Agriculture and Lake Erie Algal Blooms
An Intervention Suitability Analysis

Introduction
Lake Erie has had increasingly problematic algal blooms, growing in size, intensity, and frequency (Patel, 2017). Algal blooms are caused by an excess of nutrients, specifically nitrogen and phosphorus. Increased algae density turns the surface water a mucky blue-green and causes outbreaks of cyanobacteria, which can produce cyanotoxins (US EPA, 2013). The blooms impact Lake Erie’s ecosystem, regional tourist economy, and drinking water (Patel, 2017). The nutrient pollution is in part due to nonpoint agricultural runoff. Rain causes nutrients from fertilizer and manure sources to runoff into Lake Erie tributaries, eventually flowing into the lake.

The Western Lake Erie subregion spans three states: Michigan, Indiana, and Ohio (Figure 1). The area is dominated by an agricultural landscape and contains the Maumee River, the largest Lake Erie tributary. This Intervention Suitability Analysis aims to identify the areas in the Western Lake Erie subregion that have the most intensive agricultural practices and are oriented to be impactful sources of nitrogen and phosphorus runoff—therefore most suitable for intervention.

Cartographer: Molly Bailey
Tufts University, Introduction to GIS 101
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Projection: North America Albers Equal Area Conic
Data Sources: USGS, USDA NASS, Sierra Club, ArcGIS Online
References: Patel, J. K., & Parshina

Methodology
I used ArcMap 10.6.1 to perform the analysis. I used display XY data to add the CAFOs as a layer using table provided latitude, longitude. I executed kernel density of CAFO points by square kilometers and then reclassified by five natural breaks for new values of 1-5 for low-high. I joined the data tables including data of cropland, farms, county-level fertilizer, and livestock to county boundaries using the 5-digit FIPS codes. I executed polygon to raster (30 sq. km) for the following attributes: self-calculated crop difference and livestock totals, crop acres 2012, farm P 2012, farm N 2012, farms 2017, HUC8 sheds. I reclassified the raster values using five natural breaks for new values of 1-5 values low-high. HUC8 sheds were reclassified with Maumee Basin receiving a five to others 1.

I used an unweighted raster calculator to sum the eight inputs (Figures 2-9) and then reclassified the outcome using five natural breaks to reassign final new values 1-5 for low-high.

The analysis of both cropland and livestock agricultural practices show different geographic distributions across the Western Lake Erie region. Cropland and fertilizer use (Figures 2-5) is relatively more continuous throughout the region. Livestock and animal operations (Figures 6, 7) are more intensive in the western part of the region.

Number of farms (Figure 8) corresponds to the counties with increased cropland (Figure 2) and livestock (Figure 6), and the Maumee River basins (Figure 9) run through the center, with the lower basin closer to the lake larger in size. The areas most suitable for intervention (Figure 10), most intensive agricultural practices, are pockets within Adams and Allen counties in Indiana and Putnam county of Ohio. Values of four are in all three states: Lenawee county of Michigan, Mercer, Putnam, and Wood counties Ohio, and Adams and Allen counties Indiana. Lacasa county has relatively low agricultural activity, indicating the pollution is coming from upstream.

Discussion
The widespread agricultural practices of the Western Lake Erie region indicate that a multi-state intervention effort is needed to ultimately contain the nitrogen and phosphorus nutrient pollution contributing to Lake Erie’s algal blooms. This analysis connects the broader research on agricultural causes of nutrient pollution to specific counties to promote a local focus. It will prove useful for environmental and agricultural policy makers to properly focus and align their efforts.