi Spectral Imagery

Imagery from Landsat 5 TM and Landsat 8 OLI was acquired via the USGS EarthExplorer web portal. This imagery was stacked and corrected for atmospheric interference. Data was processed using ERDAS IMAGINE and Exelis ENVI image processing software.

1. Infrared images of the study area were further processed to extract water features using ERDAS IMAGINE. A mask of permanent water features was created in order to show only the ephemeral water features.

**Data Processing**

What did you do to the data? Were there conversions needed to be able to analyze it? Did you have to mosaic images? Did you have to normalize anything to fit other datasets? Did you run an NDVI, change detection, etc? (LAYERAGE)

**Data Analysis**

How did you analyze the data? What methods did you use?

# IV. Results & Discussion

Insert images, graphs, maps, charts, etc. here. Choose the most important results to highlight here. No word cap, but two to six pages is a good range.

Things to discuss:

* Analysis of Results: What can you tell from your graphs, images, etc? What does this mean for your project?
* Errors & Uncertainty: What factors could you not account for, what things didn’t work out like you expected they would, etc.
* Future Work: If this project was to be selected for another term, what would be the focus? What other areas would be of interest?

# V. Conclusions

Final conclusions. Word count: 200-600 (~a page).

# VI. Acknowledgments

* Joseph Spruce - Senior Scientist and Lead Science Advisor at NASA SSC
* James “Doc” Smoot - Senior Scientist and Assistant Science Advisor at NASA SSC
* Ross Reahard - SSC DEVELOP Center Lead
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* Ed Moody - USDA Forest Service: DeSoto Ranger District - Wildlife Biologist
* Linda LaClaire - US Fish and Wildlife Service (USFWS) - Wildlife Biologist
* Danny Hartley – US Army Corps of Engineers – Wildlife Biologist

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# VII. References

U.S. Fish and Wildlife Service. 2014. Technical/Agency Draft Recovery Plan for the Dusky Gopher Frog (*Rana sevosa*). Atlanta, Georgia. 90 pp. Available online at <http://www.fws.gov/endangered/species/recovery-plans.html>

National Gap Analysis Program Land Cover Data. US Geological Survey. U.S General Land Cover Map. Available online at <http://gapanalysis.usgs.gov/gaplandcover/viewer/>.

National Land Cover Database. US Geological Survey. Conterminous United States Land Cover. Available online at <http://www.mrlc.gov/nlcd2011.php>.

LANDFIRE. US Geological Survey. Conterminous United States Land Cover. Available online at <http://www.landfire.gov/>

The National Elevation Dataset, US Geological Survey. U.S General Elevation Map. Available online at <http://ned.usgs.gov/>.

WebGIS. Geographic Information Systems Resource. Elevation Map Available online at <http://www.webgis.com/>.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. U.S. General Soil Map (STATSGO2). Available online at <http://sdmdataaccess.nrcs.usda.gov/>.

Soil Information for Environmental Modeling and Ecosystem Management. US Conterminous Soil Map. Available online at <http://www.soilinfo.psu.edu/index.cgi?soil_data&conus&data_cov&texture>

Coastal Change Analysis Program Regional Land Cover and Change. NOAA Digital Coast Office for Coastal Management. Available at

<http://coast.noaa.gov/dataregistry/search/collection/info/ccapregional>

PRISM Climate Group, Oregon State University. US Conterminous Precipitation Data. Available online at <http://www.prism.oregonstate.edu/>

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# IV. Appendices

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