

Food Access and Equity in Prince George's County

Darcy Drewyer, Laura Exar, Eva Macek, Katherine Rush,
Adam Scheckman, Liana Torres, Jared Williams

under the supervision of
Professor Michael Spivey

ENSP400: Capstone in Environmental Science and Policy
The University of Maryland, College Park
Spring, 2021

PALS - Partnership for Action Learning in Sustainability
An initiative of the National Center for Smart Growth

Gerrit Knaap, NCSG Executive Director
Kimberly Fisher, PALS Director



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Executive Summary

The purpose of this report is to provide the Maryland-National Capital Park and Planning Commission (M-NCPPC) with a comprehensive analysis of food equity in Prince George's County, with a focus on the most vulnerable communities. The project has two objectives: determine appropriate definitions of food access, food security, and food equity and conduct a ArcPro spatial analysis of Prince George's County to produce maps identifying healthy food priority areas. This report also provides policy recommendations to the M-NCPPC and outlines further steps for future capstone groups.

The density analyses of food retailers conducted in this research revealed four main healthy food priority areas in the county—Region A: Parkland Terrace and Marlow Heights along Suitland Parkway; Region B: Walker Mill, Yorkshire Knolls, and Carmody Hill; Region C: Langley Park and the Adelphi area; and Region D: College Park mainly within the University of Maryland's campus extension. These areas are typically characterized by high access to fast food and convenience stores and low access to supermarkets, WIC vendors, and SNAP retailers.

Analyzing the density of food retailers also revealed disparities in the amount of different types of retailers within the county. Areas that are classified as supermarket “hot spots” actually have low access to supermarkets, as the highest density value for supermarkets is 1.178 retailers per square mile. Thus, when areas are noted as having the highest density/being “hot spots,” it doesn't indicate that there is sufficient access to those retailers. In contrast, the highest density value for fast food is 8.444 retailers per square mile. Prince George's County residents generally have disproportionate access to unhealthier food options than to healthier choices.

Spatial analyses and research informed this report's policy recommendations. Considering the high density of fast food retailers, fast food access should be reduced, particularly in fast food hot spots. Access to supermarkets and farmers markets should be increased throughout the county, emphasizing areas with limited access to supermarkets and “food swamps,” which are characterized as having a low number of supermarkets and high number of fast food retailers. Although SNAP access is high overall, WIC access should be expanded, particularly for the most vulnerable residents. This report also recommends supporting small businesses by increasing community engagement and providing grants and loans. Finally, this report recommends supporting urban agriculture, particularly by mapping urban farms, creating gardens, and expanding existing urban agriculture programs.

While the report identifies food priority areas and provides recommendations, work remains. Future analysis and research should address the accessibility of food sources using public transportation, the cultural appropriateness of food retailers, the relationship between fast food access and the prevalence of nutritional diseases, and the impact of COVID-19 on the food system in Prince George's County.

Introduction

Food equity is a community's secure access to the ability and opportunity to grow and consume healthful, affordable, and culturally significant foods (U.S. Department of Agriculture, 2019). Alternately, food inequity occurs when a community has inadequate access to healthy foods or is faced with a disproportionate burden to obtain that food. Food inequity is a global phenomenon with infinite variability, as the context of each affected community is unique. In some communities, the primary food equity concern is the spatial distribution of food sources. In these areas of limited access, food sources of all kinds may be limited in number and/or located too far from residential areas to be properly accessible. Other communities may not necessarily lack access to food sources, however, the available food sources may be disproportionately unhealthy options. These communities, known as food swamps, are often characterized as areas with convenient access to densely placed fast food franchises and limited access to healthier alternatives such as grocery stores or farmer's markets. Approximately 44 percent of Prince George's County residents live in communities defined as food deserts; 55 percent of the food outlets in these communities are unhealthy options, such as fast food (Kavi et al., 2019).

While food inequity affects people of all demographic backgrounds, some groups are more vulnerable than others. The racial disparities in food equity in the US can be traced to the country's history of systemic racism; the intersectionality of economic status and race consistently place burdens of food inequity on low-income, minority communities (Slocum and Cadieux, 2015). According to a study conducted by Preventative Medicine, the availability of supermarkets in the US for majority Black neighborhoods is about half that of majority White neighborhoods (Powell et al., 2007). As a result of limited access to healthy, affordable, and culturally appropriate food, minority populations experience disproportionate rates of nutritional disease.

A healthy diet is essential for proper development and to maintain a healthy lifestyle; by contrast, an unhealthy diet primarily consisting of processed and fast foods is associated with obesity and a variety of other health risks. Obese individuals are at greater risk for diseases such as hypertension, coronary heart disease, Type 2 diabetes, stroke, numerous cancers, and other potentially life-threatening diseases (CDC, 2021). Additionally, childhood obesity is associated

with impaired cognitive development, including reduced memory, executive function, and increased impulsivity.

In 2015, 15.1 percent of the county's adolescents aged 12-19 were considered obese compared to the state average of 11.5 percent (Regional Primary Care Coalition, 2017). Likewise, 12.5 percent of the county's adults were diagnosed with diabetes, higher than Maryland's average of 10.4 percent. (Regional Primary Care Coalition, 2017). Overall, Prince George's County has an adult obesity rate of 71.2 percent, substantially higher than the national adult rate of 42.4 percent (Prince George's County Health Department, 2019). These numbers demonstrate the disproportionate health risks faced by county residents compared to the state and can largely be attributed to the quality and affordability of the food sources available to them.

With nearly half of Prince George's County living in a food desert and nearly three quarters of adults classified as obese, there is a clear need to improve the state of food equity in the county. Policies addressing food equity should focus on local communities within Prince George's County as each locality has its own unique issues, demographics, and regulations that affect the food environment (Kavi et al., 2019).

In 2015, the Maryland-National Capital Park and Planning Commission (M-NCPPC) conducted a food system study to gauge the state of food equity throughout Prince George's County. The report accounted for areas of limited access to healthy food options and the impacts of limited access on public health. The report also provided policy recommendations aimed at making healthy food sources more equitable and accessible to county residents. The study outlined the spatial distribution of food sources and the pricing of items at these sources as the ultimate drivers of inequity in accessing healthy foods (M-NCPPC, 2019).

The spatial distribution of these food sources and their relation to low-income communities result in ALAs to healthy foods (M-NCPPC, 2019). Therefore, an interactive display identifying restricted access areas and their intersection with specific demographics will be a valuable resource for Prince George's County. The county can use this tool in future efforts to attract healthier and more accessible food options to areas in need.

With data provided by the Partnership for Action Learning in Sustainability (PALS), our team was tasked with creating a map that displays the state of food equity in Prince George's County. This map will serve as a tool for policymakers to assess the conditions of food equity,

identify priority areas, ascertain the variables that have resulted in food inequity in those communities, and, ultimately, formulate policies to address those areas.

The team hopes that this food equity map will be a valuable resource that will provide a framework for the M-NCPPC to address food insecurity more effectively and equitably in Prince George's County in the future.

Objectives

This project aims to assess the current state of food security in Prince George's County, with appropriate definitions of food access, food security, and food equity. The report will include a GIS map identifying predominantly low-income and low-access areas, the demographic groups in these areas, and recommendations for addressing food insecurity. This project's purpose is to assist the Prince George's County Planning Department in providing access to nutritious, affordable, culturally appropriate food for county residents by identifying areas with the greatest need. To accomplish these goals, the following list of objectives was developed.

The first objective is to determine appropriate definitions of food access, food security, and food equity and to research current food insecurity in Prince George's County. The second objective is to conduct a spatial analysis that identifies healthy food priority areas in the county. We also hope to provide policy recommendations so that future capstone teams can further our work.

Methods

Preliminary Research

The team began by determining appropriate definitions for food access, food security, and food equity and by researching food access in Prince George's County. The team began with a literature review using Google Scholar, the University of Maryland's library research engine, and other relevant food equity and accessibility resources in Prince George's County. The team also did data research to establish the project's spatial analysis. We used an Environmental Justice Screen data layer from the Environmental Protection Agency that included

environmental, social, and demographic data on specific areas in the nation, including Prince George's County (U.S. EPA, 2020).

Data Gathering

The spatial analysis to create a geospatial map of the county's predominantly low-income and low-access areas, began by identifying publicly available datasets of food retailer data. The point data layers used in our analysis are from the Johns Hopkins University's Center for a Livable Future, which has updated food retailer data for the entire state. The team used shapefiles that included data on WIC Vendors 2020, SNAP Retailers 2020, Maryland Food Stores (2017-2018), and Maryland Restaurants (2019). After finalizing these datasets, we cleaned and streamlined the data by overlaying the different layers and creating an initial map to visualize the data.

Layer Formation

To properly represent food retailers by categories, we broke down the Maryland Food Stores and dataset into separate layers. We separated individual food retailers into several layers: WIC Vendors, SNAP Retailers, Fast Food Restaurants, Restaurants (limited-service restaurants and snacks and nonalcoholic beverage bars), Supermarkets, Convenience Stores, and Small Grocers/Corner Stores. To fairly represent food access, the access to supermarkets was used as a proxy for access to healthy food, while access to fast food was used as a proxy for access to unhealthy food (given its nutritional value). We worked along this fast food/other restaurants and supermarkets/other food stores binary for the first half of our analysis; accordingly convenience stores and small grocers/corner stores were combined as a single layer until the Kernel Density Maps were created.

Assigning Demographic Classifications

We analyzed three indicators from the EJScreen: low-income percent, minority percent, and vulnerable percent (an index of low-income percent and minority percent). Each of these indicators was divided into four levels using Jenks Natural Breaks, where "low" has the lowest

population of vulnerable, low-income, or minority individuals, and “very high” is the highest population of vulnerable, low-income, or minority individuals. Jenks Natural Breaks is a method of data classification that arranges a data set into “natural” classes, which are considered to be the ideal class ranges formed “naturally” in a data set (Esri, 2021). Table 1 shows how the four levels were divided for each of the three indicators from the EJScreen: vulnerable percent, low-income percent, and minority percent.

Table 1.

This table shows the level definitions as assigned by the percentage of residents living with the block group that can be classified as vulnerable, low-income, or minority percent.

	Vulnerable Percent	Low-Income Percent	Minority Percent
Low	≤ 0.363	≤ 0.145	≤ 0.465
Moderate	≤ 0.526	≤ 0.301	≤ 0.723
High	≤ 0.651	≤ 0.478	≤ 0.899
Very High	≤ 0.857	≤ 0.992	≤ 1.000

Using these classifications, we created a new attribute table for each EJScreen layer titled “Level,” in which we assigned a corresponding number (1=low, 2=moderate, 3=high, 4=very high) to be able to conduct spatial analysis according to the demographic variables.

Access Buffers and Population Analysis

The first step in the spatial analysis was to create 0.5-mile buffers around every point location in each food retailer layer. 0.5-miles is the distance determined by the USDA as “high walkability” in urban areas (U.S. Department of Agriculture, 2019) and was used as a proxy for food access. To create these buffers, we used ArcPro’s “buffer” tool with distance set to 0.5-miles and none of the features dissolved. Once these buffers were created for every data layer, we used them for spatial join operations.

Our first analysis was to spatially join the EJScreen layer to each food retailer data layer to produce an output layer that identified which block groups overlapped with a buffer. For each

of the food retailer spatial join layers, we exported an Excel sheet and found the number of block groups with access to that type of food retailer, according to their vulnerability level, while ignoring repeats so that each block group was only included once.

We also determined the percent of the population in each block group that fell within the 0.5-mile buffer as another measure of food access. This was done by creating new buffers for every food location layer using the same parameters as above, except for the “dissolve type” set to “dissolve all output features into a single feature.” Then the intersect tool was used with each of these new buffer layers and the EJScreen layer. The output was a new layer indicating the extent of each block group that fell within buffers.

For each intersect layer, we calculated the buffer area in square miles, using the “calculate geometry” tool, set to “area.” For each block group, we divided the total area of the group’s buffers by the group’s total area (provided in the EJScreen data). This method assumes that population is evenly distributed across the block group, so this proportion of intersect area to total block group area was used as a proxy for the percent of each block group’s population that had access to the different types of food locations. To determine the actual number of residents, we multiplied the area proportion by the total block group population (provided in the EJScreen data). To calculate the total number of residents in each vulnerability level with access to the food location being analyzed, we separated out the four vulnerability classifications using “select by attribute” and used the “statistics” tool to summarize the buffer population field. This procedure was repeated for each of the six food retailer layers.

Hot Spot Analysis Using Kernel Density Estimation

To analyze the spatial distribution of food access and food points in the county, we used kernel density estimation for each of food point feature to calculate the density of each food retailer point layer around each output raster cell (Esri, 2021). To do this, we created a model in Esri’s ArcGIS Pro using the ModelBuilder tool to create each of the Kernel Density maps (Esri, 2021). The Kernel Density tool in ArcGIS Pro allowed us to calculate the density of each feature selected in a specific area around each feature (Esri, 2021). The Kernel Density tool is specifically useful in identifying hot spots “due to the series of estimations which are made over a grid placed on the entire point pattern” (Kalinic & Krisp, 2018). Each of these estimations

calculate and presence the intensity of food retailers at a certain location and therefore detects the highs and lows of point pattern densities, with high densities colored as red, mid-moderate densities as orange or yellow, and low densities as blue (see Maps 4 through 15).

The model inputs consisted of five layers: Fast Food, Convenience Stores, SNAP Retailers, Supermarkets, and WIC Vendors. A Kernel Density was performed on each of the input point layers. The Kernel Densities were calculated with an output cell size of 30 and area units in square miles.

To further spatially analyze various features, we combined the layers of interest to overlay several rasters to get the distribution of each retailer within 0.5-miles. The WIC vendors and SNAP retailer layers were merged into one and fast food and convenience stores were merged into another. Small grocers/corner stores, other restaurants and supermarkets were left as their own separate layer.

Once each input was finalized, we ran the model and generated initial maps that showed density over the whole county. However, to further analyze areas of priority and need, we created hot spot maps against high vulnerability block groups, represented as “very high” vulnerability. Using the Clip Raster tool, we clipped each of our KDE maps to the “very high” vulnerability block group layer, which revealed densities with only very high vulnerability block groups, allowing us to focus on four specific sub-regions (Esri, 2021).

Results

The project’s goal was to identify challenges and opportunities, and provide recommendations for creating a healthy, equitable, and sustainable food system that ensures every Prince Georgian has access to nutritious, affordable, sustainably grown, safe, and culturally appropriate food.

Through the spatial analysis, our objectives were to identify areas of low food access and determine if these areas are located in the very high vulnerability block groups. This analysis will present county food trends and highlight priority areas, which is crucial to create an updated interactive map showing access priority areas and developing recommendations for future policies. This work can be continued by future capstone groups.

