**NASA DEVELOP National Program**



Mobile County Health Department

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Natchez Trace Ecological Forecasting

and Water Resources

Utilizing NASA Earth Observations to Assess Current and Historic Wetlands Extent along the Natchez Trace Parkway

 **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**

Wetlands, Beavers (*Castor canadensis*), Landsat 8, Land cover , TerrSet Land Change Modeler, ArcGIS 10.3

# II. Introduction

**Background**

Wetlands are a critical natural resource for species diversity and ecological services. They improve water quality through filtration, store excess stormwater runoff, and provide necessary habitats for thousands of species of reptiles, fish, birds, amphibians, mammals, and plants (United States Environmental Protection Agency (USEPA), 2001; USEPA, 2002). The Natchez Trace Parkway contains many wetland ecosystems, including streams, ponds, lakes, and riparian woodlands, with swamps and bayous stemming from nearby rivers within its southern, lower-elevation regions (National Park Service (NPS), 2015). The parkway is managed by the National Park Service and averages 800 feet wide, spanning 444 miles across Mississippi and into portions of Alabama and Tennessee. The Natchez Trace functions as a greenway “habitat corridor” for hundreds of species throughout the parkway (NPS, 2015).

Beavers (*Castor canadensis*) are a keystone species for wetland ecosystems. Beaver dams create ponds and slow stream currents which improves habitat conditions for aquatic species and connection between water bodies (Baldwin, 2013). Balancing beaver populations in wetland parks is a significant part of proper land use management and conservation planning (Baker & Hill, 2003). Beaver populations and their damming behavior along the Natchez Trace Parkway have had an increasing impact on wetland extent, river and streamflow, flooding, road maintenance, and private land quality (Deanna Boench, personal communication, September 14, 2015). The NPS manages beaver dams through the use of levelers (which allow water flow below dams), dismantling and removing dams, and trapping beavers. These methods are used as needed for parkway maintenance and in response to nearby private landowner complaints. The NPS is in the process of conducting an environmental impact assessment to determine best management practices to balance parkway quality, habitat preservation, and conservation planning (D. Boench, personal communication, September 14, 2015).

**Objective**

The objective of this project was to collaborate with the National Park Service to address community concerns involving shifting wetland extents as a result of beaver damming activity along the Natchez Trace Parkway, causing damage to roads, property, and private lands.

NASA Earth Observations data were used to produce a time series of land use/land cover (LULC) classification for wetlands along the parkway. A wetlands extent prediction map was generated using the TerrSet Land Change Modeler.

**Study Area**

The project study area included wetland extents within a 500 meter buffered region around the Natchez Trace Parkway. This parkway is a 444 mile national road stretching throughout the state of Mississippi and into portions of Alabama and Tennessee.

**Study Period**

The study period ranged from February 1992 to January 2015. Landsat 5 Thematic Mapper (TM) and Landsat 8 Operational Land Imager (OLI) data for land use/land cover classification were collected incrementally for the years 1992 through 2015. United States Geological Survey (USGS) National Land Cover Database (NLCD) data were collected for the selected years between 1992 and 2011. United States Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP) data were collected for the selected years between 2006 and 2015. USGS Gap Analysis Program (GAP) data for beaver species distribution were collected for the year 2013.

**National Applications Addressed**

This project addressed the Ecological Forecasting application area which focuses on issues requiring the modeling and analysis of ecosystems to promote the management of ecological resources. The Water Resources application area, which focuses on the availability, supply, and quality of water, was also addressed with this project.

A land use/land cover time series classification throughout the Natchez Trace Parkway was provided showing wetland extents changes from 1992 to 2015. A prediction map showing future wetland extents was also produced in this same study area. This time series and prediction map will aid in the management of wetlands preservation, beaver populations, and parkway maintenance.

**Project Partners**

The project partner for this study was the National Park Service (NPS). Quality of roads, property, and park land are important concerns for maintenance. Current practices involve the management of beaver populations along the parkway in efforts to reduce the negative impacts of beaver dams (such as flooding, forest destruction, and changing river flow). Before this project, no products showing the recent historic or projected wetland extents along the parkway were available for the NPS to incorporate into management plans. The time series will provide historical perspective on shifting trends in wetland extent changes, while the prediction map will show a modeled projection of potential wetland extents. These products will assist the National Park Service in wetlands conservation and management in current and future plans.

