Internship Project: Revealing Lake Ecosystem Function from Bathymetric and Hydrologic Modeling in ArcGIS

Adrienne Rodriguez (Junior, North Carolina State University), Charlotte Roehm (NEON Aquatics), Melissa Slater (NEON GIS Specialist)

neon
National Ecological Observatory Network

Introduction

Lake ecosystem function can be assessed in part by measuring its bathymetry, morphology, and hydrology. For thirty years, NEON will be providing data following standardized methods that will undergo rigorous quality assurance. Records called Algorithm Theoretical Basis Documents (ATBD) will reveal how Raw L0 data collected in the field will be converted to higher level data products. When rectified, the ATBDs and associated data products will be freely available for scientific, educational, and public policy use. For my project, I created and tested ATBDs for Lake Bathymetry and Morphology, as well as Watershed Hydrology and Land Use. Included is the methodology for transforming L 1 Quality Assured Data into L4 Algorithmic Model Products using ArcGIS.

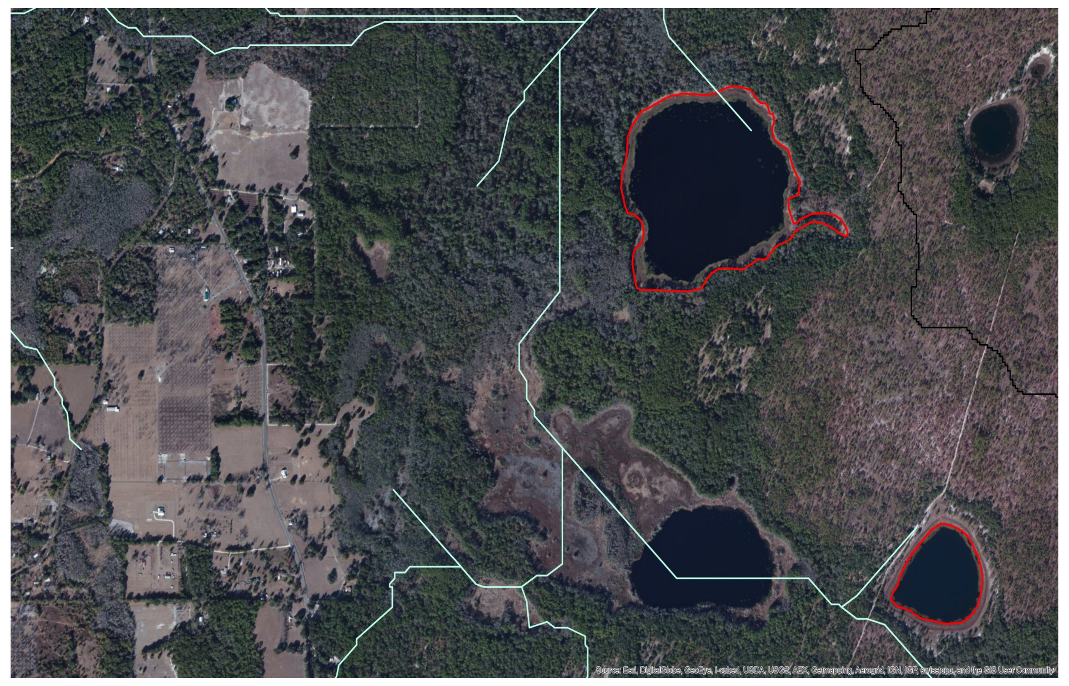


Figure 1. Google image of Lake Suggs and Barco in D3
Red = Lake Outline
Blue = Potential Dominant Flow Path Relative to Watershed

Barco Water Quality

Figure 2. Lake Barco

Low Nutrient Loading
Lower Sediment Loading
Low Organic Matter Loading
Low Algal Biomass

Therefore, high transparency

Suggs Water Quality

Figure 3. Lake Suggs

High Nutrient Loading
Higher Sediment Loading
High Organic Matter Loading
High Algal Biomass

Therefore, low transparency

If Lake Barco and Lake Suggs are in the same watershed, why is their water quality so different?