Using the 2020 EJScreen data for Prince George’s County, we found 523 block groups in the county (U.S. EPA, 2020). The Census Bureau defines a block group as “statistical divisions of census tracts, [which] are generally defined to contain between 600 and 3,000 people and are used to present data and control block numbering.” (U.S. Census Bureau, 2019). There are 884,764 residents in Prince George’s County (U.S. EPA, 2020).

This geospatial analysis can help determine areas of Prince George’s County that suffer the most from lack of access to healthy, affordable food; these are defined as “priority access areas.” Measuring fast food and supermarket access across the county provides basic spatial patterns that help identify priority access areas.

We analyzed three demographic indicators from the EJScreen: percent of vulnerable, low-income, and minority population. Using the classifications for each indicator (assigned in the methods section), we calculated the number of individuals who are vulnerable, low-income, and minority at each of the four levels (low, moderate, high, very high), as well as their percentage of the county’s total population see Table 2).

Table 2.

This table shows the number of individuals in each level and the percent of each level of the total county population classified as vulnerable percent, low-income percent, and minority percent.

	low	percent low of total pop.	moderate	percent moderate of total pop.	high	percent high of total pop.	very high	percent very high of total pop.
vulnerable percent	69116	7.81	298092	33.69	323297	36.54	194259	21.95
low-income percent	283970	32.09	313962	35.48	199603	22.56	87229	9.85
minority percent	57558	6.50	88932	10.05	236590	26.74	501684	56.70

Low-income percent had the highest “low” population at 283,970 individuals (32.09 percent of total county population). Low-income percent also had the highest “moderate” population at 313,962 individuals (35.48 percent of total county population). Vulnerable percent had the highest “high” population at 323,297 individuals (36.54 of total county population).

Minority percent had the highest “very high” population at 501,684 individuals (56.70 percent of total county population). Because most the analysis was conducted using the vulnerable percent layer, it’s important to note that over half of the county’s population (58.49 percent) lives in block groups categorized as either high or very high vulnerability.

To analyze food access in the County, we looked at several categories of food establishments in the county: WIC vendors, SNAP vendors, fast food (limited-service restaurants and snacks and nonalcoholic beverage bars), restaurants (full service and fine dining), supermarkets, and convenience stores and small grocery/corner stores (see Table 3).

Table 3.

This table shows the number of food establishments of each type in the county.

	Count
WIC vendors	712
SNAP vendors	3410
fast food	3579
restaurants	6658
supermarkets	710
convenience stores/small grocers	4406

For a more complete understanding of food access in Prince George’s County, and to determine if one demographic measure has a larger impact on food access than the others, we analyzed the total number of block groups, divided into four vulnerability levels, that have residents with access to food vendor locations within a 0.5-mile, as well as the percent of block groups with access to total number of block groups, again divided by vulnerability level. We conducted this analysis for vulnerable, low-income, and minority populations to identify similarities and differences among the three metrics (see Tables 4 through 6).

Table 4.

Vulnerable block groups whose residents have access to point data locations within 0.5-miles, followed by the percent of block groups with access to the total number of block groups (by vulnerability level).

	total low	total moderate	total high	total very high	percent low	percent moderate	percent high	percent very high
WIC	27	92	142	90	57.45%	52.57%	75.13%	80.36%
SNAP	43	148	180	111	91.49%	84.57%	95.23%	99.11%
Fast food	41	148	169	102	87.23%	84.57%	89.42%	91.07%
Super- markets	31	103	128	85	65.96%	58.86%	67.72%	75.89%
Restaurants	43	157	180	112	91.49%	89.71%	95.24%	100.00%
Convenience stores/small grocers	43	158	181	112	91.49%	90.29%	95.77%	100.00%

Table 5.

Low-income block groups whose residents have access to point data locations with 0.5-miles, followed by the percent of block groups with access to the total number of block groups (by low-income percent level).

	total low	total moder ate	total high	total very high	percent low	percent moderate	percent high	percent very high
WIC	78	129	101	35	48.15%	67.19%	82.11%	76.09%
SNAP	136	179	121	46	83.95%	93.23%	98.37%	100.00%
Fast food	132	173	113	42	81.48%	90.10%	91.87%	91.30%
Super- markets	88	132	93	34	54.32%	68.75%	75.61%	73.91%

Restaurants	143	180	123	46	88.27%	93.75%	100.00%	100.00%
Convenience stores/small grocers	144	182	122	46	88.89%	94.79%	99.19%	100.00%

Table 6.

Minority block groups whose residents have access to point data locations within 0.5-miles, followed by the percent of block groups with access to the total number of block groups (by minority percent level).

	total low	total moderate	total high	total very high	percent low	percent moderate	percent high	percent very high
WIC	20	36	89	198	57.14%	58.06%	65.93%	68.04%
SNAP	33	55	120	274	94.29%	88.71%	88.89%	94.16%
Fast food	31	55	118	256	88.57%	88.71%	87.41%	87.97%
Super-markets	27	37	92	191	77.14%	59.68%	68.15%	65.64%
Restaurants	33	58	124	277	94.29%	93.55%	91.85%	95.19%
Convenience stores/small grocers	34	55	126	279	97.14%	88.71%	93.33%	95.88%

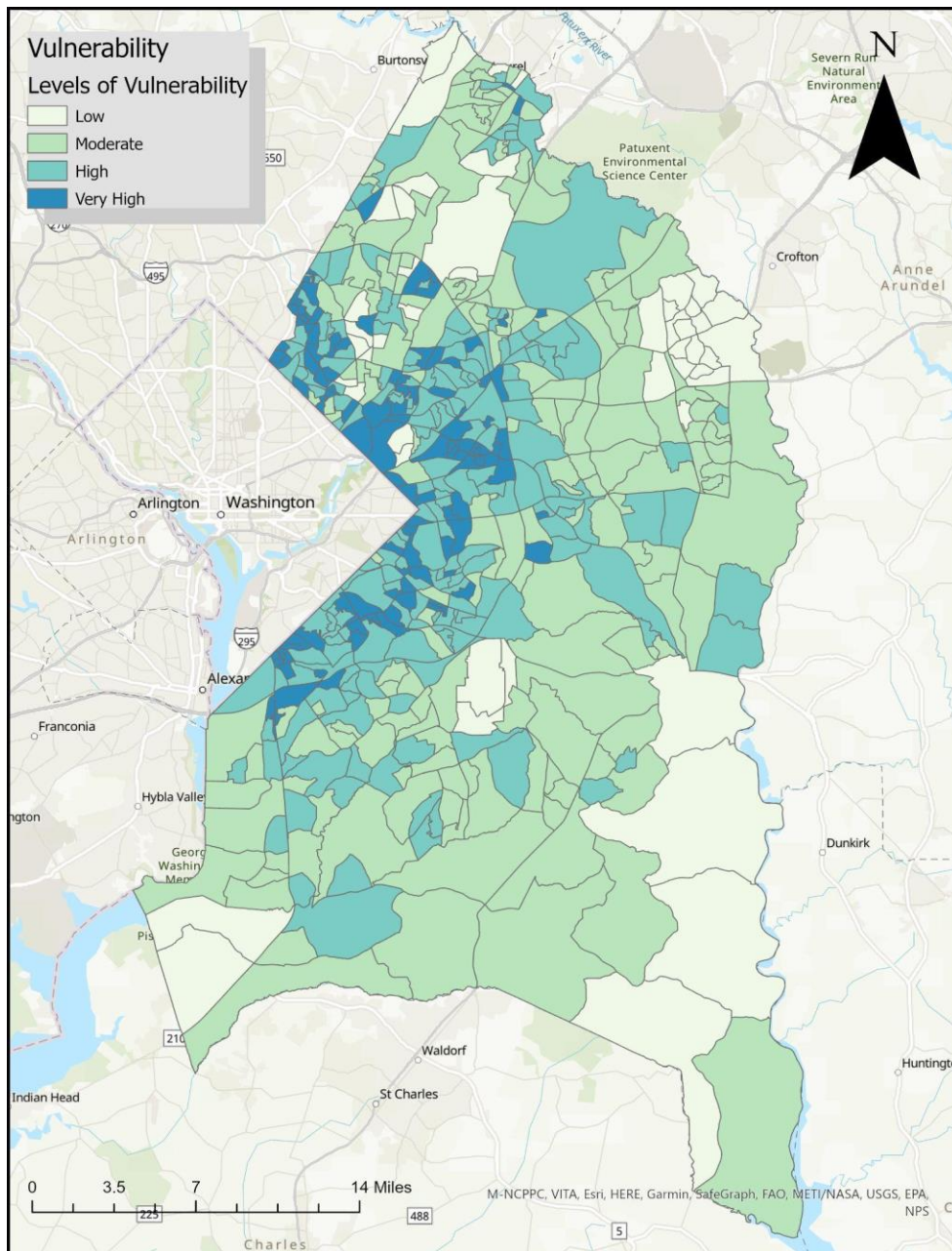
Tables 4 through 6 breakdown the total number of block groups, by vulnerability level, income percent level, and minority percent level respectively, whose residents have access to point data locations within 0.5-miles, followed by the percent of block groups with access to total number of block groups by vulnerability level, income percent level, and minority percent level respectively.

In all three metrics, from low to very high, the number of block groups with access increases. It's difficult to determine trends and draw overarching conclusions from these tables, particularly whether the percent of low-income or minority residents had a significant effect on food access in the County. The effect of low-income and minority percent on food access varies

by food access vendor. Thus, we decided to focus our research on the effect of vulnerable percent on food access because this metric takes both low-income and minority percent into account.

Map 1.

Levels of vulnerability at the block group level in the county, as calculated by the EPA using a combined metric of low-income and minority percent. The vulnerability levels for each block group are divided into four levels, with “Low” being the least vulnerable and “Very High” being the most vulnerable.

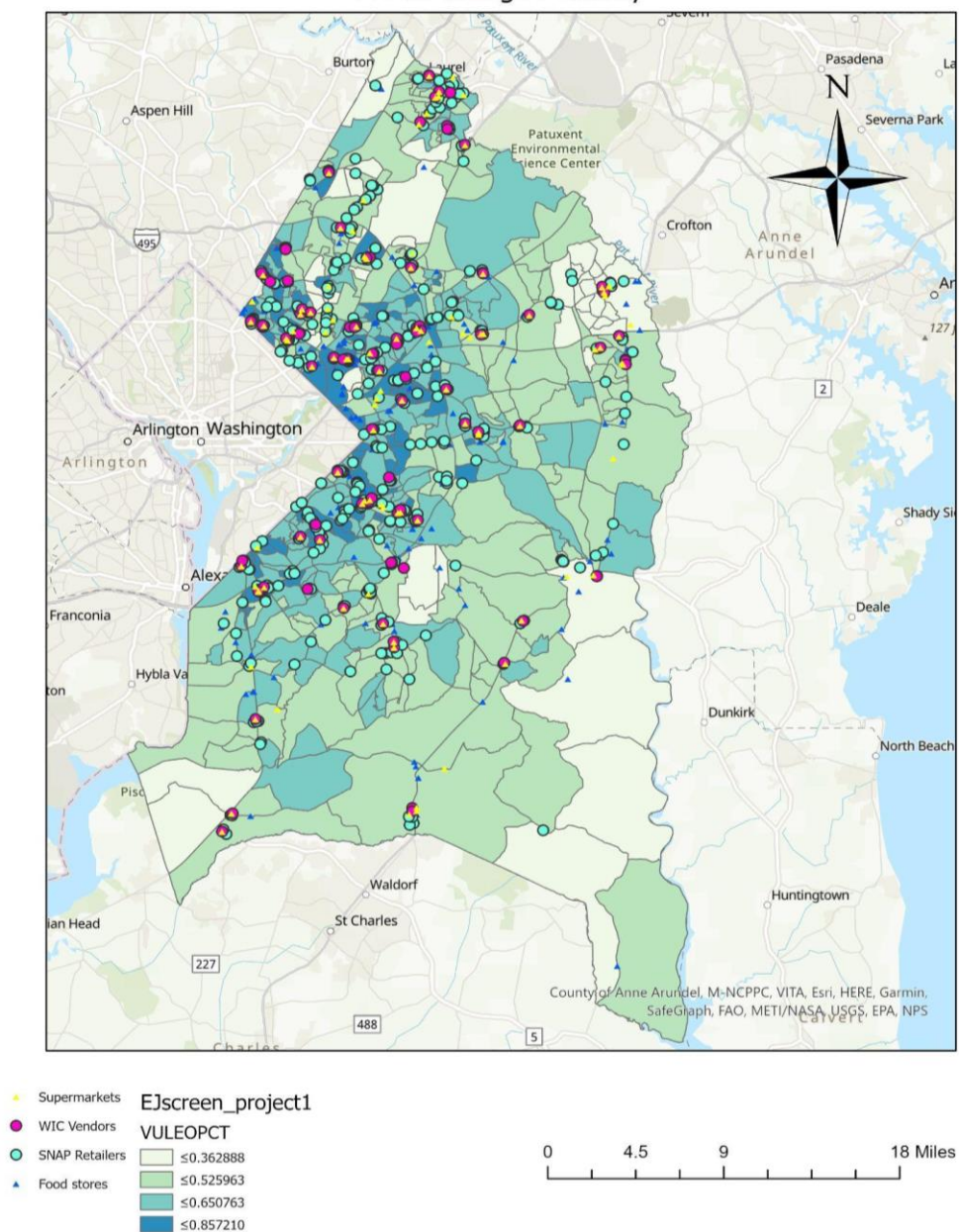


To better visualize areas with low food access, we overlaid point data of WIC vendors, SNAP vendors, fast food, other restaurants, supermarkets, and convenience stores/small grocers on the vulnerable percent layer (see Maps 2 and 3).

Map 2.

WIC vendors, SNAP retailers, and food stores in Prince George's County. The percent vulnerable for each block group is divided into four levels, with "Low" being the least vulnerable and "Very High" being the most vulnerable.