# III. Methodology

**Data Acquisition**

Landsat 5 TM and 8 OLI data were collected from the USGS LandsatLook Viewer as level 1 GEOTIFF files for January or February for the years 1992, 2001, 2006, 2011, and 2015 for the LULC time series classification. Land cover data for accuracy assessment were collected from the USGS NLCD Multi-Resolution Land Characteristics Consortium (MRLC) for 1992, 2001, 2006, and 2011. High-resolution aerial imagery for accuracy assessment were downloaded from the USDA NAIP for the agricultural growing seasons (June - August) of 2006, 2011, 2013, and 2015. Raster data for beaver (*Castor canadensis*) species distribution were collected from the USGS GAP for 2013.

Vector data for national parkways, roads, and state boundaries were downloaded from the USGS National Map Viewer for 2015. National hydrography data for 2015 were also collected from the USGS National Map Viewer. A point layer of field-checked beaver dams along the Natchez Trace Parkway was provided by Deanna Boensch, a natural resource specialist at the NPS.

Work still in progress

**Data Processing**

The LULC time series classification was produced using Landsat 5 TM data for the years 1992, 2001, 2006, and 2011; Landsat 8 OLI imagery was used for the year 2015. Three Landsat scenes were used to cover the extent of the study area: path 22, row 36; path 22, row 37; and path 22, row 38.

The imagery was processed using DEVELOP National Program Python Package (dnppy) functions to calculate the top of atmosphere (TOA) reflectance and apply atmospheric corrections. ArcMap 10.3.1 was used to mosaic Landsat scenes from each year together (1992, 2001, 2006, 2011, and 2015) and clip them to the 1 km buffered extent of the study area. ArcMap was also used to reproject all data to match the Landsat imagery projection (WGS 1984 UTM Zone 16).

Work still in progress

**Data Analysis**

The LULC time series was composed of five land cover classifications, one for each selected year within the study period (1992, 2001, 2006, 2011, and 2015). Each LULC classification was performed in ERDAS Imagine 2014 using a technique which implemented both unsupervised and supervised methods. The unsupervised classification was used initially to converge pixels with similar spectral signatures into distinct classes. A supervised classification was then performed using a maximum likelihood algorithm to group the types of land cover (such as forest, impervious surfaces, water, etc.). USDA NAIP imagery and USGS NLCD data were used for accuracy assessment using ERDAS Imagine. An error matrix was constructed based on the accuracy of the supervised classification.

The prediction map was produced using the TerrSet LCM software. The LCM used the beginning date (1992) and the end date (2015) to generate an output showing the expected amount of change in wetland extents within the study area for a selected future date. The model incorporated the hydrology, roads, and parkways layers in its calculations.

Work still in progress

# IV. Results & Discussion

**Analysis of Results**

LULC classification for the time series showed a shift in wetland extents along the Natchez Trace Parkway throughout the study period (1992 - 2015). This highlighted areas which have consistent flooding or dryness within the study area. The time series revealed portions of the parkway which have had unsuitable conditions for maintenance throughout recent years.

The projected wetland extents performed in TerrSet LCM showed potential wetland boundaries along the parkway. The output indicated regions which were likely to become inundated or experience habitat shifts in the future.

Work still in progress

**Errors & Uncertainty**

Comprehensively mapping beaver dams would have been useful for LULC analysis and for future modeling. However, Landsat imagery has a 30 meter resolution, which is often much larger than most beaver dams. This made identifying them from satellite imagery very difficult and unreliable. High resolution aerial photography (NAIP imagery) was also not useful for this purpose, since this imagery is taken during “leaf-on” seasons when most dams are obscured by trees and bushes.

Work still in progress

**Future Work**

Work still in progress

# V. Conclusions

Work still in progress

# VI. Acknowledgments

Thanks are due to the following people for their assistance in the completion of this project: Bernard Eichold, M.D., Dr. PH (Mobile County Health Department), the team’s mentor; Dr. Kenton Ross (NASA Langley Research Center), DEVELOP’s national science advisor; and James “Doc” Smoot (NASA Stennis Space Center) and Joe Spruce (NASA Stennis Space Center), the team’s science advisors.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration.

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# VII. References

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# VIII. Content Innovation

AudioSlides

Featured Multimedia for this Article (VPS)

Interactive Map Viewer

# IV. Appendices

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