Bathymetry

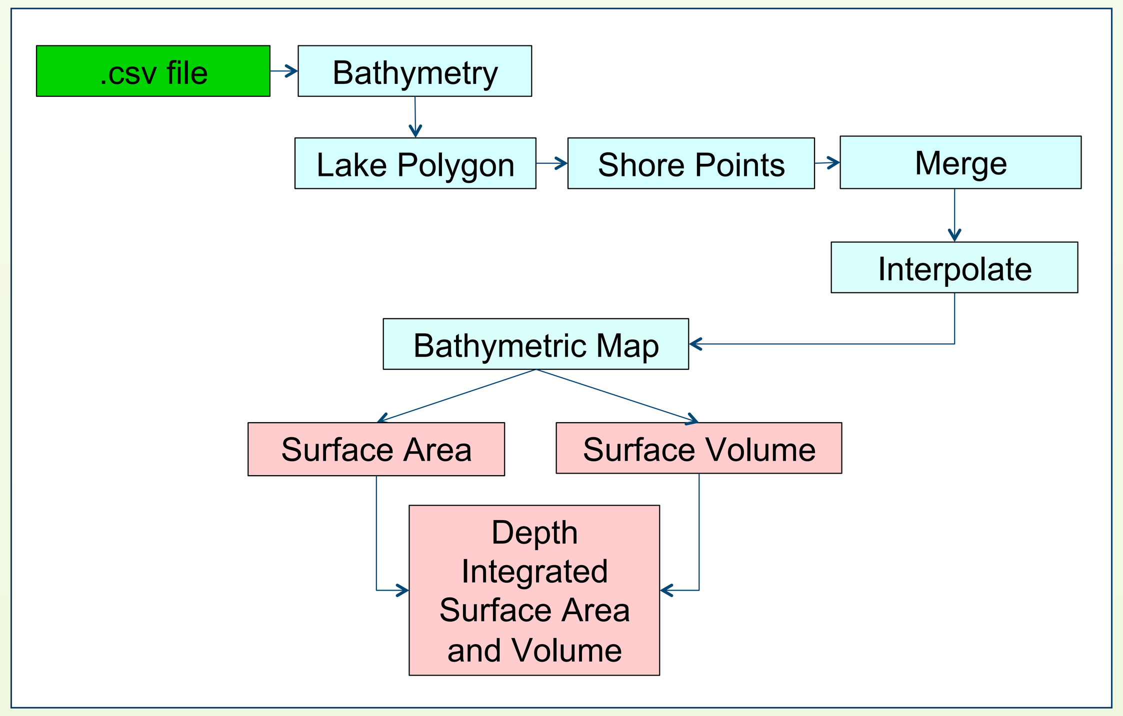


Figure 4. Model Flow of L1 into L4 Modeling Process in ArcGIS

Maps

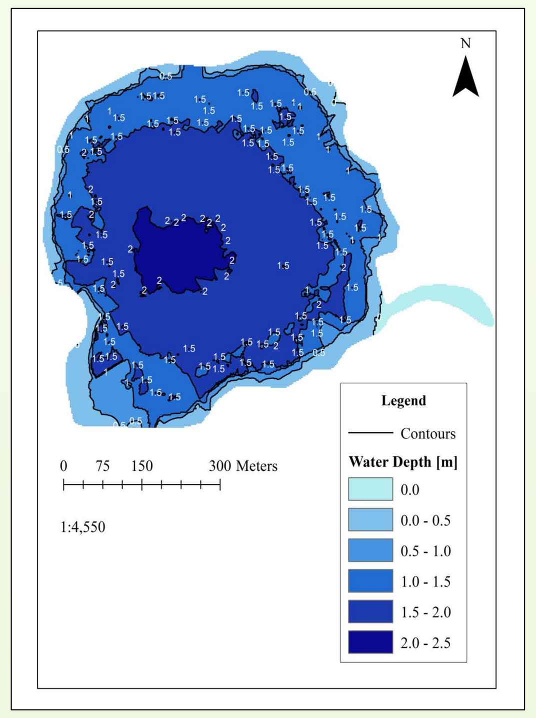


Figure 5. Lake Suggs Bathymetry

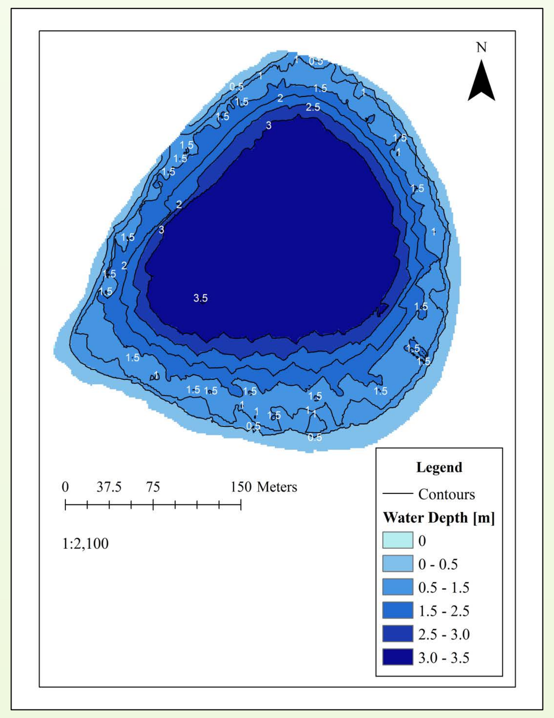


Figure 6. Lake Barco Bathymetry

Explanation

Figure 4. Bathymetric Raw Data (L0) transforms into Calibrated Data (L1) product via QA/QC procedures and saved as a .csv file. Once imported into ArcGIS, the .csv file becomes bathymetric point data and the lake polygon is added into ArcMap. Shore points are calibrated by establishing a latitude, longitude and Z depth at each point. After merging shore points and bathymetric data, all unknown values in the lake are interpolated using the Empirical Bayesian Kriging method, creating L3 Spatially Rectified Data. Kriging quantifies unknown values from known values based off of their respective distance and direction. Depth integrated surface area and volume is an example of L4 Algorithmic Products. **Figure 5.** Lake Suggs bathymetric interpretation; deepest point: 2.5 meters. **Figure 6.** Lake Barco bathymetric interpretation; deepest point: 3.5 meters.