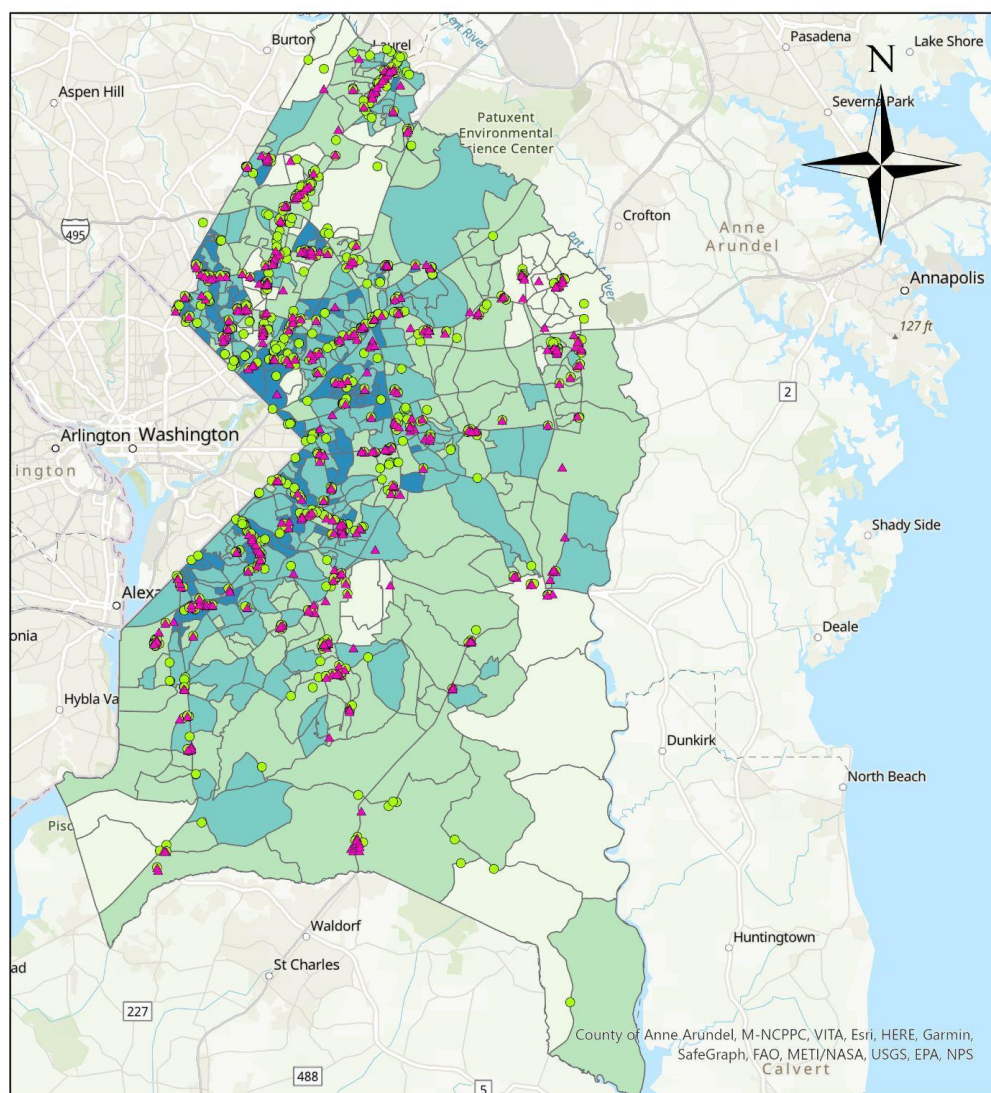
WIC vendors, SNAP retailers, supermarkets, and food stores in Prince George's County



Map 3.

Fast food establishments and other restaurants in Prince George's County. The percent vulnerable for each block group is divided into four levels, with "Low" being the least vulnerable and "Very High" being the most vulnerable.

Fast food establishments and other restaurants in Prince George's County



- ▲ Fast food
- Other Restaurants
- ≤0.525963
- ≤0.650763
- ≤0.857210

EJscreen_project1

VULEOPCT

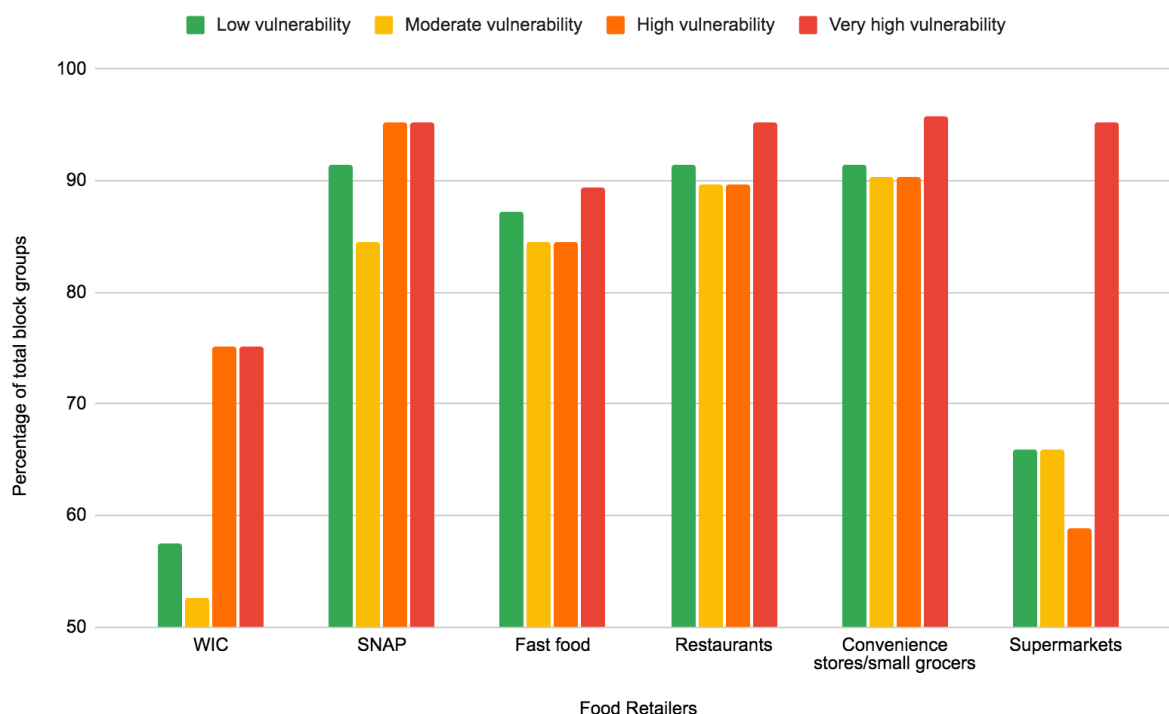
≤0.362888

0 4.75 9.5 19 Miles

These maps show basic spatial patterns. For example, most of the food access points are at the D.C. border, the most populated area of the county. Fewer block groups outside the Capital Beltway area have access to these point locations, but these groups are also less vulnerable. Using the vulnerable percent data, we analyzed the total number of block groups with access to different types of food retailers, and then the population of each in the four vulnerability levels within 0.5-miles of food access metrics (WIC vendors, SNAP vendors, fast food, restaurants, supermarkets, and convenience stores/small grocers). Figure 1 displays the data from Table 4.

Figure 1.

The percent of total block groups by vulnerability classification with residents who live within a 0.5-mile radius of food access locations.



This figure shows that the percentage of block groups within each vulnerability classification with access to fast food and restaurants is similar. Moderate vulnerability block groups have limited access to WIC vendors and have the least access to supermarkets. Very high vulnerability block groups have the most access to supermarkets. This measure likely

overestimates access in Prince George's County because each block group that slightly overlaps with a buffer counts as the entire block group having access.

Next, we compared vulnerability levels and food access to the county's total population within the 0.5-mile access buffers (see Table 7).

Table 7.
The percent of vulnerable populations living within 0.5-miles of different food access points.

	total pop. within buffers	low pop. within buffers	percent total low pop.	moderate pop. within buffers	percent total moderate pop.	high pop. within buffers	percent total high pop.	very high pop. within buffers	percent total very high pop.
WIC	255,967	7683	11.11%	50,477	16.93%	102,241	31.62%	95,565	49.19%
SNAP	501,370	23,169	33.52%	116,802	39.18%	194,897	60.28%	166,502	85.71%
Fast food	458,413	27,626	39.97%	115,496	38.75%	171,068	52.91%	144,224	74.24%
Restaurants	549,553	31,230	45.18%	142,445	47.79%	206,562	63.89%	169,317	87.16%
Supermarkets	261,175	13,741	19.88%	64,779	21.73%	86,481	26.75%	96,174	49.51%
Convenience stores/small grocers	538,945	25,896	37.47%	130,005	43.61%	209,376	64.76%	173,667	89.40%

Figure 2.
The percent of the total county population living within 0.5-miles of food access locations.

Proportion of total PGC population that lives within a 0.5 mile
buffer of food access locations

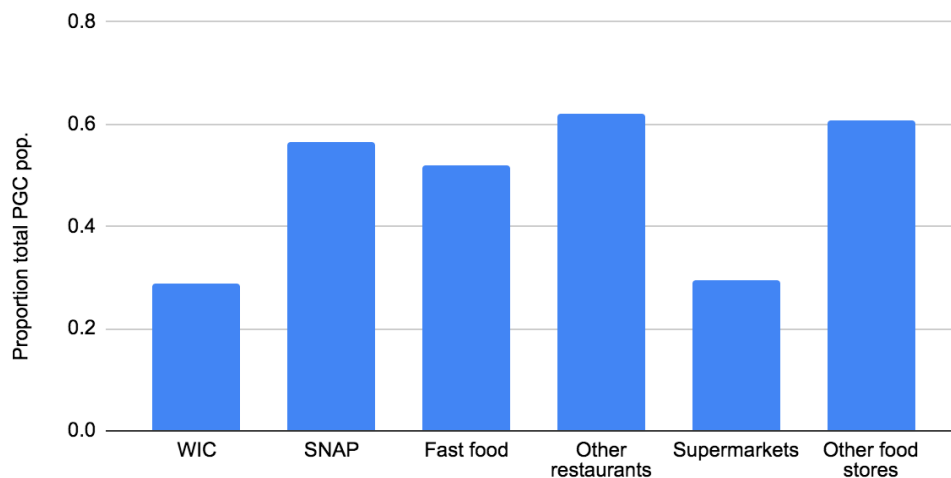
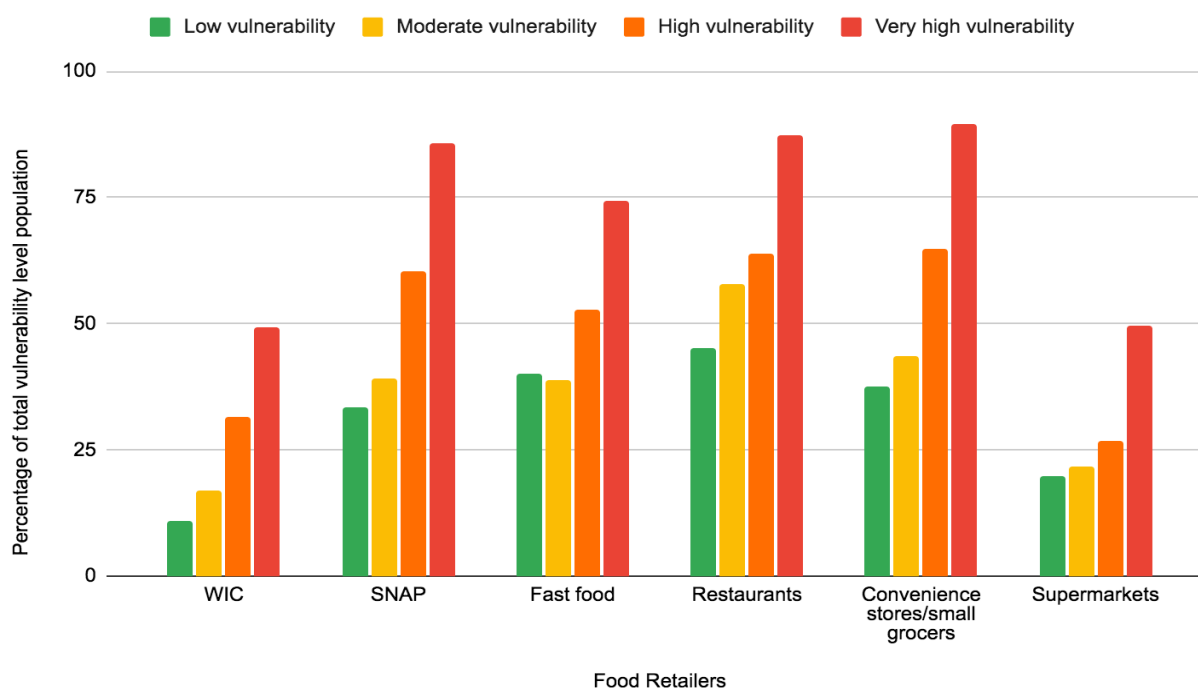


Figure 3.

The percent of total residents in each vulnerability classification with access to food locations.



These figures show several trends in the four levels' access to different food vendors. The low vulnerability population has the highest access to other restaurants, followed by fast food and convenience stores/small grocers, while also having the lowest access to WIC vendors. The moderate vulnerability population has the highest access to other restaurants and convenience stores/small grocers followed by SNAP and fast food. This group also has the lowest access to WIC vendors. High vulnerability groups have the highest access to convenience stores/small grocers and other restaurants, followed closely by access to SNAP vendors. This group also has the lowest access to supermarkets. The very high vulnerability population also has the highest access to convenience stores/small grocers and other restaurants, followed closely by access to SNAP vendors. This group also has the lowest access to supermarkets and WIC vendors.

This analysis also shows that many more residents live within a 0.5-mile radius of a SNAP vendor than a WIC vendor, and the highest percent of the total population within a 0.5-mile radius has very high vulnerability; 85.71 percent of residents have access to SNAP and 49.19 percent of residents have access to WIC. Those with very high vulnerability also have the

highest access to both fast food and other restaurants; 74.24 percent of the residents and 87.16 percent of residents, respectively.

Interestingly, very high vulnerability also has the most residents within a 0.5-mile radius of a supermarket, however, this is only 49.51 percent, so still more than half of residents don't live within 0.5-miles of a supermarket. Convenience stores/small grocers have a much higher percentage of very high vulnerability individuals living within 0.5-miles, 89.40 percent, which is also the highest of the three levels.

Additionally, we calculated the percentage of total population within these buffers by vulnerability classification who have access to each of the different food access locations (see Table 8).

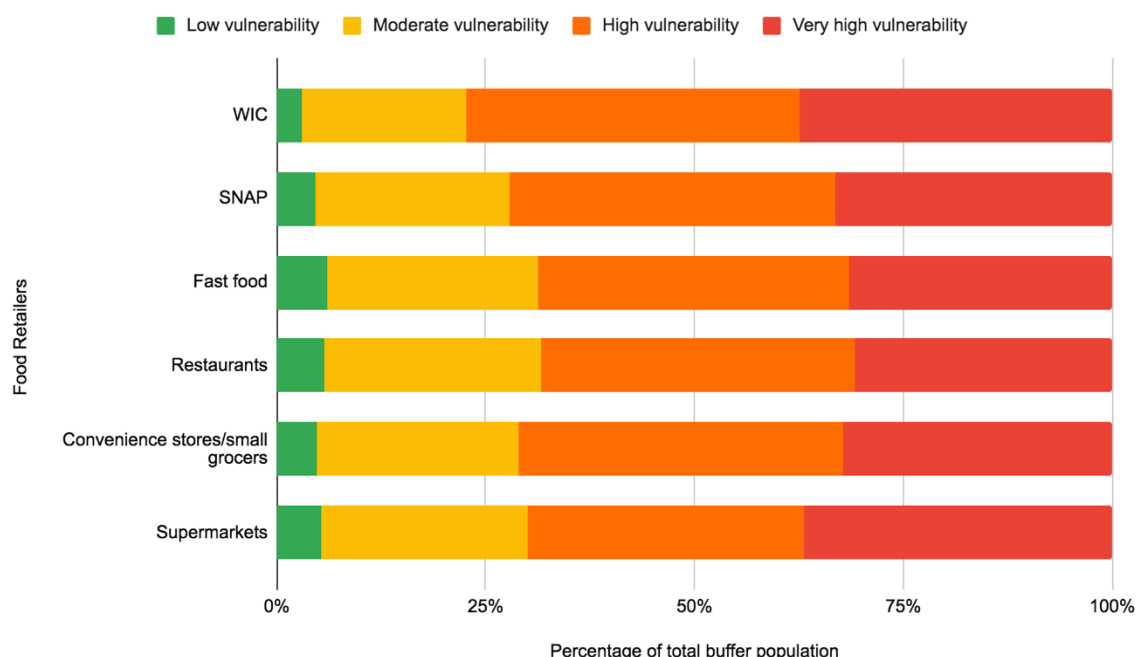
Table 8.

The percent of the total population at each vulnerability level that lives within the buffer areas.

	Low			Moderate			High			Very high		
	Total pop.	Percent	(within PGC buffers)	Prop. total pop.	(within buffers)	total buffers	(within buffers)	total buffers	(within buffers)	total buffers	total buffers	total buffers
	(0.5 mi buffers)	pop.	pop.	pop.	pop.	pop.	pop.	pop.	pop.	pop.	pop.	pop.
WIC	255,967	28.9%	7683	3.0%	50,477	19.7%	102,241	39.9%	95,565	37.3%		
SNAP	501,370	56.7%	23,169	4.6%	116,802	23.3%	194,897	38.9%	166,502	33.2%		
Fast Food	458,413	51.8%	27,626	6.0%	115,496	25.2%	171,068	37.3%	144,224	31.5%		
Restaurants	549,553	62.1%	31,230	5.7%	142,445	25.9%	206,562	37.6%	169,317	30.8%		
Supermarkets	261,175	29.5%	13,741	5.3%	64,779	24.8%	86,481	33.1%	96,174	36.8%		
Convenience stores/small grocers	538,945	60.9%	25,896	4.8%	130,005	24.1%	209,376	38.8%	173,667	32.2%		

Figure 4.

The percentage of population by vulnerability classification living within the buffers of each food retailer.



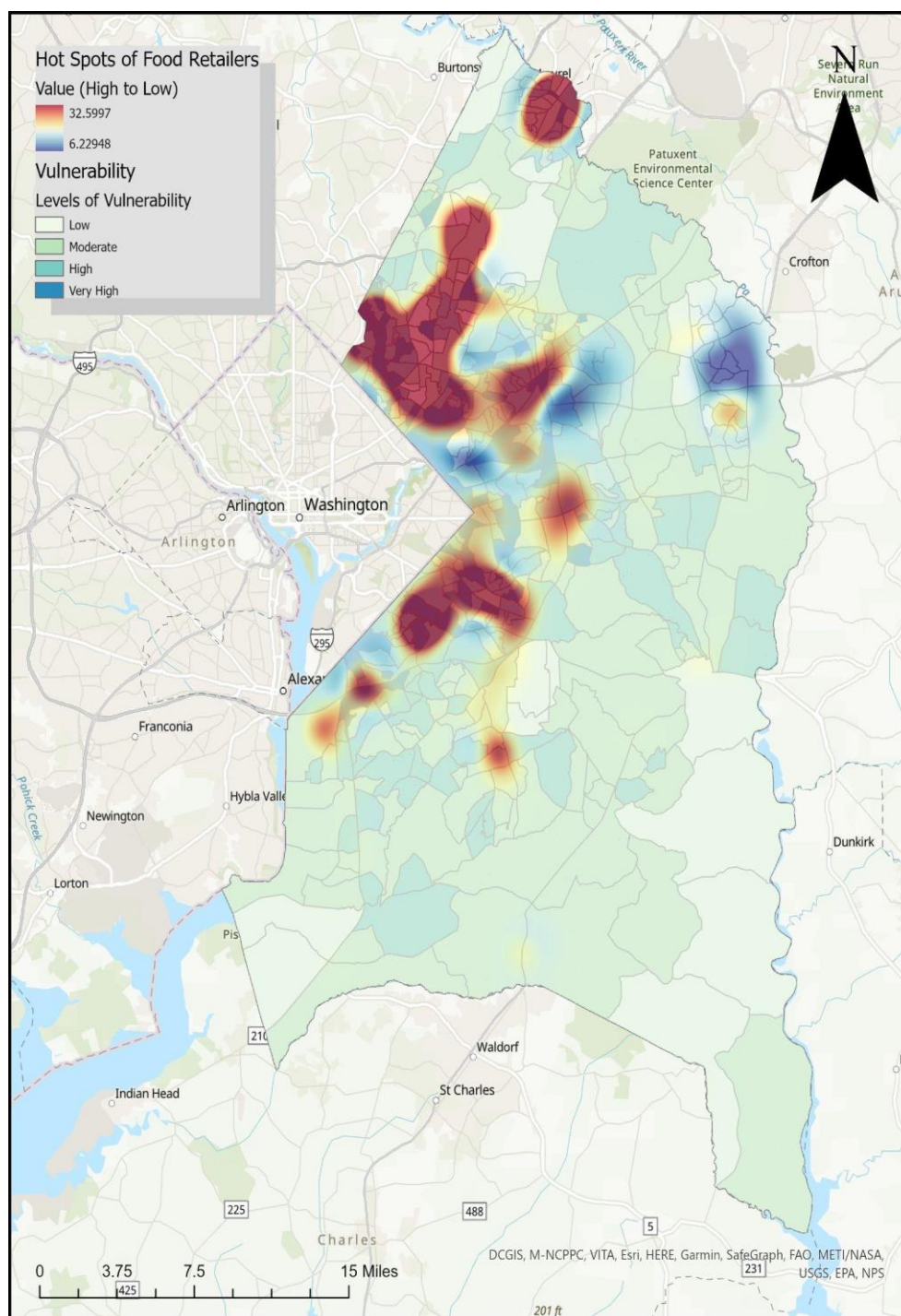
At the county buffer level, those with high vulnerability have the highest access to WIC, followed closely by very high vulnerability, at 39.9 percent and 37.3 percent, respectively. Access to SNAP is similar, with 38.9 percent of high vulnerability residents within the buffers and 33.2 percent of very high vulnerability residents. These measures indicate that those most likely to need access to these vendors are also most likely to have access within walking distance.

The most vulnerable block groups in the county have disproportionate access to fast food: 58.49 percent of county residents are in high and very high vulnerability block groups but are 68.8 percent of those within walking distance of fast food establishments. Low vulnerability block groups, by contrast, make up only 6 percent of residents with access to fast food.

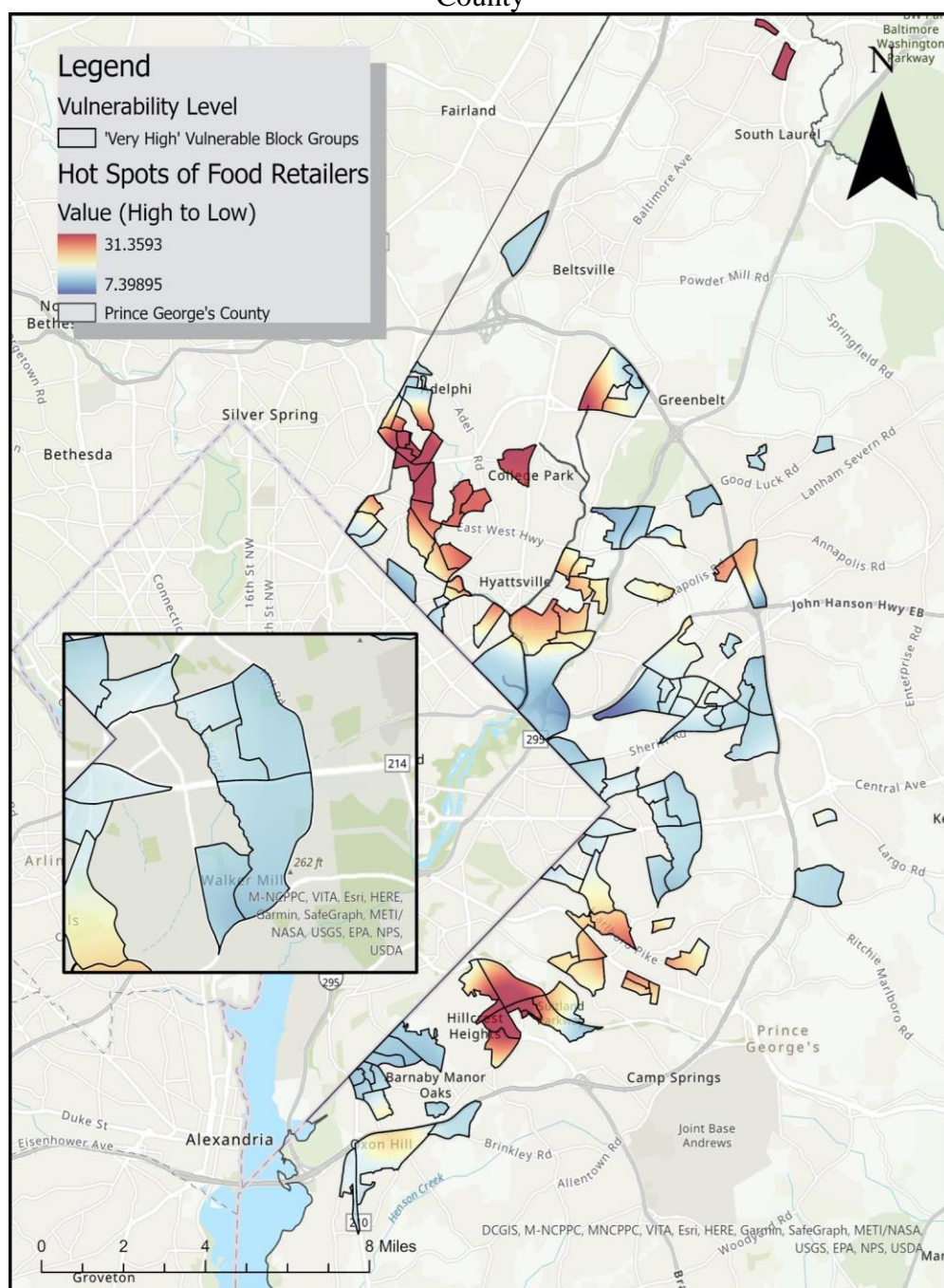
The vulnerability level breakdown for access to supermarkets and convenience stores/small grocers is very similar: there is no significant difference in access to those establishments. The least vulnerable block groups don't have disproportionate access to

supermarkets; residents in low vulnerability blocks are 7.81 percent of the county's population and 5.30 percent of those with walking access to supermarkets (see Maps 4 and 5).

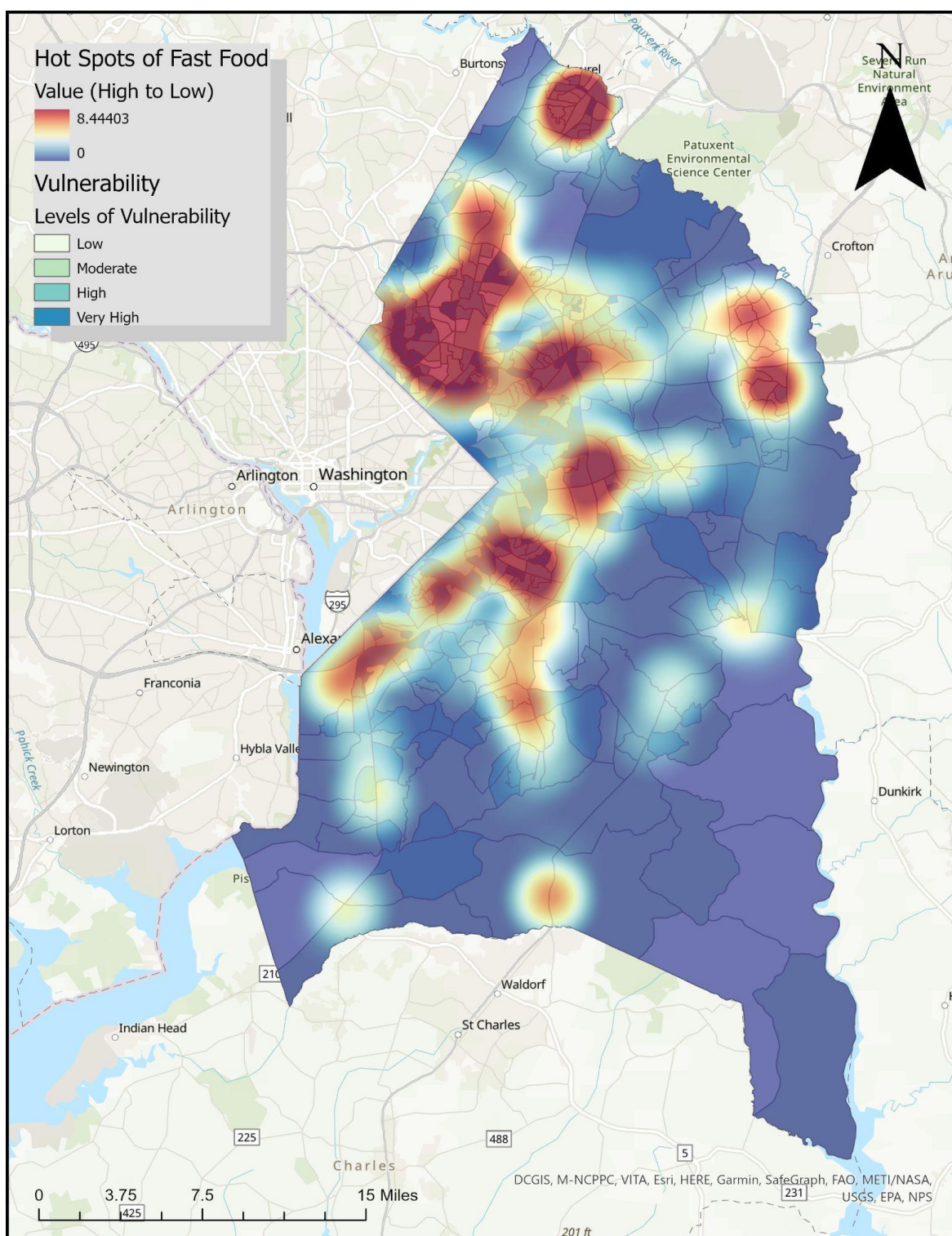
Map 4.
Food Retailer Hot Spots in Prince George's County