Hydrology

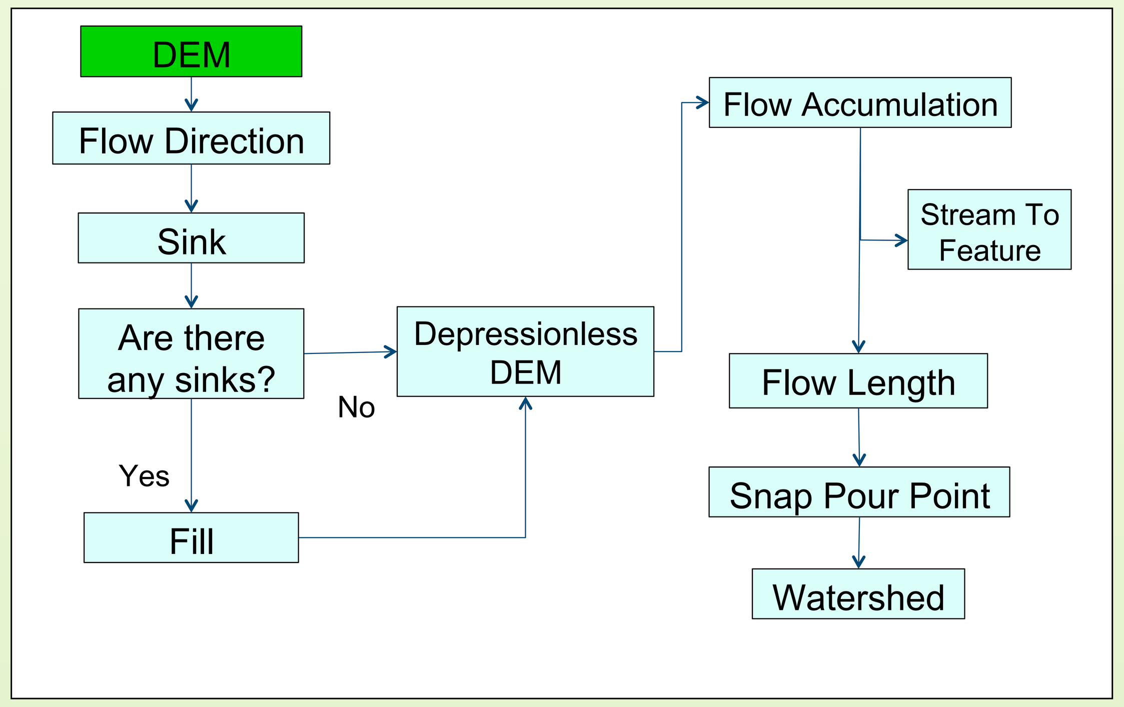


Figure 7. Model Flow of L1 into L3 Modeling Process in ArcGIS

Map

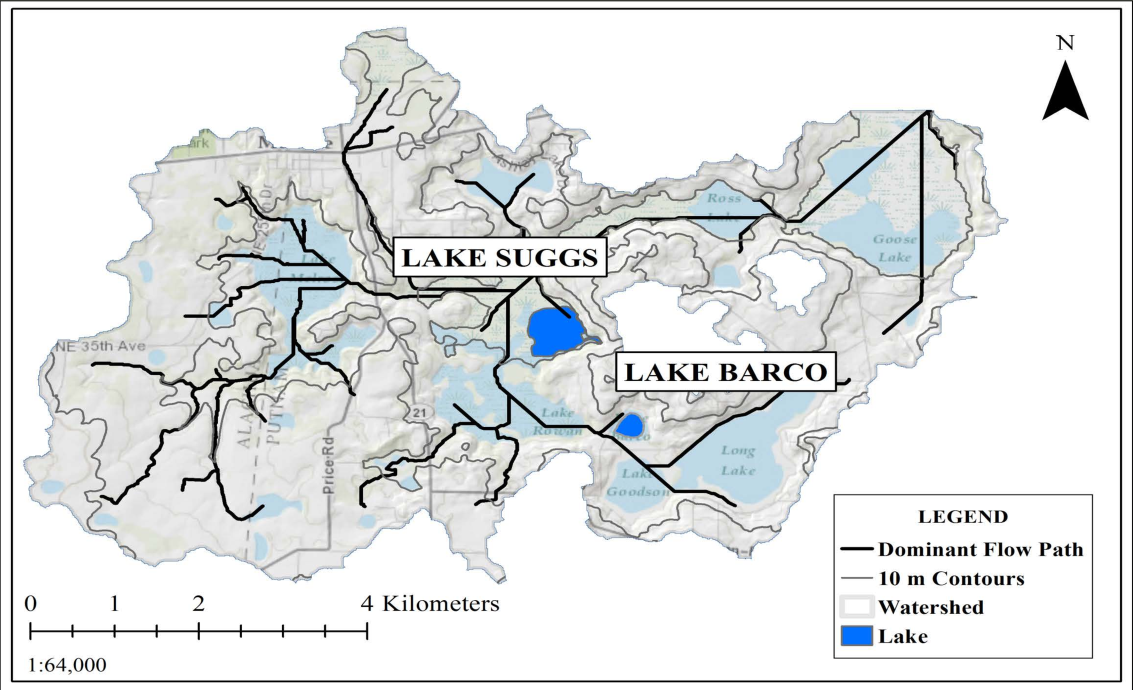


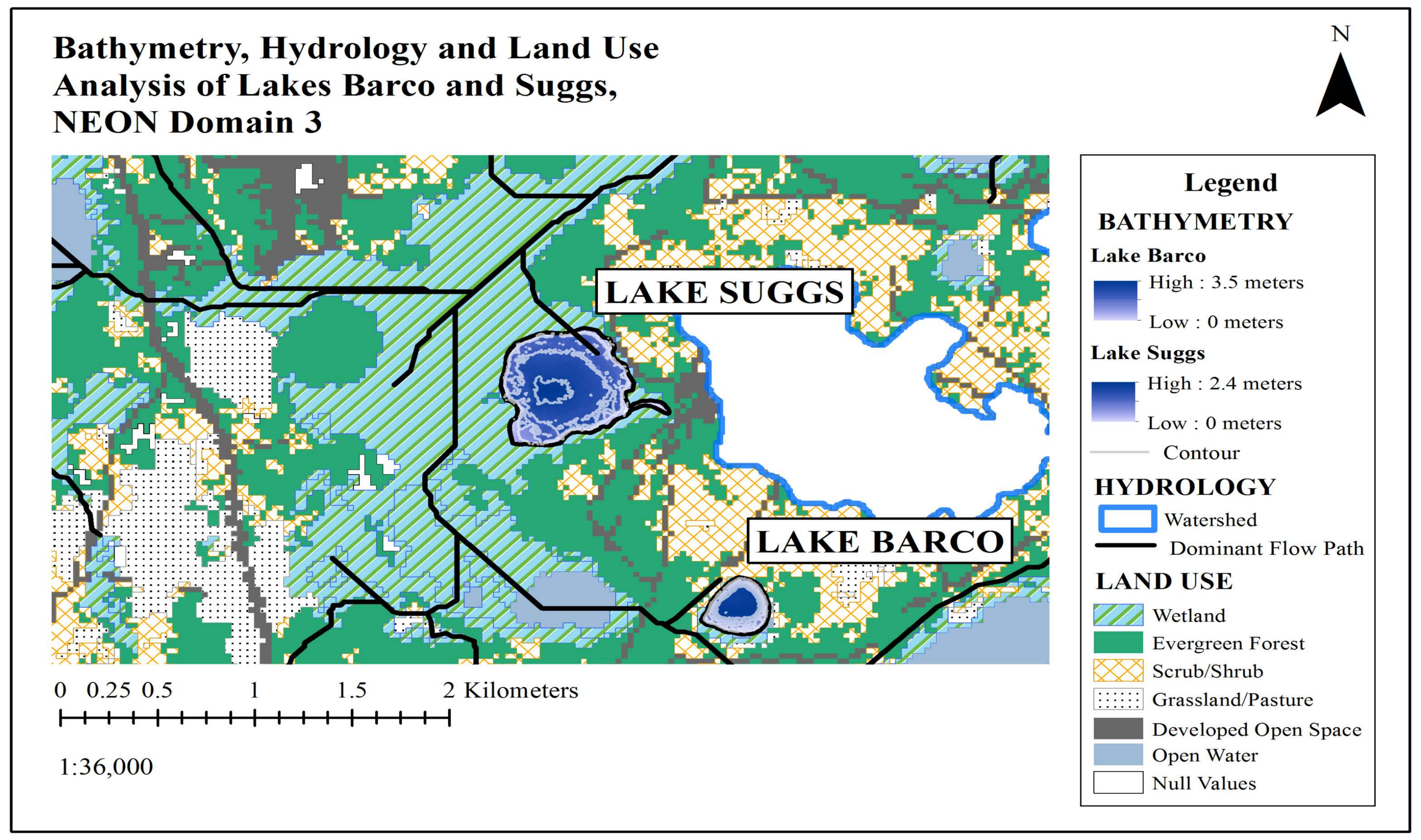
Figure 8. D3 Watershed

Explanation

Figure 7. Hydrologic data transformation process from Calibrated Data (L1) into a Spatially Rectified Data (L3) product. The Digital Elevation Model (DEM) undergoes a series of ArcGIS processes to correct erroneous data errors and creates a Depressionless DEM. Once achieved, another smaller set of functions are required before the watershed can be defined.

Figure 8. Lake Barco is located at higher elevation than Lake Suggs. During precipitation events, water flows along the dominant flow path, defined by the catchment slope and orientation. While Barco is dominated by groundwater inflow, Suggs receives inputs from both groundwater and shallow surface/subsurface flow, as defined by the potential dominant flow path.

Multi-layer Map Representation of D3



Watershed Hydrology, Bathymetry and 2006 *National Land Cover Data* in D3. The bathymetric data was collected in 2011 and reflect water levels at the time of recording.

Interpretation

The primary land coverage around Lake Suggs were wetlands and evergreen forests while Lake Barco had minimal wetlands, and a mix of scrub/shrub and evergreen forest. The derived hydrologic and land use data show Barco as less influenced by external surface water inputs and wetlands than Suggs, thus increasing the likelihood for Suggs to experience higher nutrient and organic matter loading than Barco over time.

Using ArcGIS layers together enables the potential detection of trends in lake ecosystem structure and function over time. The creation of each ATBD demonstrates the application, transparency and standardization NEON data will provide.

Contact Information: amrodri4@ncsu.edu

www.neoninc.org