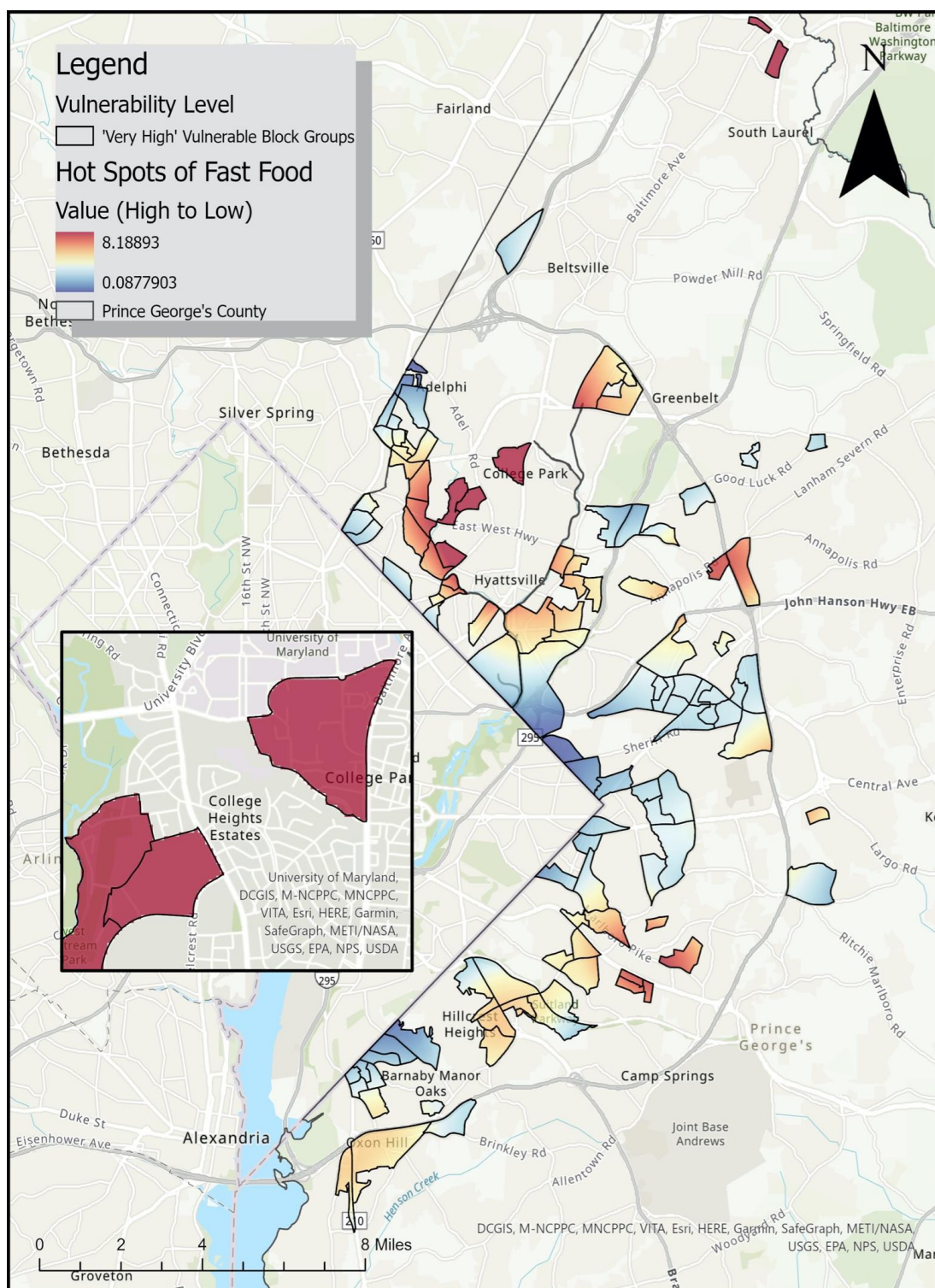


Map 5.
Food Retailer Hot Spots in Very High Vulnerable Block Groups in Prince George's County

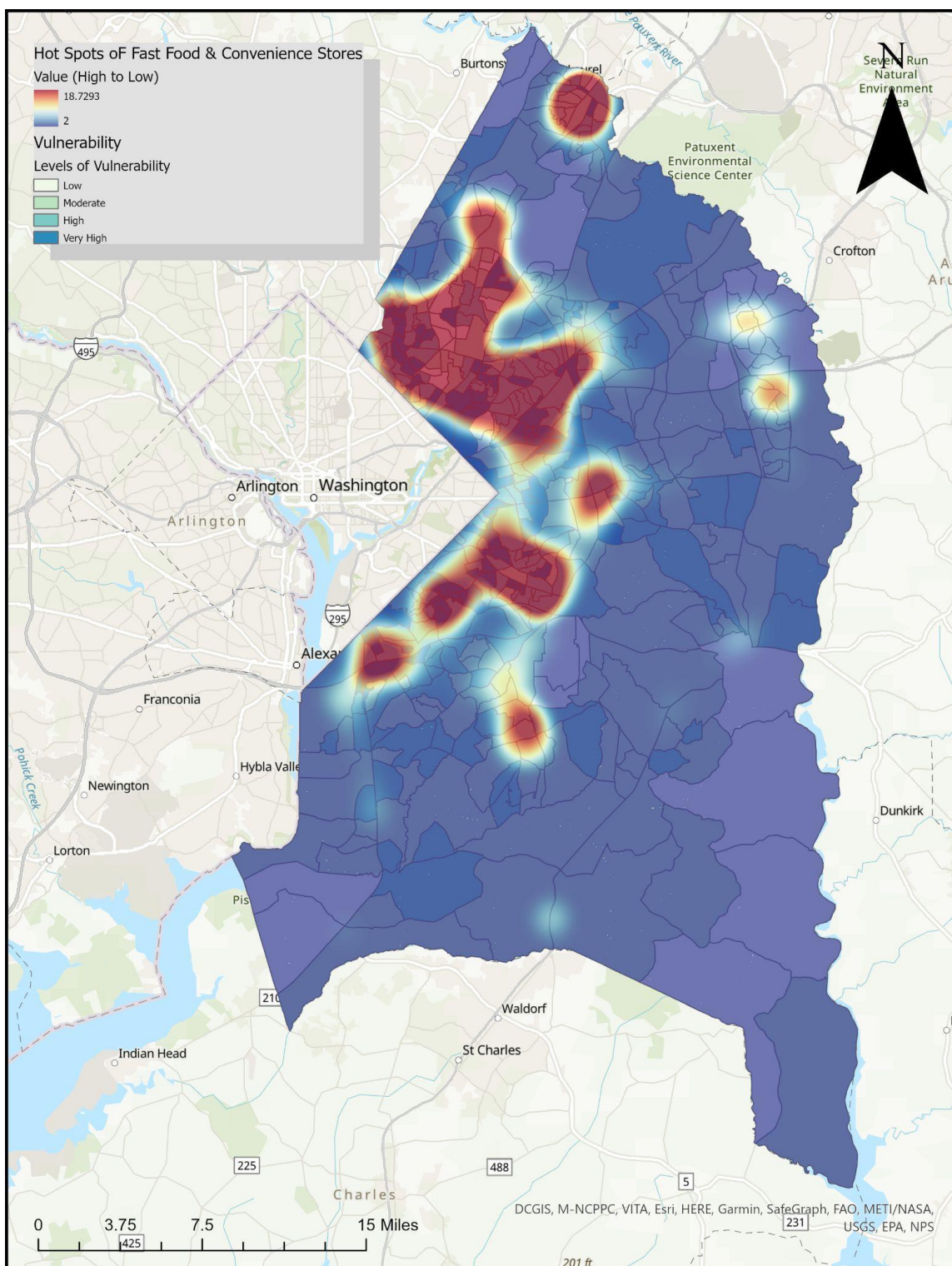


Map 6.
Fast Food Retailer Hot Spots in Prince George's County

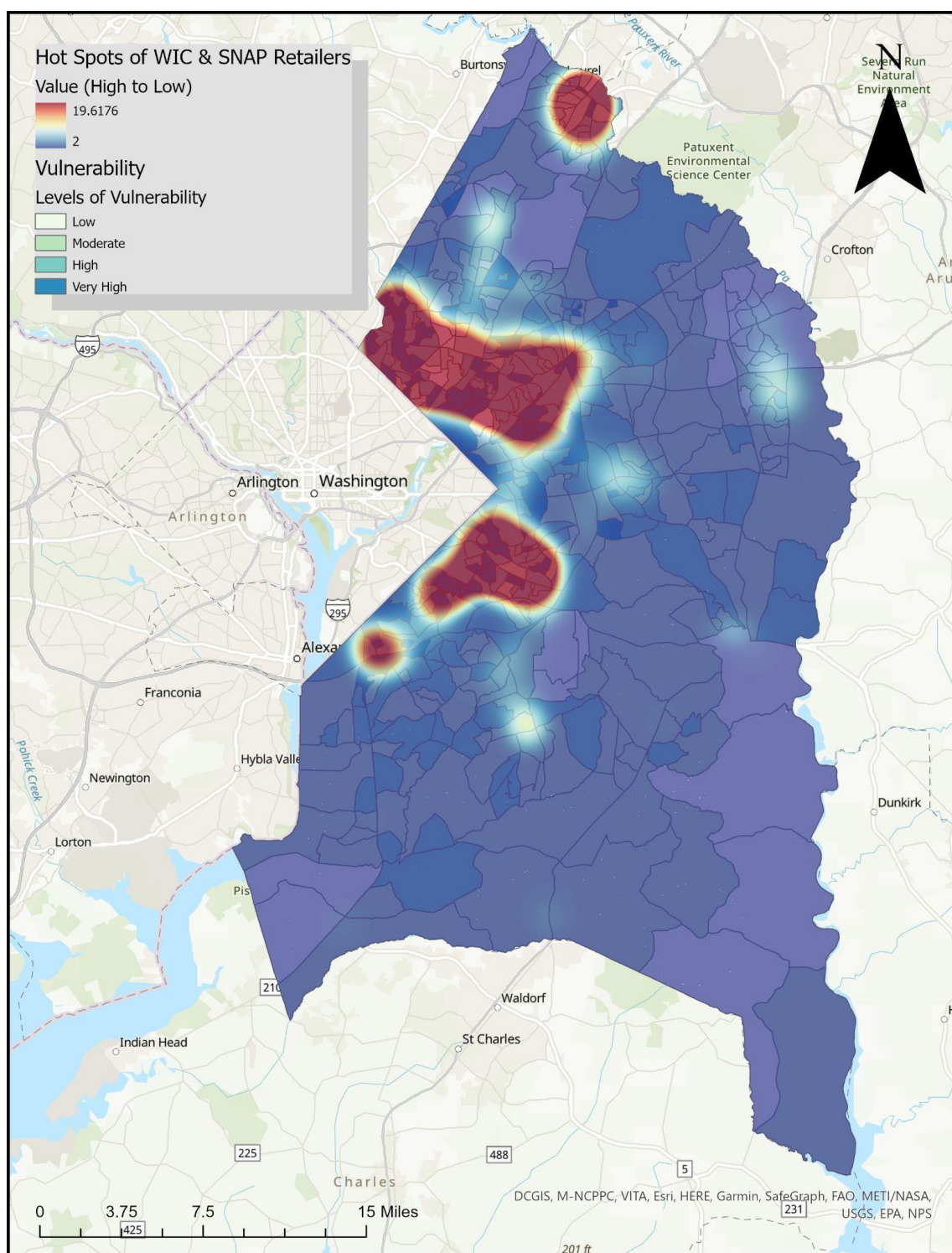




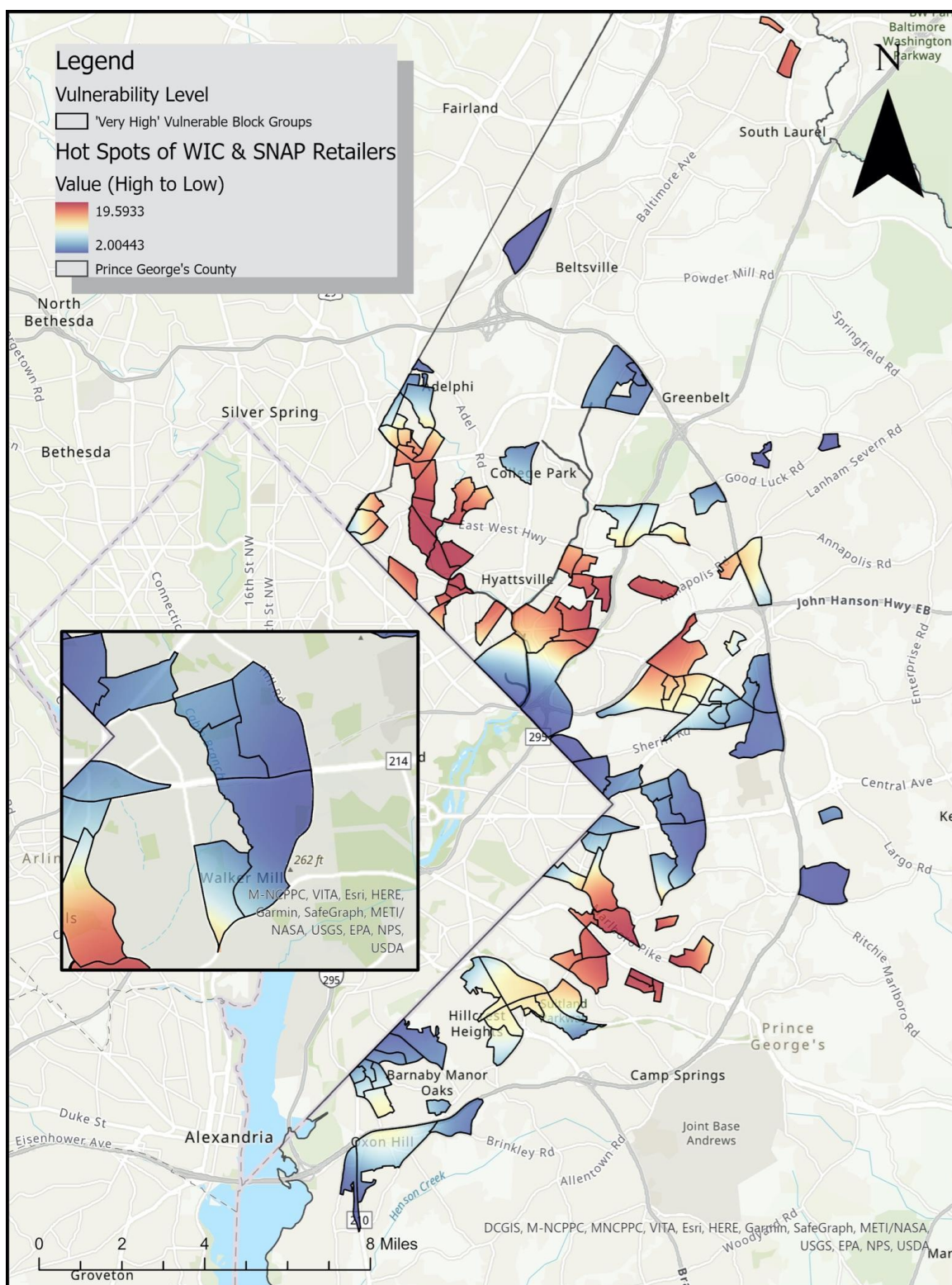
Map 8.
Fast Food and Convenience Store Hot Spots in Prince George's County



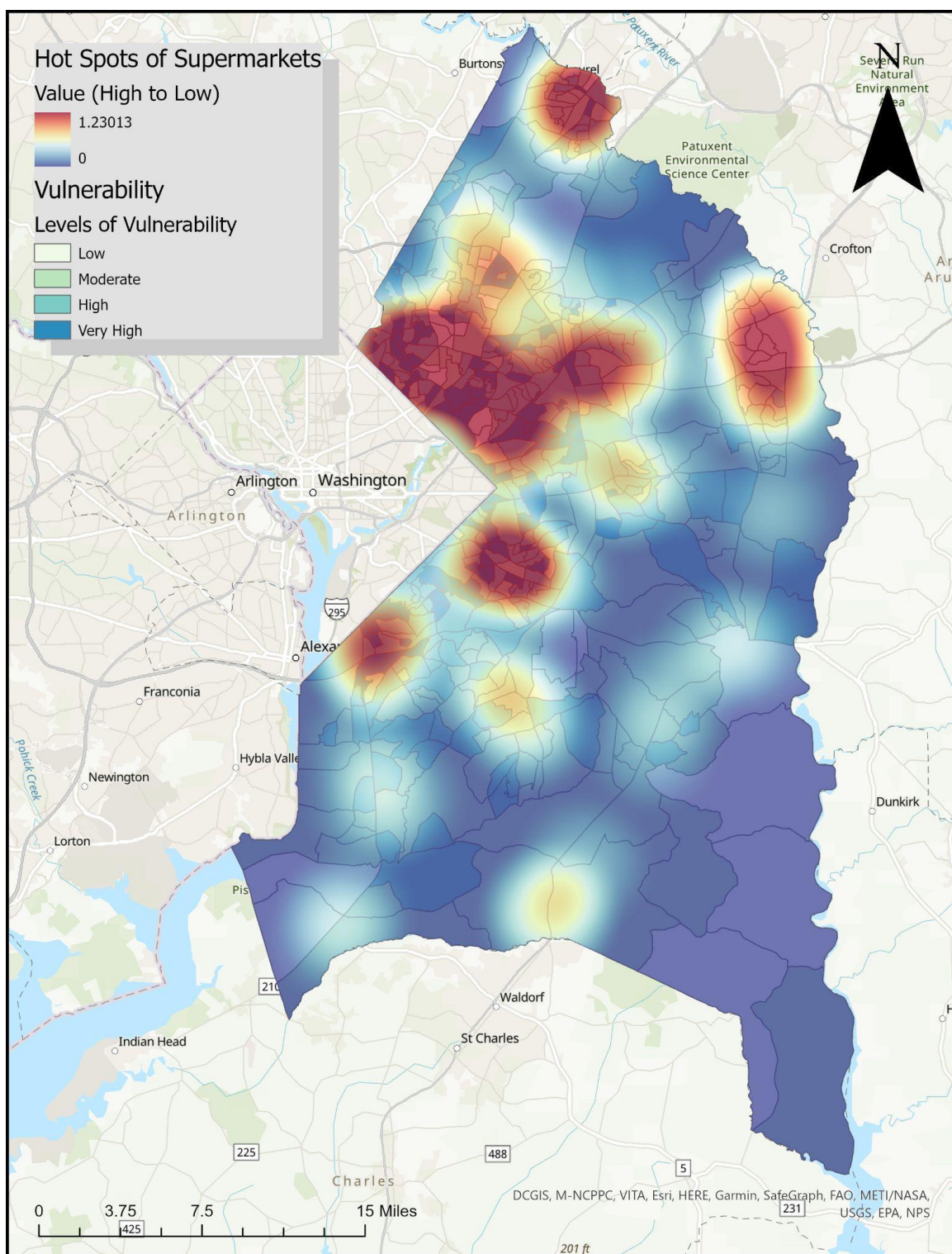
Map 10.
WIC Vendors and SNAP Retailer Hot Spots in Prince George's County



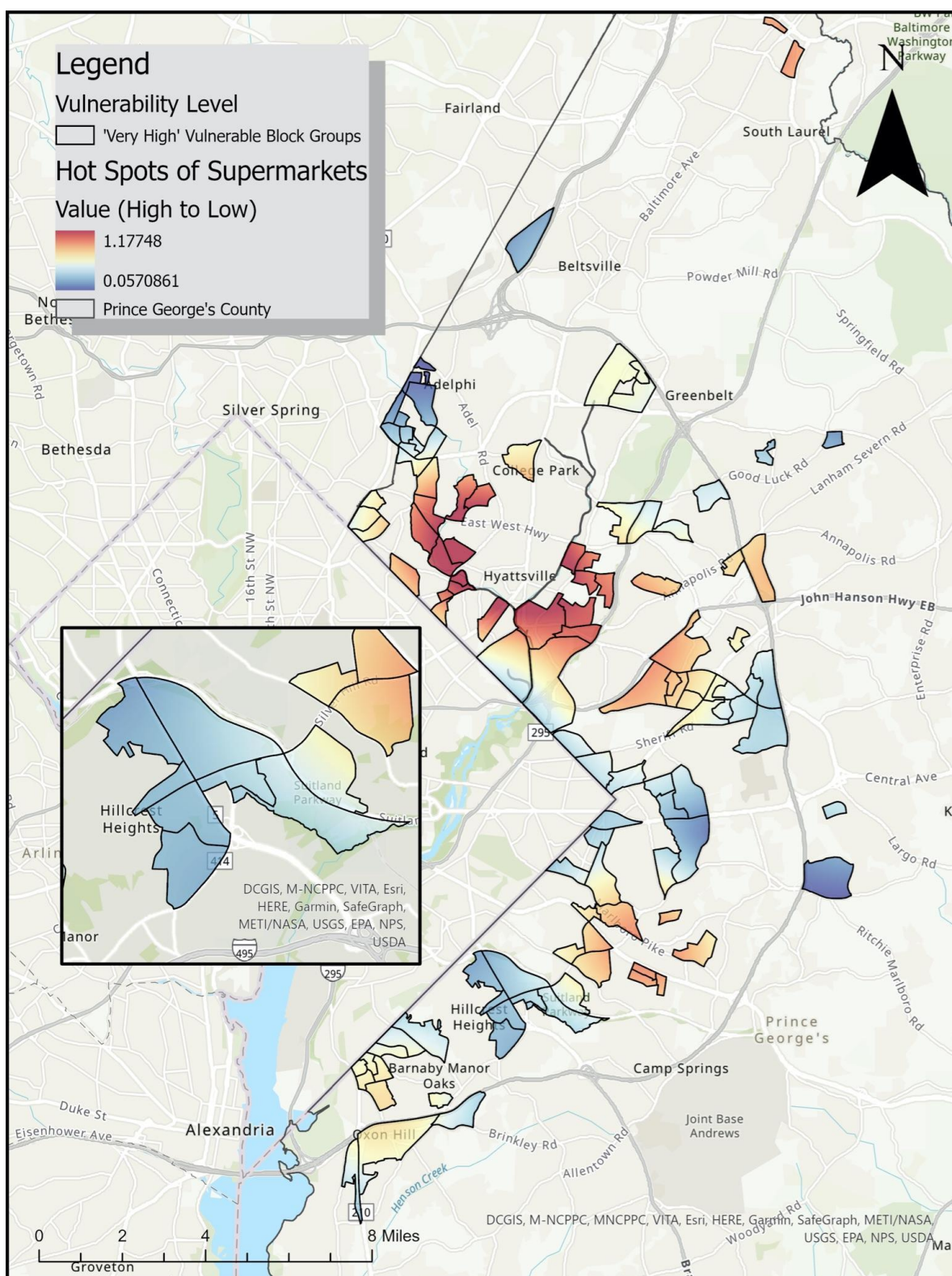
Map 11.
WIC Vendors and SNAP Retailers Hot Spots in Very High Vulnerable Block Groups in Prince George's County



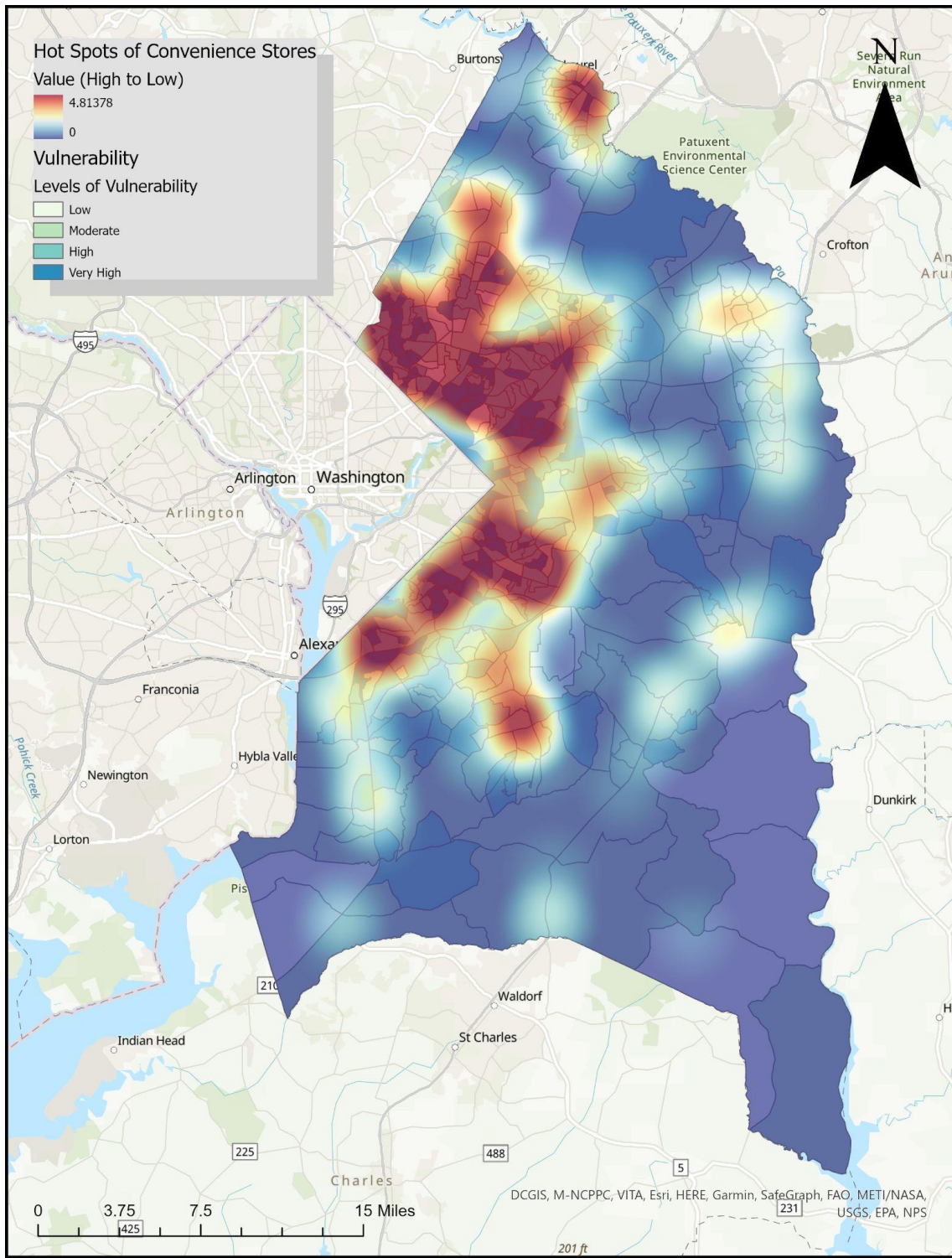
Map 12.
Supermarket Hot Spots in Prince George's County



Map 13.
Supermarkets Hot Spots in Very High Vulnerable Block Groups in Prince George's County

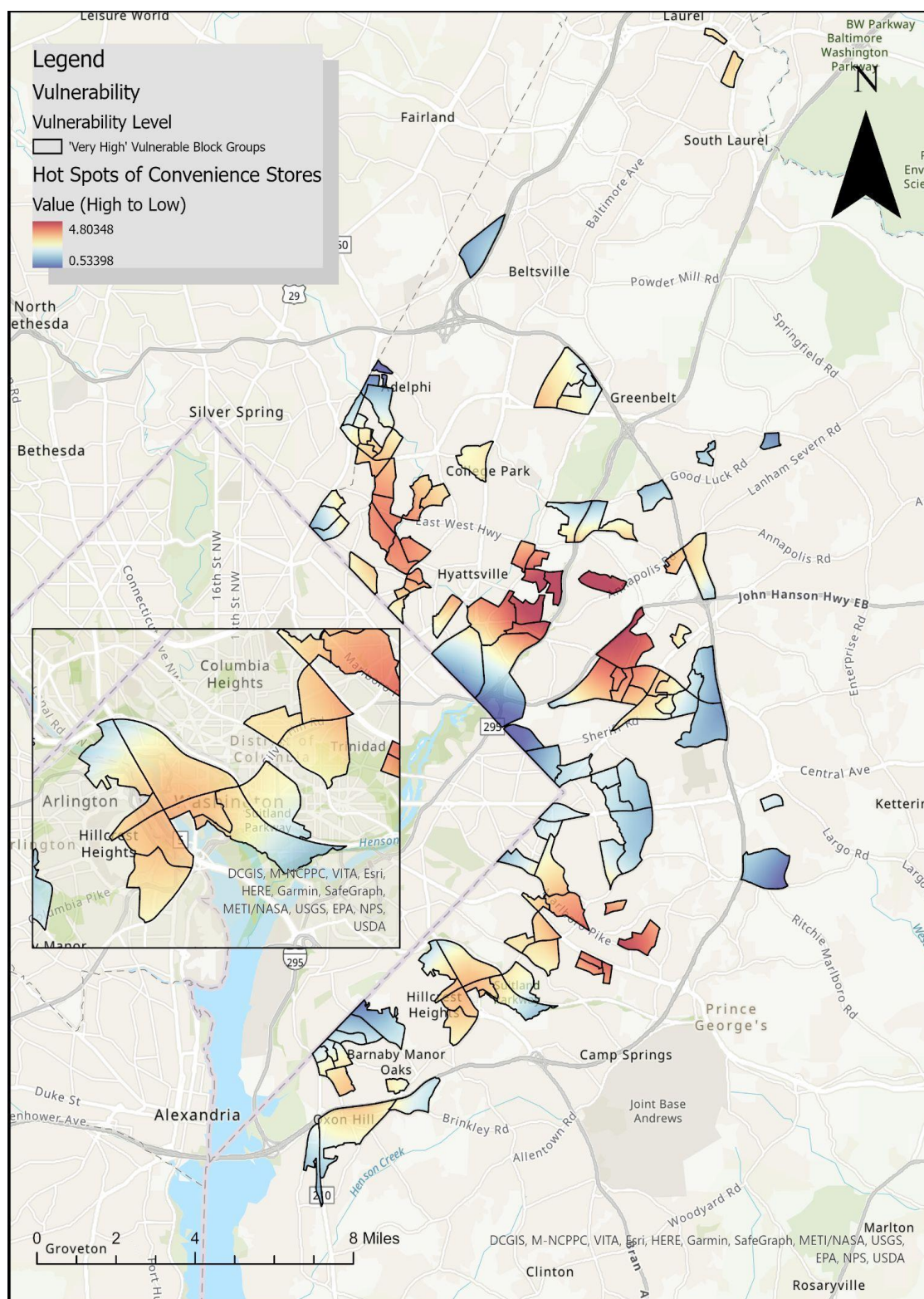


Map 14.
Convenience Store Hot Spots



Map 15.

Convenience Store Hot Spots in Very High Vulnerable Block Groups in Prince George's County



Summary of Results

Our analysis found a majority of county residents can be classified as either vulnerable, low-income, and/or minority populations falling within high and very high vulnerability.

To further the analysis, we coupled the three socio-demographic factors with food retailers to assess the spatial distribution of food retailers throughout the county. We found that although a majority of residents within each level have access to food stores, supermarkets, restaurants, WIC and SNAP vendors, a large majority, about 70 percent, were classified within high and very high vulnerability block groups. However, an overall trend shows that the same individuals who lack access to WIC vendors and super-markets, have greater access to SNAP vendors, fast food, other restaurants, and convenience stores/small grocers.

The Kernel Density maps showed high densities of many of the food retailers at the county's border with Washington D.C. and low densities of food retailers farther into the county, away from Washington D.C. The spatial distribution of food retailers throughout the county follows a pattern; they are grouped in similar areas that offer less access to marginalized individuals. From the maps, the very high vulnerable block groups had consistently high access to fast food, convenience stores, WIC and SNAP vendors and low access to supermarkets.

Discussion

Significant Trends

The data leads to significant findings about food equity in Prince George's County. The statistics and spatial analysis show that the county's most vulnerable residents have disproportionate access to unhealthy foods than those who are less vulnerable.

Unhealthy food stores are more accessible and more prevalent for highly vulnerable minority and low-income communities compared to their less vulnerable neighbors. This is the case for low-income communities and for the very high vulnerability category in general. According to Table 4, fast food is most prevalent within walking distance of block groups are in the very high vulnerability category, which accounts for 91.07 percent of those in the highest vulnerable category. Similarly, Table 2 shows that over half the county's population, 58.49 percent, lives in block groups categorized as "very high" vulnerability, which means the majority

of the county is less resilient than other block groups who also lack access to healthy food. This is born out by Map 3, which shows clusters of fast food stores in the most vulnerable block groups compared. When there are fast food stores in the least vulnerable category, they are not as spatially grouped as they are for the more vulnerable block groups.

But quantity is not necessarily quality. Even in areas with have many food stores available to residents, they consist mostly of dense clusters of unhealthy food sources, not healthier stores like supermarkets. According to Table 7, the highest vulnerability group has the highest proportion of access to fast food, 74.2 percent. Interestingly, this vulnerability group also has the highest number of individuals living within a 0.5-mile radius of a supermarket. However, this is only 49.5 percent of residents, so still more than half of residents don't live within 0.5-miles of a supermarket.

Those who do have access to supermarkets within walking distance, only have one store available, which is concerning. Table 8 also demonstrates that the 31.5 percent of the highly vulnerable population is within walking distance of fast food stores, compared to the least vulnerable category at only 6 percent. This shows the disparate placement of unhealthy food sources in communities of highly vulnerable residents.

General KDE Analysis

The Kernel Density maps allow us to visualize hotspots of particular food sources and their proximity to vulnerable groups. It is obvious from these maps that there are areas of higher concern and priority regarding food equity. All four areas of high vulnerability that demand attention due to food inequity are listed below.

Region A is the block groups in Parkland Terrace and Marlow Heights along Suitland Parkway. Region B is the block groups in Walker Mill, Yorkshire Knolls, and Carmody Hill. Region C is the block groups in Langley Park and the Adelphi area. Region D is the block groups in the College Park area mainly within the University of Maryland's campus extension.

Before interpreting what the Kernel Density maps show for different food retailers in specific areas of the county, it's important to understand the various density measurements and what they indicate. Density measurement is used to identify how many food retailers, WIC and SNAP vendors, supermarkets, or fast food vendors are within a square mile of each block group.

The highest density reported is on the map of all food retailers, 31.359. When looking at individual retailers, the densities are much lower. Supermarkets have a high-density value of about 1.178 retailers per square mile, but in actuality very few supermarkets are categorized as highly dense. This means that when areas are noted as having the highest density, it doesn't mean there is sufficient access.

In general, the County's border with D.C. has the highest density of food retailers, with a density value ranging from 7.399 to 31.359 per square mile. This shows that food retailers are comparatively widely available in areas with highest vulnerabilities. Food retailers includes WIC/SNAP vendors, supermarkets, fast food vendors and convenience stores.

The general trends on WIC and SNAP vendors, show a much larger density range, around 2.004-19.593 per square mile, compared to other food retailers. This indicates a larger supply of vendors when the density is high compared to other food retailers in the county with a correspondingly high density. While there are more WIC and SNAP vendors across the county than supermarkets or fast food stores, there are still many areas of highly vulnerable block groups with very low WIC and SNAP vendor densities, suggesting a need for more vendors in these areas.

WIC and SNAP retailers provide food access, in a nontraditional sense, for citizens who require financial support. WIC and SNAP vendors benefit communities because their versatility and allowances and are part of the Food Supplement Program in Prince George's County (Prince George's County, MD). WIC is a statewide program that offers aid for women, infants, and children, providing nutritious foods, nutrition education, breastfeeding support, and access to health care for low-income pregnant women, new mothers, infants, and children under five (Maryland Hunger Solutions).

In Prince George's County, SNAP assists 53 percent of households, those that are low-income with children to obtain adequate and nutritious diets (Prince George's County Health Department). There is a strong dispersion of WIC and SNAP retailers across the highly vulnerable populations in the county, but significant regions lack access, especially at the D.C. border.

Supermarkets are a crucial factor in distributing food equity as they provide a variety of healthy food options at a variety of price ranges. There aren't many supermarkets serving the county's highly vulnerable populations, indicated by their low density compared to other food

access options. It's important to note that the supermarket density range is very narrow, from about 0.057 to 1.177 per square mile. Supermarket density for highly vulnerable block groups in the county is much lower than other food retailers, mainly because supermarkets are just one component of food retailers. This very low density suggests that even in the areas with the highest supermarket density, there is still an overall lack of supermarkets that would provide adequate access to the county's vulnerable citizens.

Again, despite the highest vulnerability block group having access to the greatest number of supermarkets, this still only comes to roughly two stores per square mile within walking distance of these block groups. This demonstrates a need for more supermarkets across the county despite some vulnerability groups having more access to supermarkets than others.

Across the county, density trends among highly vulnerable groups vary, especially along the D.C. border. The north-central part of the county has the highest density of supermarkets, similar to trends for the highest density of other food retailers.

For fast food stores and convenience/corner stores, the density range is larger than other retailers, from around 2.005 to 18.629 per square mile, indicating a much wider availability of across the county. While there is generally a low density of these stores in the center of the county, moderate to moderately high densities are most noticeable in the block groups with highest vulnerability that also have access to supermarkets and WIC/SNAP vendors. It is common that fast food and convenience stores are more available in areas with higher populations.

Specifically, the county's highly vulnerable block groups tend to have a moderate to moderately high access to fast food; densities across groups are in the mid-range around 4.000 per square mile in a total fast food density range of 0.088-8.189 per square mile. Access to fast food may provide citizens with a fast and affordable food but limited healthy options. That the majority of the county's vulnerable population has access to fast food but not necessarily supermarkets indicates a lack of equitable options for citizens across the county.

Overall, areas with the highest densities of food access are located in the county's northern areas and away from the D.C. border. This high density could be a response to larger populations, major business, and other contributing factors. This area of food access benefits the citizens in the nearby block groups but not the county as a whole, as areas with lower food

access densities struggle with a lack of access to healthy food and fewer economic or healthy options.

Region-Specific KDE Analysis

Region A: Parkland Terrace and Marlow Heights along Suitland Parkway

Region A is just outside the D.C. border to the southwest and varies in its equity of access to different food retailers. In general, there is a high density of food retailers across the region, about 31.359 retailers per square mile but this density offers very low access to supermarkets and fast food/convenience store options. The higher density of food retailers offers residents multiple food access options. It's important to note that this doesn't necessarily mean that all food retailers are available throughout Region A.

WIC and SNAP retailers are present but not predominant showing a density range of about 2.004-9.455 per square mile, indicating there are vendors in this area but not as many as in other regions, specifically Region C (Langley Park and Adelphi). The proportion of WIC/SNAP vendors is much greater than supermarkets in this region but is similar to the proportion of fast food access. This correlation may indicate a greater demand for fast food because of income ranges.

Supermarket density across Region A is moderately low, ranging in a density value of 0.065 to 0.345 per square mile. This part of the county with high vulnerability has less access to supermarkets compared to other vulnerable block groups. It puts this region at a disadvantage with less access to healthy food options.

The region's convenience store density varies from low to moderate, about 2.055-4.556 per square mile. This less dispersed density range indicates there is little access to such stores in the center of the region, forcing citizens to travel for a convenience store. Lack of fast food and convenience stores may diminish access to more affordable food options.

Fast food density across Region A is moderate to moderately high ranging from 2.456 to 7.025 per square mile, showing a generally accessible supply of fast food. This dispersion is correlates with the highly vulnerable population, seeing that fast food access is only minimal in a few parts of the county. In this region, fast food outweighs the number of supermarkets

accessible within walking distance of residents. There is approximately one supermarket for every five fast food stores in Region A.

Region B: Walker Mill, Yorkshire Knolls, and Carmody Hills

Region B is in the central area of the border with D.C. and is highly inequitable in its food sources. The area's density of food retailers is lower than in other regions, leaving residents with fewer overall food options. The density of food retailers here is about 7.399-8.000 retailers per square mile, much lower than Region A's density of about 31.359 per square mile. This area is also uniform in its food accessibility with a low density of food options across the region.

This region also has one of the lowest densities of WIC and SNAP retailers, with some parts having as few as 2.004 WIC/SNAP vendors per square mile. This density is among the lowest of all the regions and shows the lack of access the region's residents have to healthy, affordable food compared to the other vulnerable regions. This correlates with the region's very low number of supermarkets.

Region B's supermarket density is comparable to Region A since both areas have very low access to this healthy food source. However, Region B is even worse off with a supermarket density as low as .057 per square mile, which means those residents have access to less than one supermarket within walking distance. This region also has a high concentration of residents in the highest vulnerability group, leaving those who are highly vulnerable without good access to healthy food sources.

Combined, fast food and convenience stores have some of the lowest densities compared to the other regions with a density value as low as 2.005 stores per square mile. This value is practically uniform throughout Region B. The fact that this region's highly vulnerable communities have low access to these food vendors compared to the other region's highlights the disparities in access across the county. If food access and quality were equitable, the densities would be practically the same throughout, yet Region A, which is near Region B has much more access to fast food and convenience stores.

Fast food trends in this region reveal a moderate density of these unhealthy food sources. Region B doesn't have the same high density as Region D, yet the density is still higher than that of supermarkets. Again, supermarkets have less than one store accessible to high vulnerability

residents, the only one isn't within walking distance. Meanwhile, there are up to four fast food options within walking distance. This region's density of fast food retailers is about 4.000 per square mile demonstrating that unhealthy food sources outweigh healthier ones almost four-fold and showing that food is not equitable in this region compared to others in the county.

Region C: Langley Park and Adelphi

Region C is in the westernmost part of Prince George's County, on the border with Virginia. Generally, it has a very low density of food access and this trend is uniform with no major differences. The region's food retailers have a high density in Langley Park and extending south but north toward Adelphi, food retailer density is lower closer to the Virginia border, eventually reaching as low as 0.0571-2.00443 stores per square mile.

The area's density of WIC and SNAP vendors shows that even in adjacent communities, retailers aren't evenly dispersed. WIC and SNAP vendors range from 19.5933 to 2.00443 vendors per square mile but even with this wider range there is still a sharp density change between Adelphi and Langley Park. Adelphi has a very low density while Langley Park has a higher density reaching 19.5933 stores per square mile. However, this isn't the case for supermarkets, which have a different range and density than WIC and SNAP vendors.

The range of supermarkets range in the county's vulnerable areas is narrow with values between 0.0571 and 1.1775 stores per square mile. Region C's low-density value of supermarkets extends south where there is a gradual change to a higher supermarket density. The overall low density and narrow range reveals a need for more healthy food options to reach these communities.

Fast food and convenience stores have a wider density range and a wider range of values. The values range from about 19.6916 to 2.0049 stores per square mile with notable differences between Adelphi and Langley Park. Adelphi has low densities of fast food and convenience stores with an abrupt change in density toward Langley Park with a moderate to high density. For fast food specifically, there is a gradual density change between the two communities. Adelphi has a low density of fast food with the density slowly increasing toward Langley Park shifting to moderate density past Langley Park. For fast foods it's important to note the narrow range of values—as low as 0.0878 retailers per square mile and only a maximum of 8.1889

retailers per square mile. The range is not as narrow as supermarkets but should be noted when looking at the change in densities between Region C communities.

Region D: College Park and University of Maryland - College Park campus extension

Region D is characterized by a high density of food retailers, particularly fast food, a moderate density of supermarkets, and a low density of SNAP and WIC vendors. The high density of fast food establishments combined with moderate to low supermarket and WIC/SNAP vendor access qualifies Region D as a “food swamp.”

The high density is consistent throughout Region D, carrying over into neighboring Region C and south into Takoma Park, Chillum, and Hyattsville. Notably, many of the region’s food retailers are fast food establishments. Region D and the area of College Park have the county’s highest density of fast food, with up to 8.444 fast food establishments per square mile. College Park has disproportionately high access to fast food, but only moderate access to supermarkets.

Supermarket access in the southern area of Region D is moderately high given its proximity to a high-density supermarket area in Silver Spring and Takoma Park. By contrast, the region’s northern area D has considerably less supermarket access. The lack of access to supermarkets in Region D is further emphasized by the low density of WIC and SNAP vendors around College Park; however, Region D is located just outside an area of high WIC/SNAP access on the northeastern border of Washington, D.C. near Silver Spring and Takoma Park. Expanding the number of WIC and SNAP vendors in Region D would increase access for residents of College Park, especially for those who walk or rely on public transportation.

Summary

The location and density trends in these communities are not new, rather, these areas have been dealing with food access issues for years. Past studies demonstrate similar patterns (U.S. Dept. of Agriculture, 2020). A Frontiers in the Built Environment study found that in areas around College Park only 19 percent of residents lived within 0.5-miles of any food store and that 91 percent of residents lived within walking distance of a fast food store (Kavi, 2019). This

region also has a high percentage of non-White residents living within a half-mile of fast food stores, 74 percent (Kavi, 2019), compared to White residents who have access to significantly less unhealthy fast food establishments within a half-mile. This indicates that vulnerable minority and low-income communities have many more unhealthy food options compared to their less vulnerable neighbors.

Comparing these regions to Prince George's County overall, is revealing. For example, overall, 4 percent of county residents have limited access to healthy foods and 10 percent face food insecurity (County Health Rankings, 2021). Food insecurity is measured by limited access to healthy food, low-income population, and distance to a supermarket, showing the percentage of the population without access to a reliable source of food (County Health Rankings, 2021).

Though comparisons to Prince George's County may be skewed due to different geographic boundaries, population densities, and cultures, our team also looked at counties in neighboring states with a similar population to make the most accurate comparison. For example, Fairfax County, Virginia has a similar population and area, but only 2 percent of its population has limited access to fast food and 5 percent living with food insecurity (County Health Rankings, 2021).

This demonstrates that similar counties in the US have better access to food than residents of Prince George's County. The demographics of both counties' populations are striking. Fairfax is 65 percent White and 11 percent Black; Prince George's County is 64 percent Black and 27 percent White (U.S. Census Bureau, 2019). Even areas that are similar in population size and area have different access to food sources based on demographics. It is an environmental injustice that areas with a larger proportion of minority residents have less access to healthy food sources.

Within Maryland, other counties have better food access than Prince George's County. For example, Montgomery County, which has a slightly larger population and area than Prince George's County, should have similar access. However, only 2 percent of its residents live with limited access to healthy foods and 8 percent live with food insecurity (County Health Rankings, 2021). This makes correlates with the percentage of minority communities. Montgomery County's population is 60 percent White and 20 percent Black while Prince George's County is about 64 percent Black and 27 percent White (U.S. Census Bureau, 2019). Though the statistics for Montgomery County aren't perfect and the county has its own food equity issues, by

comparison food equity in Prince George's County is worse than other counties and reflects a correlation between the minority population and food access.

As another example, Baltimore City has similar demographics to Prince George's County: 32 percent White and 63 percent Black (U.S. Census Bureau, 2019). But even with similar demographics, only 1 percent of Baltimore City residents have limited access to healthy foods (County Health Rankings, 2021). Even those counties with a similar population of minority residents are doing better than Prince George's County in terms of food equity.

Prince George's County overall has a food equity issue but specific localities within the county should be considered "priority areas" to make food access more equitable. The regions defined in this study have the most access to unhealthy foods and a lack of access healthy foods, exposing their residents to more health risks. The policy recommendations outline initial steps that to explore that can address these issues, especially in the priority areas.

Policy Recommendations

Several policies could be implemented to improve food equity in Prince George's County, including increasing the number of supermarkets, beginning a community-led public health campaign, imposing a tax on high-sugar foods and beverages, increasing the number of WIC vendors, encouraging urban agriculture, and supporting local small businesses.

Increasing Access to Supermarkets

Two drivers of food inequity in Prince George's County are a lack of access to healthy, affordable food sources, such as supermarkets and farmers markets, and excessive access to unhealthy, processed food sources, such as fast food and convenience stores. Across all levels of vulnerability, block groups with access to fast food was an average of 21 percent higher than block groups with access to supermarkets. This study defines accessibility wit as being within a 0.5-mile radius of a food source; however, it's important to note that most people in Prince George's County drive, rather than walk, to the supermarket, just as 88 percent of Americans do. However, SNAP and WIC recipients are more likely to walk or use public transportation than non-recipients (USDA, 201). In 2018, car ownership in Prince George's County averaged two

vehicles per household, implying that most, though not all, County residents can drive to the supermarket (Data USA, 2021).

While our data suggests that supermarkets are too widely dispersed for some communities to access via walking, the preference for driving to the supermarket likely means that relatively few households would be limited by walking distance. WIC and SNAP recipients most likely to be limited by walking distance or public transportation are located in the very high vulnerability block groups. Fortunately, those block groups tended to have the highest level of supermarket accessibility.

Prince George's County would benefit from expanding the number of supermarkets; three of the study's four priority areas, A, B, and C, lack sufficient supermarket access. To increase access, the county should prioritize attracting supermarkets to priority areas. This might include outreach to supermarket chains with information on community need and the potential profitability of proposed locations based on existing supermarket access and population and traffic data (Shelton, 2021).

Discourage Fast Food Consumption

The high proportion of accessibility to fast food across all levels of vulnerability is another driver of food inequity in the county. This study used proximity to different food sources to evaluate food equity, but the actions of individual consumers are more complex and are influenced by variables including convenience and advertising (UConn, 2021). Fast food sources are designed to be convenient and accessible; locations often have both dine-in seating and drive-thru windows, and multiple fast food establishments are often located in the same commercial centers.

Consumer behavior is an important consideration in evaluating the state of food equity. Food and beverage companies annually spend approximately \$14 billion on advertising in the US, and over 80 percent of that is spent on advertising fast food, sugary drinks, and candy (UConn, 2021). Fast food marketing also disproportionately targets children, teens, and communities of color; one study found that in 2017, the average child, across all demographics, viewed about 10 food-related ads a day, but that Black and Hispanic children were exposed to 16.4 and 17.1 food-related ads per day, respectively (Rapaport, 2019). These figures only

evaluate exposure to food advertising on TV and likely underestimate overall exposure to food marketing such as the internet and physical advertising, such as billboards.

Prince George's County could counteract some of the influence of fast food marketing by implementing community-led, public education campaigns to discourage fast and processed foods and encourage healthier choices. Howard County's "Unsweetened" campaign used public and television advertising, social media, and outreach to local physicians and pediatricians to reduce the consumption of sugary drinks. Between January 2013 and December 2015, the "Unsweetened" campaign reduced soda sales by 20 percent and fruit drink sales by 15 percent in Howard County (Schwartz, et al., 2017).

Imposing a Sugar Excise Tax

Prince George's County could impose an excise tax on sugary foods and beverages as a financial disincentive to reduce demand for fast food and soda and to generate revenue to fund food equity programs. The degree of taxation largely defines the public response. A small tax is likely to result in significant tax revenue, but with little influence on consumer choice. A larger tax is likely to more effectively reduce consumption of sugary foods and beverages, particularly among the most vulnerable populations, but is less likely to be politically palatable (Franck, et al., 2013).

Some studies claim that a sugar excise disproportionately impacts vulnerable communities and that it's tantamount to taxing low-income and minority residents who lack access to other options. While this may be true in some communities, our data shows that the county's very high vulnerable communities had the highest access to all food retailers. A sugar excise tax in Prince George's County might reduce the consumption of unhealthy food choices without limiting overall access to food sources.

Expanding Urban Agriculture

Continuing to expand and support urban agriculture would further improve access to nutritious, locally grown produce sold at local farmers markets. Approximately 73 percent of county land is designated for urban farming, however no data is available on how much of that

land is currently being farmed (Healthy, 2018). Collecting data on the extent and location of urban farming in Prince George's County may be helpful in evaluating further policies to encourage urban agriculture.

The county could also institute school and community gardens and engage in public education initiatives to facilitate urban farming in public spaces.

Finally, the County could expand existing urban agriculture programs, such as SNAP to Health, which allowed vendors at farmers markets to accept SNAP benefits; the Urban agriculture tax credit ordinance, which gives tax credits to urban farmers; and the Bloomin' PGC initiative, a Food Equity Council a network for urban farmers that offers training and support (Healthy, 2018).

Increasing Access to WIC Vendors

While access to SNAP vendors, particularly in the most vulnerable block groups, is generally high, WIC vendors in Prince George's County are notably less accessible. Very High vulnerability residents, who had the highest level of access to WIC vendors, still had less than 50 percent access to a WIC vendor. Averaged across all levels of vulnerability, only 66.4 percent of block groups have access to WIC vendors. The least vulnerable and moderately vulnerable groups averaged 77.8 percent WIC access and the vulnerable and most vulnerable block groups averaged 55 percent access to WIC vendors.

That access to WIC vendors increases as vulnerability level increases implies that those who rely on WIC benefits have the greatest access, however, access to WIC vendors could be improved throughout vulnerability levels. Expanding the number of WIC vendors, particularly at the D.C. border and in Region B, would increase WIC access and increase food equity in Prince George's County.

To become a WIC vendor, one must first register as a SNAP vendor (WIC, 2021). To increase the number of WIC vendors, the county should begin by encouraging existing SNAP vendors (which are denser than WIC vendors) to become WIC vendors as well.

Supporting Local Food Businesses

The COVID-19 pandemic has had wide-reaching social and economic impacts on Prince George's County; over 1,400 Prince George's County residents have died due to COVID-19 and an unknown number of local businesses have been forced to close (New York Times, 2021). Across the US, an estimated 100,000 small businesses have shut down permanently, including many locally owned restaurants and other food sources (Lambert, 2020).

Larger corporations, especially fast food franchises, are more economically resilient than competing small businesses. Additionally, most fast food locations were allowed to continue operations during the pandemic and, with drive-in windows, were less constrained by dine-in limitations. As small, local restaurants continue to close, franchises increasingly seek to replace them, leading to more fast food franchises and fewer local restaurants (Russ, 2020).

Prince George's County can support local small businesses by instituting and expanding grant and loan programs, such as the Prince George's County COVID-19 Business Recovery Initiative (formerly Relief Fund) for struggling small businesses to help them compete with corporate entities (Prince, 2021). Offering free or subsidized advertising for locally owned businesses may also help to both support local restaurants and encourage healthier eating habits.

Future Research

Future capstone groups can expand on this work and more effectively evaluate the state of food equity in Prince George's County. Due to time constraints, our study was limited to the number of variables we could explore in a single semester. While this study offers insight into a few variables that influence food equity, there is considerable room to explore new variables and build on our deliverables.

One goal of a new team should be updating this study's data sets to be as current as possible; keeping data sets up-to-date is essential to ensuring accuracy and assessing change over time.

A future team might also consider incorporating community outreach into their projects. Conducting interviews with county residents, supermarket managers, and food equity experts may give insight into the reality of food equity in Prince George's County and gain first-person

perspectives on the challenges and needs of vulnerable communities, especially in the aftermath of the COVID-19 pandemic.

Food equity is defined as a community's secure access to purchase, grow, and consume healthful, affordable, and culturally significant foods (USDA, 2019). This study evaluated the "healthful" element by using different food sources as a proxy for health. However, it neglected the elements of "affordable" and "culturally significant."

A future team could evaluate the affordability of different food sources and subcategories within those food sources. In the current model, a more expensive supermarket, such as Whole Foods, is indistinguishable from a less expensive supermarket, such as Lidl. This equivalency fails to reflect the reality of affordability for varying levels of vulnerability. Assessing how establishments vary in price would offer a more in-depth analysis of access to affordable foods.

Additionally, future teams could evaluate the "culturally significant" element of food equity by analyzing communities' access to foods significant to their culture. This is a challenging variable to assess because what is "culturally significant" varies. It would require a demographic analysis of each cultural group in Prince George's County and defining their culturally significant foods. While this is a difficult variable to explore, it is central to the definition of food equity.

Transportation is an additional variable that our group didn't analyze. Our study used the USDA's range of high walkability access, a 0.5-mile radius, to evaluate accessibility. This is an oversimplification of how people get around, most people in Prince George's County own vehicles and those who don't may use public transportation. Evaluating the county's public transportation system and its role in providing access to food sources is important to better understanding the reality of food access in Prince George's County.

The COVID-19 pandemic has likely significantly changed the county's food equity landscape. Local business and restaurant closures and customer behavior changes in the wake of the pandemic mean that some of this study's conclusions may not apply in a post-pandemic environment. As data for 2020-2021 becomes available, a future team should explore how the pandemic has impacted food equity in Prince George's County.

This study determined four priority areas in the County that are particularly food inequitable. The macro level analysis only measured some variables in evaluating food equity.

Future teams could do a more in-depth study of the subregions to assess their state of food equity and gain a better understanding of the needs of specific communities.

Future teams could expand the scope and evaluate the state of food equity in the county compared to other counties, states, or even countries. Data comparisons between Prince George's County and other regions may lend insight into the factors and policies that have the greatest effect on food equity.

It would also be worthwhile to examine the relationship between access to fast food and other unhealthy food options and the prevalence of diseases. While our data explored the access to food sources, we lacked the necessary public health data to overlay with other metrics. The relationship between fast food access and disease prevalence may show whether the obstacle to nutritional health in the County is high access to fast food or low access to supermarkets and farmers markets.

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